HARTFORD STEAM BOILER

HARTFORD

CONN.

INSPECTION AND INSURANCE CO.

The Locomotive.

PUBLISHED BY THE

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.
HARTFORD. CONN.

NEW SERIES.

Vol. VII.

HARTFORD, CONN.

1886.

INDEX TO VOL. VII. NEW SERIES.

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

New Series—Vol. VII. HARTFORD, CONN., JANUARY, 1886. No. 1.

Examples of Scale Formation in Boilers.

Our illustrations with this number show two samples of scale such as is frequently found in boilers in this locality, and is a source of great trouble and expense to the boiler owner. The two samples shown are among the worst forms of scale met with, and unless care is constantly exercised in the management of the boilers in which it may be formed, constant repairs will be necessary.

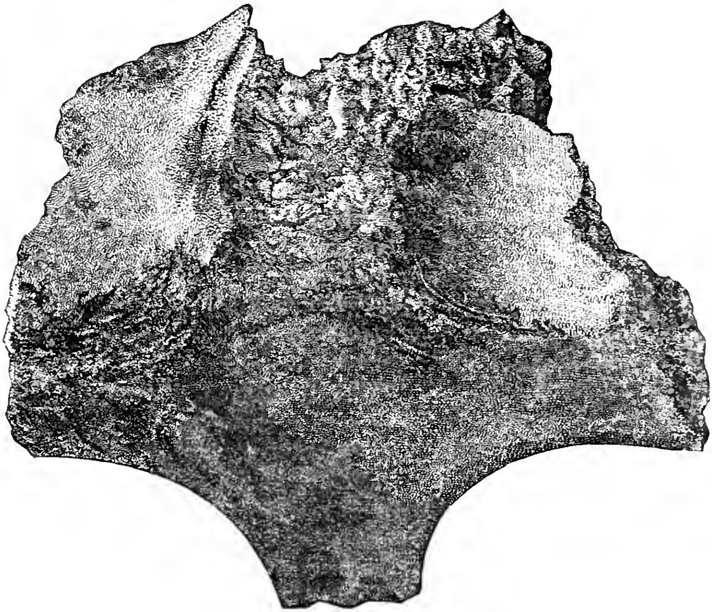

Fig. 1.

The engravings were made from photographs of the pieces now in our office. Fig. 1 is a portion of a compact mass of hard scale which formed between the tubes in contact with the back tube head of the boiler. It covered the back head to a depth of six inches. This mass closely adhered to the tubes and the tube sheet, and prevented contact of the water therewith. This caused burning of the head and tubes, and was allowed to go so far before measures were taken to prevent it, that entirely new tube sheets and tubes were necessary.

Fig. 2 shows a piece of scale taken from the water leg of a very popular form of upright boiler. The water space was entirely filled up with this hard scale, and it was found impossible to make the required quantity of steam. The furnace plates were found by our inspector, who was called in, to be so badly burned that a new fire-box was necessary. After the boiler had been cleaned, and the necessary repairs completed, the capacity of the boiler proved to be ample for the needs of the establishment.

Very many cases of leakage around tube ends, and most cases of burning and cracking of tube sheets, result from some such collection of scale as that above described, and it is a defect that cannot be too carefully guarded against. Boilers having the tubes arranged in the old-fashioned way, that is "staggered" and crowded too closely together, as was nearly always the case, are peculiarly apt to become fouled up in this manner if the water is at all bad, and when they are so fouled, it is almost impossible to clean them. Owing to the difficulty with which circulation goes on, scale is very rapidly

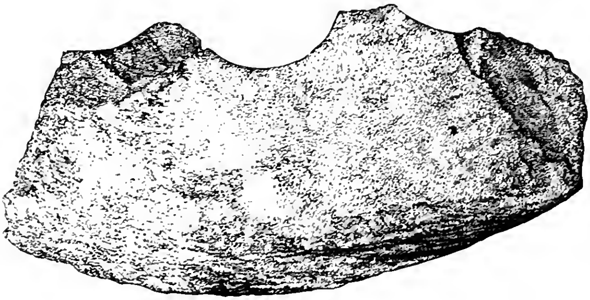

FIG. 2.

formed, and it is almost impossible to dislodge it by mechanical methods. Solvents are the only resource, and they must be perfectly adapted to the needs of the case, and persistently and judiciously used. Frequent blowing out and cleaning of the boiler is imperatively necessary, its frequency depending somewhat on the circumstances in each particular case.

The opinion is held by some, that the location of the feed-pipe in a boiler is sufficient to determine the place where scale will be formed. The idea is that it will invariably be found at the opposite end of the boiler from that through which the feed-pipe enters. This is an error. The point where the greatest formation of scale occurs is determined by the currents arising from the circulation, and with two boilers constructed precisely alike, fed by the same arrangement, and running side by side, one may have the heaviest deposit at the back end, while the other may have it at the front end. A difference in firing the two may be sufficient to bring this about. With easy firing the bulk of the deposit will be found at the back end of the boiler. If the boilers are habitually forced, the deposit will be oftener found at the front end, for a different distribution of the circulation currents may then be established.

A VALUABLE discovery has been made, whereby the faded ink on old parchments may be so restored as to render the writing perfectly legible. The process consists in moistening the paper with water, and then passing over the lines in writing, a brush, which has been wet in a solution of sulphide of ammonia. The writing will immediately appear quite dark in color, and this color, in the case of parchment, it will preserve. Records which were treated in this way in the Germanic Museum in Nuremburg, ten years ago, are still in the same condition as immediately after the application of the process. On paper, however, the color gradually fades again; but it may be restored at pleasure by the application of the sulphide. The explanation of the action of this substance is very simple; the iron which enters into the composition of the ink is transformed by the reaction into the black sulphide.—*Paper World.*

Inspectors' Reports.

NOVEMBER, 1885.

Our usual monthly report of the work of the inspection department is given below, and will be found as interesting and suggestive as usual. The number of inspection-trips made foots up 2,935, the number of boilers examined 5,433, the number thoroughly inspected, both externally and internally, 2,237; while 411 were tested by hydrostatic pressure.

3,898 defects were reported, of which 582 were considered dangerous, and led to the condemnation of 46 boilers.

Below is given our usual tabular statement of defects.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	426	26
Cases of incrustation and scale,	569	23
Cases of internal grooving,	31	6
Cases of internal corrosion,	136	31
Cases of external corrosion,	291	25
Broken and loose braces and stays,	61	23
Settings defective,	130	26
Furnaces out of shape,	194	14
Fractured plates,	94	39
Burned plates,	104	26
Blistered plates,	202	19
Cases of defective riveting,	429	40
Defective heads,	39	12
Serious leakage around tube ends,	527	125
Serious leakage at seams,	213	50
Defective water-gauges,	96	29
Defective blow-offs,	47	10
Cases of deficiency of water,	14	6
Safety-valves overloaded,	25	11
Safety-valves defective in construction,	38	12
Pressure-gauges defective,	225	27
Boilers without pressure-gauges,	7	2
Total,	3,898	582

Fractured Plates give about as much trouble as any form of defect met with, as it is from its nature always a serious trouble, and in the majority of cases a dangerous one. Many cases occur where plates are merely cracked from the edge into a rivet hole, and no serious consequences ensue for a long time, but even this apparently trifling defect should always be closely watched, for it always indicates that there is something wrong about the seam where it occurs, which may lead to far more serious consequences. It is very generally an indication that the plate has been seriously injured in the process of manufacture. It may be due to the use of a dull or badly constructed punch, or, as may more frequently be the case, the murderous use of the ubiquitous drift-pin. Either one of these causes which has operated sufficiently to induce the defect is enough to cause the gravest apprehension for the safety of the boiler, for any of the seams may be under such a severe strain as to give way suddenly when the boiler is in use, and such an event would be more likely to be attended with a serious disaster. Such fractures, especially when they appear in new boilers, we consider serious enough to demand a most rigid inspection, in order that its exact cause may be discovered if possible, and a suitable course prescribed to avoid further trouble.

Another and more serious fracture appears along a seam parallel with it and close to the lap. If the management of a boiler is good, a fracture of this sort is generally an indication that a very serious strain has been brought upon the plate during its construction, such a strain as to render the boiler dangerous to use without a thorough overhauling and inspection. When such a fracture occurs, and the two edges of the plate along the fracture separate laterally to a considerable extent, it is a sure indication that the two courses of the shell near which it occurs were of quite different sizes, and were forcibly brought together by brute force, and held there by the rivets. Such construction is entirely inexcusable; it is simply criminal.

Fractures may occur in any part of the plate, not adjacent to a seam, from a great variety of causes. Local contraction or expansion due to different temperatures in different portions of the plate, is perhaps as often the cause as anything, and any recurrence of the difficulty may generally be prevented by a change in practice or the location of the point of delivery of the feed-water. Bad iron is also responsible for many fractures of this sort, and in this case, the treatment of the trouble is a matter of some difficulty. Probably the most *satisfactory* treatment in such a case, especially to the owner of the boiler, would be the vigorous application of a club to the party or parties responsible for the use of such materials; but this is not always practicable.

Of course, where the material or practice is bad, the first-mentioned defects are much more liable to occur, than if they are all right in every respect.

Only recently a peculiarly aggravating case occurred which was caused chiefly by the poor quality of the iron used. Six boilers were built and put in operation in a comparatively out of-the-way place, and three of them fractured on the bottom within a short time after starting up. The fractures all took place in the solid iron, not in the seams, and the only cause that could be assigned, was the very poor quality of the iron. As first class material was contracted for, and paid for, the owners of the boilers, as may easily be imagined, were in no very amiable state of mind over the occurrence. The other three are confidently expected to "go off" in the same way before long.

Boiler Explosions.

NOVEMBER, 1885.

GREENHOUSE (124). — The boiler of a greenhouse at West Lynn, Mass., exploded October 30th. The house was completely wrecked, and $400 or $500 damage was done.

TUG BOAT (125).—The boiler of the tug *Frank Moffat* exploded at Marine City, Michigan, November 1st. John Ward, first engineer, William Miller, second engineer, James Wylie, and Walter Fisher, firemen, were at their posts and all were killed. Captain Thomas Currey had a leg broken and was otherwise bruised; Frank Furtah, wheelsman, was scalded, and Andrew Reid, a deck hand, was also badly scalded. Maud Bennett, the cook, who was in the after cabin at the time of the explosion, was blown into the river, from which she was rescued uninjured. Robert Goodwin, the mate, who was ashore hauling the line, was blown over a wood-pile and had his side injured. The bodies sank in the river and have not been recovered. The scalded men are at Sombra, under the care of a physician from Port Huron. The tug *Frank Moffat* was built at Port Huron, in 1869, and was valued at $7,000, with $5,000 insurance. The insurance was equally divided in fire and marine companies.

STEAM DREDGE (126). — A terrible calamity, by which six lives were lost, occurred in the Race on Sunday night, November 1st, caused by the explosion of the boiler of the steam dredge No. 4, of the Atlantic Dredging Company of Brooklyn. The dredge has been employed on Providence river for four years, and in company with a water tank left Providence for New York at 9.15 Sunday morning, in tow of the tug *C. C. Waite*, Captain Tweedy. In order to keep the bilge clear, the steam pumps on the dredge were kept at work. Just before midnight, when nearing Race Rock Light, Captain Tweedy, who was at the stern of the tug, noticed a moving light on the dredge and heard a voice, but could not distinguish the words. A minute later he heard an explosion on the dredge, and saw fire and smoke and steam. The dredge sunk immediately, and the stern of the tug was drawn under water before the hawsers could be cleared. The *Waite* was immediately put about, but no trace of the dredge, her crew, or the water-tank could be found. After searching in the vicinity for half an hour, the tug headed for New London harbor, arriving in the teeth of the easterly gale that prevailed. As soon as the storm subsided, the *Waite* again went out to the Race in the hope of finding even the dead bodies of the unfortunate men who went down with the dredge, but nothing could be found, not even a floating piece of the dredge. The names of the men on the ill-fated craft are Captain, Robert H. Kent; mate, Andrew Straub; engineer, Thomas Fitzpatrick; crew, Frank Finnegan, Herman Straub, and one unknown. Captain Kent leaves a widow and eight children in Providence.

Sugar House (127).—A fatal boiler explosion occurred at the Texas plantation, Iberville parish, Louisiana, November 3d, by which one of the most prominent physicians and planters of the parish lost his life, and the colored engineer was badly scalded. Dr. A. R. Gourrier, the owner of the plantation, had recently erected a small boiler and pump on the river bank for the purpose of supplying water to his sugar-house. The boiler scarcely had capacity to run the pump at the speed desired, and it was necessary to carry all the steam possible. Last evening Dr. Gourrier went to the pump to see how it was working. While there a messenger arrived with the mail. Dr. Gourrier threw the boiler door open while he opened a letter. Almost immediately the boiler exploded with a terrific noise that was heard for several miles. Portions of the boiler struck Dr. Gourrier and killed him instantly. His chest was smashed in, and his back crushed to a jelly; both legs were broken below the knees, and the right arm broken. The colored engineer, Dabney, is so badly scalded that no hopes are entertained of his recovery.

Patent Medicine Factory (128).—A terrific explosion occurred November 5th, in the laboratory of William Aiken & Co., Evansville, Ohio, which wrecked the building badly, and scalded several persons, three of them fatally. Workmen were putting in a new engine and had some steam in the boiler. The engineer says that a few minutes before the explosion he had fifty pounds of steam with water at the third. Suddenly the boiler let go from her fastenings and shot through the roof, sending a shower of scalding water over those in the vicinity, and wrecking the room and the entire side wall. R. L. Aiken, John Leidenthal, John Jack, H. B. Aiken, John McCool, Jack Kanser, and Ben Zaff were injured. The first three are fatally scalded. The wounded men were removed to their homes. The boiler was about eight years old, and was tested recently and deemed trustworthy. Loss $8,000.

Saw-Mill (129).—An explosion at Porterville, near Eau Claire, Wis., November 6th, in one of the saw-mills of the Northwestern Lumber Company, tore away the roof, and demolished one side and end of the mill. No one was injured. The mill will not be started up again this season.

Sugar House (130).—A boiler explosion at Mead's sugar house, Louisiana, November 6th, killed Edward Eden, engineer; W. Booker, John Jones, Henry Nash, Joseph Richards, Paul Richards, James Rees, William Wilson, and Henry Marcelin, colored. The last two are boys of twelve and thirteen. The wounded are August Rantz, Oscar Rantz, E. Rantz, John Tricke, dangerously scalded; John DeLord, John McGuire, slightly. The boiler was bought second-hand twenty years ago, had no water at the time, and cold water being let in it exploded, flying through the roof of the sugar-house, a distance of 250 yards, into the canal. The engineer was thrown 200 yards, landing on a wood pile ten feet high. He was the only one killed instantly. The others lived several hours.

FLOUR-MILL (131).—A boiler exploded November 7th, at three o'clock, in the Brownstown mill. Owing to the momentary absence of the engineer, no person was injured. The explosion was caused by the neglect of the engineer to properly clear out the mud-drum tube.

CHEMICAL WORKS (132).—Patrick Burke of No. 7 Chelsea place, East Boston, Mass., was admitted to the hospital at an early hour November 11th, with serious burns about his head and arms, caused by the bursting off of the lid of a tank of hot liquor and logwood in the Atlantic Logwood Company's works, where Burke was employed.

FLOUR-MILL (133).—A boiler in the flour mill of F. J. Brownell at Hopkinsville, Christier county, Ky., exploded November 13th, with disastrous results. John B. Brining, head miller, Nelson Metcalf (colored), foreman, and George Werlang, aged 14, son of the chief engineer, were killed. The chief engineer had a narrow escape, one of the boilers weighing 3,000 pounds, passing within six inches of his head, and through a brick wall. The loss is about $2,000.

LOCOMOTIVE (134).—A serious wreck occurred on the Wheeling division of the Baltimore & Ohio railroad, about fourteen miles from Pittsburg, Pa., November 17th. One heavy freight telescoped another train standing at the water tank at White Hall station. The engine rolled down an embankment. The boiler exploded, blowing the engine cab and several cars into splinters, involving a loss of several thousands of dollars. The engineer and fireman escaped by jumping.

STEAM THRESHER (135).—A steam thresher blew up at Groveland, McPherson Co., Kansas, November 19th, killing the engineer.

—— MILL (136).—A frightful boiler explosion took place at Richland City, Spencer county, Indiana, November 20th, in which two persons were instantly killed, and several others injured. The boiler was being tested when it exploded. A large section struck Mrs. McLaughlin, wife of the proprietor of the mill, killing her instantly. Passing out of this building it crossed the street and went through a blacksmith shop owned by Mr. Fisher. He was struck and killed. The mass of iron then passed through the rear end of the building and through a barn, and then striking a large tree broke it off some distance above the ground. J. T. McKinney, the storekeeper; Louis Bennett, Sebin Jones, Henry Jones, and William Hildebrand were all badly scalded. The first three are thought to be fatally injured. The damage to the building is estimated at from $5,000 to $6,000. The mill was the property of Samuel F. McLaughlin.

COAL MINE (137).—A special to Jackson, Ohio. The boilers of the Tropic Furnace coal shaft exploded November 28th, killing Andrew Dobbins, day engineer, and Lincoln Ingles, night engineer. A son of Dobbins, who was standing near the shaft, was blown fifty feet by the force of the explosion, but was not dangerously injured.

SLAUGHTER-HOUSE (138).—A boiler exploded in the slaughter-house of John Goedert, McGregor, Iowa, November 28th, and fatally injured two men. Edward Chamberlain died the next forenoon, and Hiram Barker, a young man, is not expected to live.

RELIABLE paste for labels for glass, wood, and metals: Starch, two drachms; white sugar, one ounce; gum arabic, two drachms; water, a sufficient quantity. Dissolve the gum, add the sugar, and boil until the starch is cooked.—*Paper World.*

The Locomotive.

HARTFORD, JANUARY, 1886.

J. M. ALLEN, *Editor*. H. F. SMITH, *Associate Editor*.

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Bound volumes one dollar each.

THE use of steel plates for all kinds of boiler work has now become so general, and its superiority to iron for such use is so well demonstrated, that it seems superfluous to say anything about it here; nevertheless, a few words on the subject may not be amiss.

The word steel is associated in many minds with the capacity to harden and take a temper, which is possessed by tool steel and the higher grades of machinery steel. Within a comparatively short time all metal known as steel possessed this property, and it was customary to describe the difference between wrought iron and steel by referring to their behaviour when heated and suddenly cooled in water. At the present time, however, this distinction hardly holds good, in fact it is difficult to draw any precise line dividing wrought iron and steel. The best steel for boiler purposes is characterized by the complete absence of the capacity to harden by being heated and cooled in water. The difference consists chiefly in the selection of the materials and the method of manufacture, by which all the desirable qualities of the very best wrought-iron plates are retained, the undesirable qualities are eliminated, and the product is endowed with those characteristics of steel which most recommend it for this purpose.

Cast steel is made from the purest bar iron by the process of cementation, so called. When we consider the cost of puddling, rolling, cementing, resmelting, casting, and rolling, it is evident that were such steel perfectly adapted for use in boilers, its great price would preclude its use for this purpose in competition with wrought iron.

The steel used for boiler-plates, however, is made from pig-iron by a direct process; in fact, the very best wrought iron could be so made, but for the fact that superior pig-iron has to be used for the purpose, it being selected with reference to the amount of sulphur and phosphorus it contains. At the present time, however, great advances are being made in the metalling of iron, and it is probable that before long, it will be possible to make any required quality of wrought iron or steel from almost any kind of pig-iron, and at a much less cost than ordinary puddled bar-iron.

The advantages possessed by steel over iron, and which are due to the difference in the process of manufacture, are its almost entire freedom from local defects which result in blisters and fractures, its perfect homogenity, its greater strength and ductility. This latter is a most important quality. Its elastic limit, the true measure under the conditions of use of ultimate strength, is much greater than that of iron. It is probable that all of these qualities are due in great measure to the greater homogeneity of the steel plates as compared with iron.

When steel plates began to be extensively used in boiler-work, many failures occurred. These failures, however, generally took place during the process of construction, and were due to the fact that the workmen failed to consider the difference between the behavior of steel and iron plates. Then, too, it was thought if a plate bore the name of steel its ultimate tensile strength, obtained in the usual manner, ought to be very much greater than the best iron. Quite a marked change in sentiment on this point has gradually, but very generally come about in the past few years. Elasticity and ductility are beginning to be appreciated at their true value. One thing cannot be too strongly insisted upon. The actual ultimate strength of any given material is what is commonly known as the elastic limit, which is measured by the greatest load the material will bear repeatedly without permanent set. In this respect steel has a great advantage over iron.

In working steel plates care should be exercised that nothing is done to induce local strains which may injuriously affect the metal. In flanging, the work should be done with as few heats as possible, and the metal must not be overheated. The different heats should be as uniform as possible. It would be well, and the practice is followed by many boiler-makers, to thorougly anneal all flanged work after the flanges are turned. No bad consequences would ensue if all plates were also annealed after punching. But even where this is not done, there are fewer steel heads lost in flanging than when iron is used.

MR. WM. J. BALDWIN, the well-known consulting engineer of New York, writes us that he has followed the practice of slotting mouthpieces and all plates having their edges exposed to fire for the past twelve years. This being the case, Mr. Baldwin is entitled to credit for priority of invention of this useful kind. Our practice of it extends back about six years, but it was worked out independently, without knowledge of what Mr. Baldwin had done.

WE have prepared a title page and complete index of the contents of the LOCOMOTIVE for 1885, which will be furnished gratis upon application to those who have preserved the monthly issues, and wish to bind them for future reference.

Proportions for Joints with Steel Plates and Iron Rivets.

The increasing and now very general use of steel plates for boiler shells, held together by iron rivets, makes it advisable to say a few words upon the relation between the tensile strength of such plates, and the resistance to shearing of the rivets.

With iron plates of from 45,000 to 50,000 lbs. tensile strength per square inch, and the best iron rivets, the tensile strength of the plates, and the shearing strength of the rivet metal is practically the same, so that the strongest joint is obtained when the net section of plate which remains after punching the rivet-holes, is equal to the area of the rivets exposed to shearing stress. This has been fully treated of in former numbers of the LOCOMOTIVE. With steel plates and iron rivets, the conditions are somewhat modified, though to but a slight extent.

The most usual tensile strength for steel plates for boiler shells, in this section of the country, is about 60,000 lbs. per square inch of section. In the present state of the art of steel-making, it is found to be difficult to make plates of higher tensile strength without sacrificing too much of the very essential element, — ductility. In fact, some steel-makers whose products are noted for their fine qualities, recommend plates of a still lower tensile strength for use in boilers, believing that the much greater ductility and toughness which can be obtained in such plates much more than compensates for the apparent loss due to the lower tensile strength. Be this as it may, however, 60,000 T. S. seems to have been generally settled upon as a standard of strength for boiler steel.

The shearing strength of rivet iron varies from 40,000 to 48,000 lbs. per square inch of section. Some late experiments by a leading firm of rivet manufacturers gave the latter figures as the results of tests made on their best brands, and has been adopted by some municipal boiler inspectors as the basis of their calculations on the strength of boilers under their jurisdiction. This would give for the strongest joint, a proportion of rivet area to plate area as 5 to 4; that is, when the resistance of rivets to shearing is equal to the resistance of the plates to tearing, the area of rivet shanks must be one-fourth greater than the plate area.

In the LOCOMOTIVE for July, 1882, was given a table of proportions of riveted joints for iron plates, from $\frac{1}{4}$ inch to $\frac{1}{2}$ inch in thickness, with iron rivets, which we have seen as yet no reason to modify. The table applies equally well to steel plates when steel rivets are used, for the shearing strength of steel rivets is equal to the tensile strength of steel plates.

In the table referred to the strength of the plate and rivets are kept as nearly as possible equal, due regard being paid to practical sizes of rivets and pitches. The sizes of rivets recommended varies by even sixteenths, and the pitches vary by even sixteenths and eighths. Under these circumstances, the excess of rivet strength over that of the plates varies from 3 to 8 per cent. in the single riveted joints, and from 6 to 22 per cent. in the double riveted joints, the larger percentage obtaining in the case of the thinner plates.

If it is desired to take into account the difference between the tensile strength of steel plates and the shearing strength of iron rivets, where iron rivets are to be used in steel plates, we would still advise the use of the pitches recommended in the table referred to, but to keep the strength of rivets equal to that of the steel plates, the diameter of the rivets may be increased. The original table is as follows:

TABLE OF PROPORTIONS FOR RIVETED JOINTS.

Thickness of Plate, ...	$\frac{1}{4}''$	$\frac{5}{16}''$	$\frac{3}{8}''$	$\frac{7}{16}''$	$\frac{1}{2}''$
Diameter of Rivet, ...	$\frac{5}{8}''$	$\frac{11}{16}''$	$\frac{3}{4}''$	$\frac{13}{16}''$	$\frac{7}{8}''$
Diameter of Rivet Hole, ...	$\frac{11}{16}''$	$\frac{3}{4}''$	$\frac{13}{16}''$	$\frac{7}{8}''$	$\frac{15}{16}''$
Pitch — Single Riveting, ...	2	$2\frac{1}{16}''$	$2\frac{1}{8}''$	$2\frac{3}{16}''$	$2\frac{1}{4}''$
Pitch — Double Riveting, ...	3	$3\frac{1}{8}''$	$3\frac{1}{4}''$	$3\frac{3}{8}''$	$3\frac{1}{2}''$
Efficiency — Single Riveting, .	.66	.64	.62	.60	.58
Efficiency — Double Riveting,	.77	.76	.75	.74	.73

For steel plates and iron rivets we would advise the use of the following

TABLE OF PROPORTIONS FOR RIVETED JOINTS IN STEEL PLATES WITH IRON RIVETS.

Thickness of Plate, ...	$\frac{1}{4}''$	$\frac{5}{16}''$	$\frac{3}{8}''$	$\frac{7}{16}''$	$\frac{1}{2}''$
Diameter of Rivet, ...	$\frac{11}{16}''$	$\frac{3}{4}''$	$\frac{13}{16}''$	$\frac{7}{8}''$	$\frac{15}{16}''$
Diameter of Rivet Hole, ...	$\frac{3}{4}''$	$\frac{13}{16}''$	$\frac{7}{8}''$	$\frac{15}{16}''$	1
Pitch — Single Riveting, ...	2	$2\frac{1}{16}''$	$2\frac{1}{8}''$	$2\frac{3}{16}''$	$2\frac{1}{4}''$
Pitch — Double Riveting, ...	3	$3\frac{1}{8}''$	$3\frac{1}{4}''$	$3\frac{3}{8}''$	$3\frac{1}{2}''$

From the above we see that the only change from the former table consists in making the rivets just $\frac{1}{16}$ of an inch larger for each thickness of plate. This, on the assumption that the best rivets resist a shearing stress of 48,000 lbs. per square inch of section, will give about equal strength to plate and rivet.

It may be questioned if it is, as a matter of fact, worth while to increase the diameter of the rivets in the case. If the matter is examined carefully, it will be seen that as far as wear and tear are concerned, the rivets have a great advantage over the plates themselves. They are not exposed (at least that portion of them which is under shearing stress) to corrosive action, and they are not exposed to the evil effects of contraction and expansion from varying temperatures of furnace and feed-water, all of which exert a most deleterious action on the plates themselves. We do not recall at the moment of writing any well-authenticated case where an explosion has occurred through shearing of the rivets in a seam. We do not believe there is an initial rupture of this kind on record. This being the case, it would seem admissible, and it certainly has been recommended by some very good authorities, to leave the rivets in new work, the weakest part of the joint, in order to give the plate all the advantage possible, in the matter of strength, that it might the longer resist ordinary wear and tear.

Scientific Method in Mechanical Engineering.

BY COLEMAN SELLERS, Professor of Mechanics, FRANKLIN INSTITUTE.

[Extract from an Introductory Lecture to the Course on Mechanics, delivered before the FRANKLIN INSTITUTE, November 6, 1885.]

I propose, this evening, saying a few words to you on the part that systematic, scientific method should play in the most ordinary mechanical occupations, and to point out the need of orderly method in the advancement of all the arts. I had occasion, the other day, to watch the operation of a mechanical shoemaker, at work in the Novelties Exhibition. Boots and shoes were being sewed on this machine, the stitches made with brass wire; brass staples were selected, automatically, of the proper length, and were inserted in place. My attention had been critically drawn to this machine in acting as judge in the class to which it belonged; not very far away were books, which, in binding, were sewed with wire staples, and between the two were many devices to enable hand-sewing with wire staples to be done with ease. My mind naturally grouped these objects and processes, and even flew back over many, many years to days of childhood, when I had learned one of my first lessons in mechanics from my father, who held me in his arms, so small was I, as he showed me the then great wonder of fine steel wire bent in a machine into staples and driven through thick leather in rapid succession, to form the fine teeth of the cards used in carding wool and cotton fibre. I was not at, say, five years old, too young to remember the lesson when it was facts that were given me to think over. He took good care to point out that the fine wire forming the staple could be driven through the leather with precision, and without any holes having been pierced for it by more rigid needles, or through holes no larger than the wire forming the staples. The card clothing machines at Cardington were driven by water-power, but this mechanical shoemaker at the Novelties was driven by a steam engine of the highest type. That steam engine had its lesson to teach; a life, too, could span much of the period of transition from the first crude machines that grew out of Oliver Evans' notion of a high-pressure engine to the work of Corliss and others of to-day. It had made but little advance, even as early as I can remember, as compared to the results of to-day, and its slow growth had been after the manner of the survival of the fittest. Its history is cumbered with a vast amount of negative information, by years of mistakes, the result of empirical methods as against the systematic mode of more modern research. As the steam engine grew towards its present state of perfection, in spite of the many drawbacks, the theory of thermo-dynamics took shape. The practical mechanic, who prides himself on the grand fact that he has drawn all his information, as it were, through the handle of the hammer he has worked with, has a holy horror of all that savors of science, and, what is more, he holds in contempt the scientific engineer. It was one of these practical men who presented a contrivance of his to a railroad company for trial; some of the directors thought it would be well to investigate, and the trial was made. The inventor afterwards said that the failure was due to the scientific experts who conducted the trial. He suspected they had put some thermo-dynamics or some other scientific stuff into the boiler, on purpose to prevent his device from operating. Now, thermo-dynamics is the name given to the science that takes into consideration the corelation betweeen heat and work. The designers of the great engines of to-day have the advantage of a pretty thorough knowledge of the laws that have been found to govern the conversion of heat into motion and of motion into heat. Could a knowledge of thermodynamics have preceded the steam engine, there is no telling how much farther we would have been now in our motive power department of the world's industries.

We are living in an age when the Baconian inductive system of research is relied on; the rapid progress of modern times is due to the results of the inductive system. In old times, the philosophers contrived theories to account for known facts. Lord Bacon was the one who clearly pointed out the need of obtaining many facts and finding the laws that govern matter through and by the study of the facts, but going beyond the range of the facts that we can obtain for the purpose of investigation.

The old philosopher stood on a hill and saw the land spread out before him as a mighty plain, and as he watched the movements of the heavenly bodies, he saw them rise in the East and sink below the horizon in the West. Upon this visible fact, he concluded with the more modern colored preacher in Virginia, that "the sun do move," because he saw it move, and so from this visible fact he proceeded to build up a theory of astronomy and hunted for other facts to sustain his theory.

A more modern inductive philosopher, under the same conditions perhaps, notices that objects floating on the surface of the sea sink out of sight at the horizon, and as these bodies are moving, hence infers that the surface of the world is round, and gathering many more facts, he then draws conclusions from his observation that enables him to look farther ahead and foretell, as it were, greater discoveries.

The wonderful progress of modern times is due wholly to the method that has been pursued of grouping facts in proper order, working out laws that govern matter, and proving that the laws are correct by finding no exception to them. An established law is what explains all phenomena bearing on it, and when no known fact offers any contradiction to it. Established laws are many, and the knowledge of these laws make the wisdom of the modern scientific mechanic. There are laws that can be so thoroughly trusted, that we no longer need investigate, and we follow them with confidence, knowing that we cannot change them, if we would do so. Gradually the knowledge of the world has become formulated, and we have in simple form ready for work the accumulated knowledge of all who have preceded us. We have before us, it is true, a vast field of experimental research, but we are in the position to guide our work systematically by the lights we now have. The day for empiricism in mechanics has gone by.

Steam boilers have been made to serve the purpose of death traps from the most culpable neglect of ordinary precautions for safety, coupled with gross ignorance of Nature's laws, until the authorities were obliged to step in and define, by laws, certain precautions that must be taken for the welfare of the community. Steam boilers are made of sheets of iron or steel bent into shape and joined by rivets. As the strength of the entire structure is limited to the strength of the weakest individual part of the structure, it is of moment that the true value of any particular kind of riveted seam be known by actual experiment. There is no way of making the riveted seam as strong as the body of the metal. It is now usual, to so proportion the number and size of the rivets to the thickness of the plates to be joined, that the metal remaining between the rivet holes, shall about equal the strength of the rivets that unite them. In determining the pressure of steam a boiler already made can be permitted to work under, a calculation is gone into as to the strength of the seam, as measured by the area in section of metal between the rivets, and also measured by the size and number of the rivets, and the strength of the seam is assumed to be the lowest result of the calculation. After this, it may be necessary to know the strength of metal that forms the boiler, and just here is where the lesson of the ball and the string comes into play, and our present illustration is as readily understood. It does not require a very high order of talent to master the calculations that are resorted to, to determine what strain will come on this or that part of the boiler, and we have to rely wholly on calculation for that information. The boiler must be made much stronger than its ultimate or breaking strength of the metal to insure its safety in use, and to allow for deterioration. The difference between the ultimate or breaking strength and the strain that it is to be subjected to in practice, is regulated by what is termed the factor of safety. All well-considered specifications for structural metal work, for instance, call for the material to come up to some established standard of ultimate or breaking strength, and the amount of metal to be used in the structure is determined by a factor of safety specified. This factor of safety may be as low as four in some cases of boiler and bridge construction when the known character of the material used warrants the course, or it may be as high as thirty, in the case of matter subjected to shock or blows, as in the case of rapidly-revolving gear wheels. That is to say, it may be considered safe to strain the structure to one-fourth of what would cause it to break, or the case may require that we dare not strain it beyond one-thirtieth of its breaking strength. The question now presents itself, how can every sheet of iron or steel to be used in the construction of a boiler, for instance, be tested when such sheets are usually ordered from the mill of the exact size that is required, and to test a part of such sheet would destroy it for use. This furnishes me with a suitable example of the scientific method carried out with ease and certainty in every-day practice.

Steam boilers of locomotives are worked at a rather high pressure, say 120 or 130 pounds to the square inch, and the metal now mostly used in their construction is steel of a low grade as regards hardness, that is, steel of considerable ductility. From the specification for boiler and fire-box steel issued by the General Superintendent of Motive Power of the Pennsylvania Railroad, December 1, 1882, I extract the following:

(1.) A careful examination will be made of every sheet, and none will be received that show mechanical defects.

(2.) A test strip from each sheet, taken lengthwise of the sheet, and without annealing, should have a tensile strength of 55,000 pounds per square inch, and elongation of thirty per cent. in section originally two inches long.

(3.) Sheets will not be accepted if the test shows a tensile strength less than 50,000 pounds, or greater than 65,000 pounds per square inch, nor if the elongation falls below twenty-five per cent.

(4.) Should any sheets develop defects in working they will be rejected.

(5.) Manufacturers must send one strip for each sheet (this strip must accompany the sheet in every case); both the sheet and strip being properly stamped with the marks designated by this company, and also lettered with white lead to facilitate matching.

Now let me explain this specification to you, as it has been explained to me in the admirable test-room of the shops at Altoona:

There are many makers of steel boiler plate in the United States, and without referring by name to any one, I can state that the Pennsylvania Railroad has decided on a set of arbitrary signs to indicate each maker. One is designated by a triangular stamp, one other by a circular stamp that marks a ring of about one inch in diameter, another by a square of like size, and so on. Sheets of steel come from the rolls with a more or less irregular outline and of a size that will permit the test strip to be cut off from one or the other edge without difficulty. The plate in the rough is, when cold, scribed to the required size of sheet that it is to be sheared to, and on the shear line two marks are made by the prescribed stamp, one mark being made at one blow of the hammer and the other by the same punch or stamp at another blow, and at any convenient distance from the other, but in no case are the two marks made by a twin set of punches or stamps at any fixed distance one from the other. This irregularity of the stamping renders the after-matching of the strip, or coupon as it is called, an easy matter, with the sheet from which it had been cut, the shear cut being made directly though the marks. The matching is still further facilitated by numbers or signs in white lead.

After reception by the proper inspectors on the road, the samples, or coupons, are stamped with corresponding numbers after verification, and the test piece goes into the shop to be dressed to the proper width for the test. and the sample is then broken in a testing machine, and, in a book kept for that purpose entry is made of every particular connected with the test, and the sheet received or rejected on this record. Suppose, however, that a sample shows a higher tensile strength than the maximum allowed, namely, 65,000 pounds per square inch, and that such specimen has an elongation or ductility as great as can be desired — it may be well asked why it should be rejected. In the book of record, I have seen some such cases, and reference is there made to the book of the chemist, into whose hands such sample is sure to go. His chemical test had in all cases, up to the time I saw the book, indicated too much carbon in the steel, and a simple physical test of heating and plunging the hot steel into cold water has shown it to be capable of being hardened. It is not deemed wise to employ any metal that has hardening qualities in the construction of steam boilers. After many such trials, the officers of the road have come to consider the tensile and ductility test as final, and as expressive of the qualities wanted. Thus, you see every sheet in every boiler has its physical quality when new recorded, and its marks enable its after history to be noted. No sheet of steel can meet with mishap afterwards, without having the report of the mishap recorded on the page that marked its acceptance, and its life or durability also noted. Such, in brief, is the account of the admirable scientific investigation into the quality of the material used in boilers, as reduced to practice, and so persistently pursued by this one company as to be now no longer a subject of comment. This method of test, however, is the outgrowth of systems that preceded it. Practice and theory must agree. The scientific engineer can lay claim to the title only when he is abundantly fortified by sound experience, and has learned to view all things evenly.

In the specification of the Pennsylvania Railroad, as already cited, stress is laid on the percentage of stretch before rupture takes place in the required test. The date of the printed specification I have referred to, is 1882. On January 8, 1881, I had a letter from the General Superintendent of Motive Power, in which he describes other tests which had been used for a long time. These were bending tests:

(1.) Bending cold.—A strip from each sheet must stand being bent over double, and being hammered down flat upon itself without fracture.

(2.) Bending after being heated and dipped.—A strip from each sheet must stand being bent over double, and being hammered down flat upon itself, after having been heated to a flanging heat and dipped into cold water, without sign of fracture.

He informed me that the bending tests had been insisted on for several years, but that the certainty of the ductility test had caused them to make it the final mode of determining the quality of the steel submitted to them. In order to make the bending as uniform as possible, they adopted the plan of holding the strip to be bent between rigid jaws and striking the projecting end with a ten-pound sledge until it is deflected about 135°, when it was removed from the jaws and held with tongs while it was hammered down flat on an anvil. The bending after heating and dipping was added to protect them against acceptance of hard sheets, by reason of the test strips being annealed, accidentally or otherwise, by the manufacturers. He said that for some time past they had been testing tensilly, to obtain ultimate strength and ductility, a piece from the strip sent with each sheet, and had established a tensile test, which supplanted the bending test, but covered the same ground that it did. This was done on account of the greater regularity and uniformity of the results in tensile test, and because by it they obtain figures to show the exact quality of the steel; so that even in 1881 they were working under the specification I have already mentioned, as furnished me in 1882. Time is an important element in tests, particularly so in bending tests. An expert giving testimony in a trial in which the reliability of the steam engine indicator was in question, said, "I believe in the result of the use of the indicator when I know who works the instrument." The bending test is good, when you see it done in a proper manner, or know who does the bending.

Hurry the bending of good metal and it may break. Proceed with the bending of poor metal with caution; let it rest a bit between each blow, and a skillful man can bend a strip of brittle steel so that the specimen will deceive the most expert. It is a very curious property of wrought iron and steel, that after being strained above the limit of elasticity and near to the point of fracture, rest will restore its strength. The story is told of some tests being made on beams for structural work before some officers of the Government. One maker strained a beam up to a point near the breaking point and then invited the Board to test some champagne, saying that he was willing to let the beam remain under its heavy load until after lunch. When the test was resumed, a strength was shown that could not have been reached had the rupture been hurried to completion and the metal been allowed no time to accommodate itself to the strained condition.

Let me now go back to the consideration of material used in boilers. During the latter part of Mayor Stokley's administration, say about 1880, he, at the instance of the City Inspector of Steam Engines and Stationary Boilers, and of the officers of an insurance company for inspection and insurance of steam boilers, appointed a commission to devise some fixed rules, whereby uniformity of rating could be insured as to the pressure at which boilers may be worked. I had the honor of serving on that commission, and am thus enabled to tell you that we found a set of rules in force which gave to all boilers of the same diameter and the same thickness of metal the same pressure per square inch, regardless of the quality of the metal employed in construction and of the nature of the riveted seams. Fortunately, however, our City Inspectors of Steam Boilers were practical boiler-makers, and were familiar with the requirements, and could refuse to pass boilers manifestly unfit for use; for men long familiar with work of this kind come to learn what is right by experience and good common-sense. The ordinances passed by Councils, at the suggestion of the commission, made it imperative that all the conditions that exist in each boiler as to nature of seams, thickness and quality of the metal used, should be considered, and the boilers rated accordingly, giving the greater latitude to good workmanship and good quality of material combined with judicious proportioning of the parts. At the time to which I allude, but a few years ago, the United States laws in regard to the testing of boilers used in the marine service called only for a knowledge of the tensile strength, and no notice was taken of the softness or ductility of the metal combined with great strength. I know a case in which a sheet had to be selected of higher tensile strength than could be obtained at the time, coupled with much ductility, to repair a boiler so that it would pass the Inspectors under United States laws. A lower ultimate tensile strength with high ductility would have made a safer job of the repair. We have come to the time now, when to hold our place in the world in competition with others, we should waste as little of our energies as possible in cutting and trying in any hap-hazard way, and endeavor to avail ourselves of the acquired knowledge of the world generally, and make scientific application of the knowledge in our daily work.

The Portland *Oregonian* says: "The story of the locomotive engineer stepping out on the cow-catcher of his engine and picking up the wandering child which is about to be run over has become so common that it has lost its startling effect. The engineers on the Baker City Branch of the Oregon Railway & Navigation Co. are training themselves for something novel and startling in this style of thing, and will soon be able to gather in a whole flock of sheep or kindergarten while running at full speed. The country through which this road runs abounds in jack-rabbits. These long-eared, long-legged animals take great delight in racing with the locomotives, especially at night, when they get on the track and sail away in the glare of the headlight. They will not jump the track, and they hold their own very well for a while, but the locomotive has the biggest lungs, and the rabbit's wind gives out first. As soon as he begins to weaken the fireman gets out on the pilot, and just as the panting fugitive is about to pass under the engine he is snatched from the jaws of death in the most approved style. After considerable practice at this a man can pick up a whole drove of rabbits hand-running. Firemen who have not the opportunity for this kind of exercise cannot expect to be so skillful in gathering in children as the boys on the Baker City Branch."

The leakage to the earth of the underground leads of the Edison electric lighting system, from the central lighting station in New York, is said to be about three ampères, the tension being 110 volts. It was found that numerous unprincipled persons had availed themselves of the opportunity to steal electricity, and use it for operating motors, and for induction coils. The method of filching the electricity was by boring through the iron pipe surrounding the insulating compound, and then further into one of the copper leads; a set screw fixed into the orifice formed one connection, and the earth the other. Of course this connection was made beyond the electric meter. It was hardly worth while to maintain the continuous espionage necessary to detect and punish these pilferers, but the superintendent of the station, Mr. Chamberlain, coupled in extra dynamos and threw as great an increase of current over the system as the safety catches would permit, at various times for about one second; while this current was passing the incandescence lamps would give an unwonted glow, and every induction coil and motor surreptitiously attached to the system would receive an extra current designed to burn it. In this manner the system is occasionally cleared of all trespassers.

The art of opening letters addressed to other people and refastening them so that no one will know is a profession in Spain. In the post-office they have a dark chamber, where experts inquire into things, and these have long since given up the use of steam for opening gummed communications. Even red-hot platinum wire for letters sealed with wax is out of date. The favorite means is with a knife sharper than a razor, which is run along the bottom of the envelope. The letter having been extracted and then replaced after the officials of the post-office have learned what is going on, a fine line of liquid cement is drawn along the opening, the slightest pressure conceivable is applied, and the letter is as whole as ever. The system only fails when too many letters are opened at a time, and put hurriedly into the wrong envelopes. — *Paper World.*

"Mugwump" is a very ancient noun of the Algonquin language, and it was first made known to English-speaking people by John Eliot, the apostle of the Indians, who set it forth in his translation of the New Testament into the Algonquin in the year 1661. It was first brought into modern use by the *Sun* in the spring of 1883, and naturally excited a high degree of attention. This finally led to its specific application to the political kickers of 1884. — *New York Sun.*

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

NEW SERIES—VOL. VII. HARTFORD, CONN., FEBRUARY, 1886. No. 2.

Explosion of the Boiler of a Tug-boat.

The following is an account of the explosion of the boiler of a tug-boat, by which two persons were killed. Portions of the boiler were thrown 250 feet; timbers eight inches square were wrenched into shreds. It was stated at the inquest that only 75 pounds of steam was on the boiler at the time of the explosion. Of this, however, there is no certainty. The following is the report of our special agent who visited the scene on the day of the explosion:

This tug had, to all appearances, a very strong boiler — so much so that the government inspector said if he had been called on to name the best boiler in his district, he would have selected this one. At the inquest the engineer was very sharply questioned as to his tampering with the locked safety-valve, and about a lead weight that

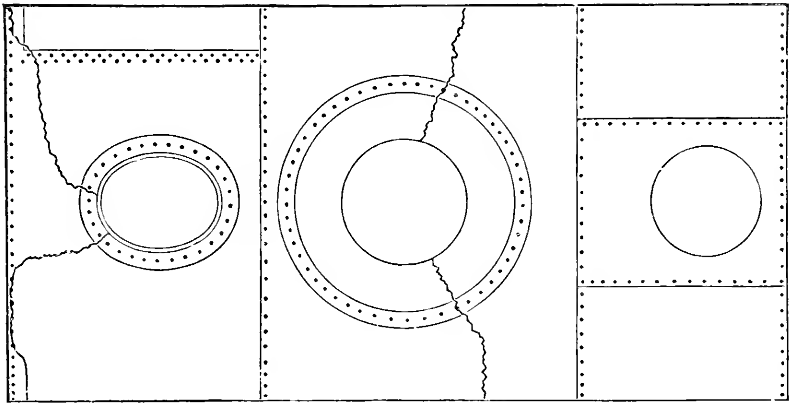

FIG. 1.

was found on the lever. It came out that the boat was much used in winter for breaking ice in the river, and the shock of butting against it would shift the weight toward the fulcrum in spite of such fastenings as had been used, so to keep up the load on the valve he had added another weight, claiming that it would "blow" at the prescribed pressure.

A short time before the accident the boiler had admirably sustained the usual hydrostatic test as the law directs. The question was then asked, whether the man-hole frame was cast or wrought iron? but the engineer could not say. Whether it was then cracked and leaking we do not know, but such a state of things would most naturally prompt such a question, inasmuch as the plate was a large one, while the frame was rather small in cross-section, and placed the long way parallel with the axis of the boiler.

Figure 1 is a view of the top of the boiler, showing the man-hole, steam dome, and smoke opening. From a careful examination the conclusion arrived at was, that the boiler, notwithstanding its assumed strength, was very weak from faulty construction. It contained within itself in the form of braces and stays the elements that caused its own destruction. The shell was cut away for the man-hole and dome 40 inches in 78, and re-inforced by a light cast-iron frame and by 8 stays or braces from the dome-cover to a yielding portion of the shell, that portion within the dome being in equilibrium of pressure. In addition to these supports six braces were connected to the shell and the back smoke-box.

Figure 2 is a longitudinal section of the boiler, showing the bracing of the dome to the unsupported portions of the shell. Other bracing is also shown, and the line of fracture on left side. These braces, which are $\frac{1}{2}\times4\frac{3}{4}$ inches in section, are nicely fitted, having round bolts fitting snugly into round holes in the arched double stirrups which stand upon an unyielding part of the crown of the smoke-box: the other ends of the braces being similarly fitted to the double-angle plates on the shell. Now glancing

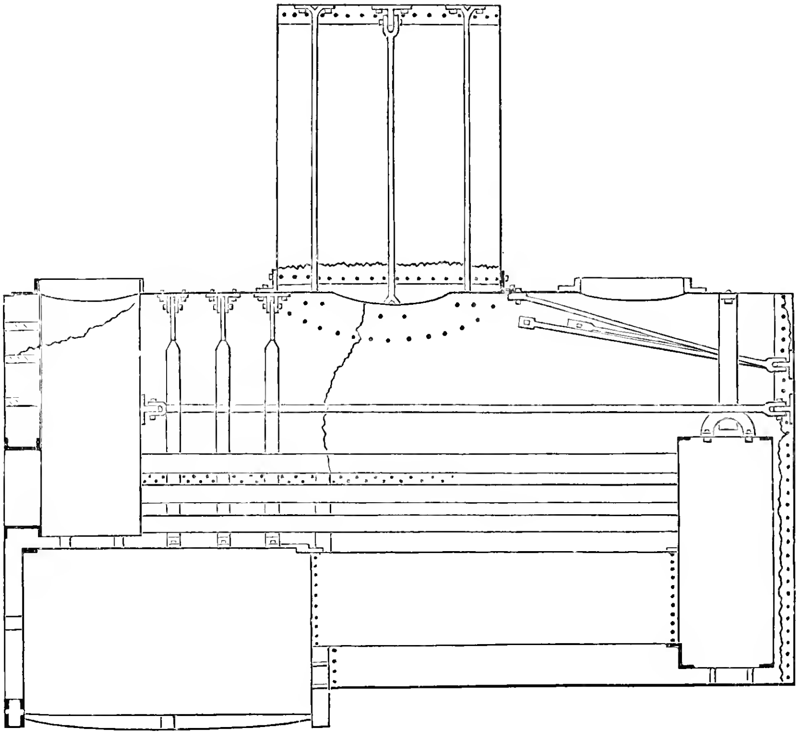

FIG. 2.

at Fig. 3, imagine this smoke-box to be an expanding body relatively to the shell; that is, imagine it to be a little hotter than the shell (and why may it not be considerably so, filled at times with intensely heated gases, and surrounded by water at 331°, which is the temperature at which it boils at 90 lb. pressure above the atmosphere, while the shell, unprotected as it was from the cold atmosphere, say at times as low as 60° outside and 331° inside?) and who can estimate the force that is added to the 90 lbs. internal pressure? But the shell was not entirely rigid and unyielding, the space above the back smoke-box must be flattened by the radial thrust of all the stays and braces around the smoke-box, which would bend the flange of the back head inward. The cracks that were caused by this action were plainly distinguishable from the first rupture, as was a crack or old fracture in the man-hole frame. Two years' action proved quite sufficient to bring it to destruction; a considerable length of weakened plate gave way like opening a door, and the contents of the boiler, water surcharged with steam, and steam expanded in so sudden a manner as to tear all before it.

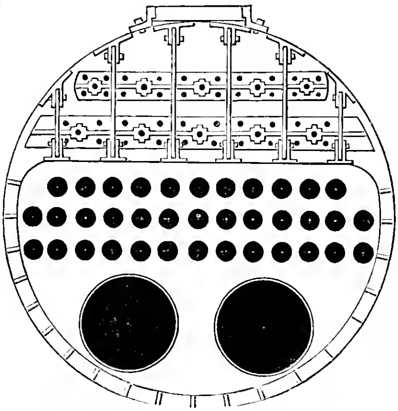

FIG. 3.

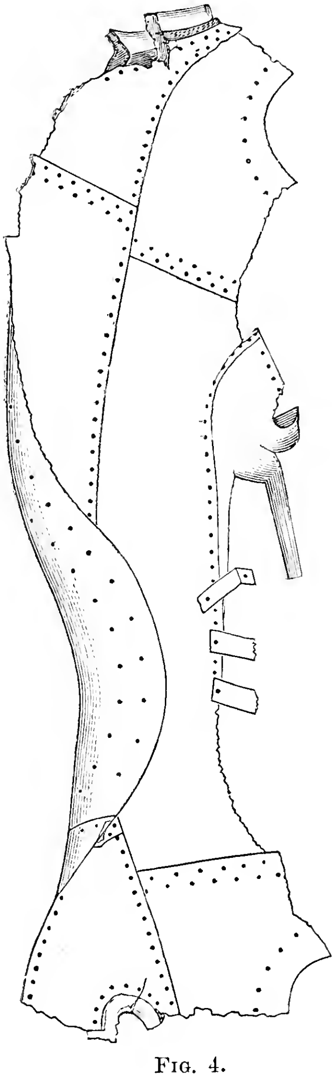

FIG. 4.

There was extensive internal corrosion at the point where the barrel joins the box and in other places on the lower parts of the shell. We can hardly escape the conviction that the lower part of the shell, where the water is cooler from defective circulation, was kept in an unhealthy state of tension by the thrust of the hotter and very rigid flues above. With sketch No. 4 before us, we could not, however, decide that the initial point of rupture was in the lower part of the boiler, or otherwise the boiler would have gone high in the air, as the dome and smokestack did. There was very little scale, incrustation, or deposit, and no burned plates or other evidence of lack of water.

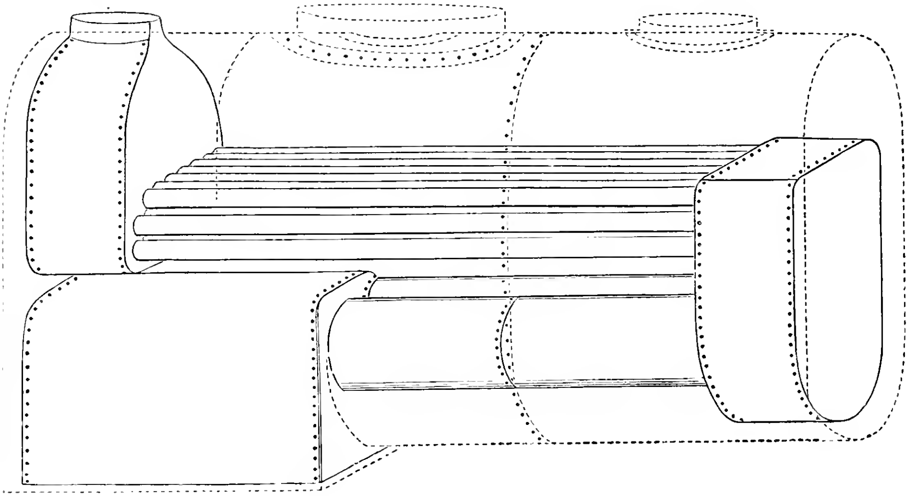

FIG. 5.

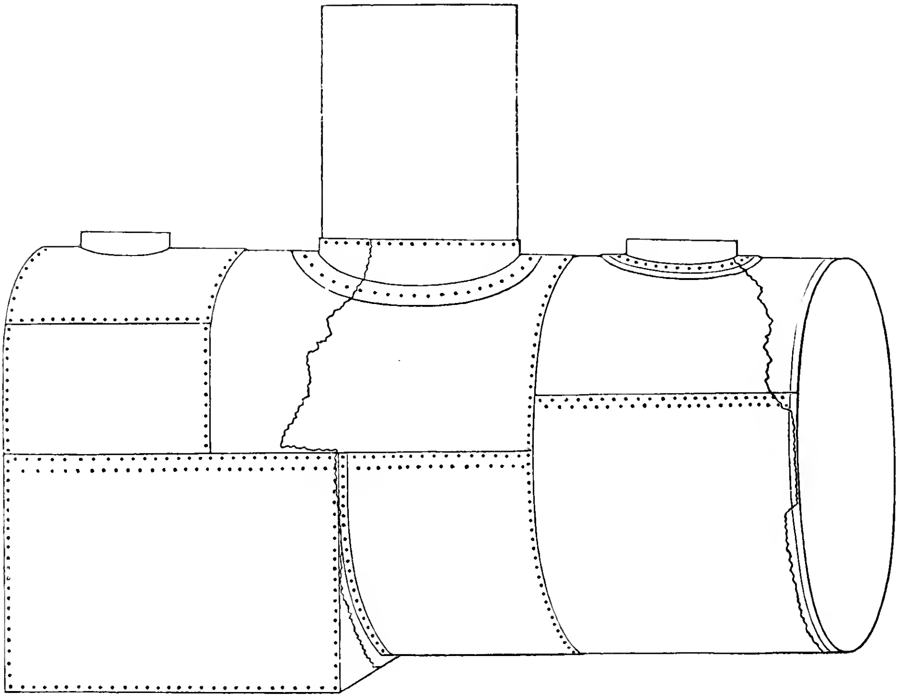

FIG. 6.

Fig. 4 represents the principal part of the shell which was torn off and thrown some distance into the water.

Fig. 5 is a perspective view of the interior of the boiler.

Fig. 6 is a perspective view of the exterior of the boiler, showing cracks around man-hole and dome.

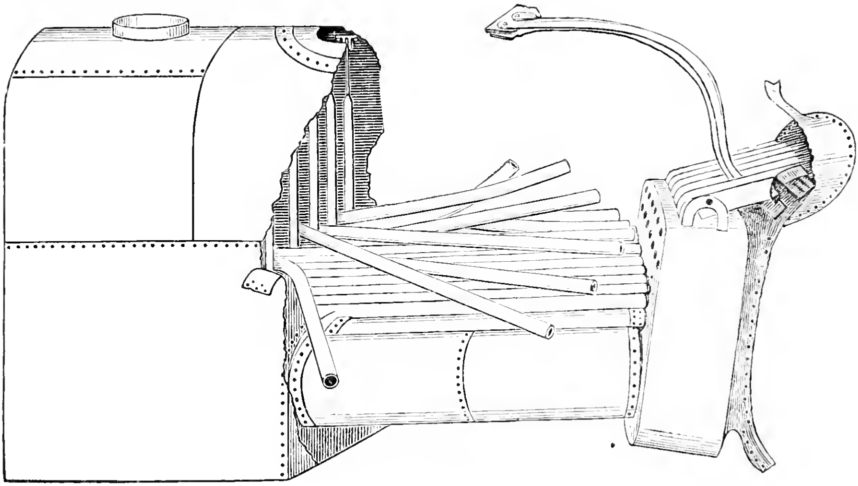

FIG. 7.

Fig. 7 shows what remained of the boiler after the explosion.

—*Reprinted from our Annual Report for* 1877.

Inspectors' Reports.

DECEMBER, 1885.

During the closing month of the year passed our inspectors made 3,228 inspection trips, examined a total of 6,127 boilers, made 2,291 internal inspections, tested 381 boilers by hydrostatic pressure, and reported 3,981 defects, of which 689 were considered dangerous, and led to the condemnation of 48 boilers.

Our usual tabular statement of defects is appended.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	419	36
Cases of incrustation and scale,	596	44
Cases of internal grooving,	25	16
Cases of internal corrosion,	139	21
Cases of external corrosion,	347	114
Broken and loose braces and stays,	83	50
Settings defective,	129	14
Furnaces out of shape,	171	14
Fractured plates,	182	84
Burned plates,	93	31
Blistered plates,	232	22
Cases of defective riveting,	306	34
Defective heads,	37	20
Serious leakage around tube ends,	549	57
Serious leakage at seams,	214	53
Defective water-gauges,	128	14

Nature of defects.	Whole number.	Dangerous.
Defective blow-offs,	45	9
Cases of deficiency of water,	9	4
Safety-valves overloaded,	22	7
Safety-valves defective in construction,	41	16
Pressure-gauges defective,	211	29
Boilers without pressure-gauges,	3	0
Total,	3,981	689

SUMMARY OF INSPECTORS' REPORTS FOR THE YEAR 1885.

We present herewith a summary of the work done by the inspectors during the year past, and for the purpose of ready comparison, the summary for the preceding year.

	1885.	1884.
Visits of inspection made,	37,018	34,048
Total number of boilers inspected,	71,334	66,695
" " " " " internally,	26,637	24,855
" " " " tested by hydraulic pressure,	4,809	4,180
" " " defects reported,	47,230	44,900
" " " dangerous defects reported,	7,325	7,449
" " " boilers condemned,	449	493

The following is the detailed analysis of defects reported during the year 1885.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	5,062	458
Cases of incrustation and scale,	6,822	490
Cases of internal grooving,	283	92
Cases of internal corrosion,	1,791	244
Cases of external corrosion,	3,552	494
Broken and loose braces and stays,	742	278
Settings defective,	1,920	246
Furnaces out of shape,	1,996	200
Fractured plates,	1,628	668
Burned plates,	1,152	323
Blistered plates,	2,903	251
Cases of defective riveting,	4,289	514
Defective heads,	489	163
Serious leakage around tube ends,	6,928	1,402
Serious leakage at seams,	2,349	409
Defective water-gauges,	1,342	245
Defective blow-offs,	476	114
Cases of deficiency of water,	130	56
Safety-valves overloaded,	363	149
Safety-valves defective in construction,	522	173
Pressure-gauges defective,	2,428	345
Boilers without pressure-gauges,	63	11
Total,	47,230	7,325

GRAND TOTAL OF THE INSPECTOR'S WORK SINCE THE COMPANY BEGAN BUSINESS, TO JANUARY 1, 1886.

Visits of inspection made,	312,241
Whole number of boilers inspected,	632,313

Complete internal inspection, - - - - - - -	223,073
Boilers tested by hydrostatic pressure, - - - - - -	46,967
Total number of defects discovered, - - - - - - -	350,948
" " " dangerous defects, - - - - - -	71,541
" " " boilers condemned, - - - - - -	4,165

We would call the attention of owners of steam boilers to the very great importance of properly "laying up" boilers and their attachments, when, for any reason they are not to be used during the cold season. When this work is not properly done, there is not only a liability, but a probability which is so strong that it is almost a certainty, that serious damage will occur to the boilers, their attachments, or both, through freezing.

Less than a week previous to this writing, we were called upon to examine a battery of eight boilers in a large manufacturing establishment which has been closed for the past few weeks, but which is to be started again soon. Naturally the first thing to be done when the starting was decided upon was to see that the motive power was in good condition. Our inspector was called in, and upon examination he found a most deplorable state of affairs. The works were closed before cold weather set in, and no especial pains were taken to guard against damage from freezing. The blow-off pipes were opened and the water allowed to run out of the boilers. No other precautions were taken, probably because they were not thought necessary, the weather being very mild. But the recent very severe weather proved very disastrous. Among the damage noted by our inspector was the following:

The channel plate beneath the air pump, a condensing engine being used, had been left full of water which had frozen, and fractured the plate.

A large feed-water heater was left standing full of water, and had burst by the expansion of the freezing water.

A large steam pump had a cylinder head broken from the same cause.

All of the steam pressure gauges, in consequence of the springs being left full of water were frozen up, and two of them were ruined.

The piping generally had not been drained, and was found burst in a great number of places.

Our inspector estimated that at least five hundred dollars would have to be expended in repairing damage done by freezing alone before the works could be started up.

In addition to this direct damage, it will be some time after the works are running before the pipes are free from pieces of scale, rust, etc., which the freezing has detached from their inner surfaces, and which will cause much trouble, annoyance, and expense, and possibly accidents and delay, by getting into valves, preventing their closing, cutting their seats, stopping up pipes, etc.

An outlay of fifteen to twenty dollars for the services of a competent person to lay up this plant properly would have prevented any damage whatever.

In refreshing contrast to the above may be mentioned the conduct of the engineer in a manufacturing establishment in a neighboring State, which was recently destroyed by fire.

The man, when the fire broke out, instead of taking to his heels, stood by his boiler long enough to take precautions which saved it from any sort of damage. He filled the boiler with water, drew the fire, closed the fire doors, saw that the safety-valve was perfectly free, and in addition blocked up the valves of his engine and left the throttle wide open, so that there should be no obstruction to the free escape of the steam which might be generated, in case the safety valve should stick from the effect of the intense heat, or through the timbers of the boiler-house falling on it. As soon as the ruins had cooled off sufficiently to permit it, he drew the water remaining in the boiler from it in order that no damage should result from freezing.

As a consequence of this exercise of intelligence and forethought, the boiler remains uninjured, although the heat was sufficient to destroy all the fittings and attachments.

Boiler Explosions.

DECEMBER 1885.

TOW-BOAT (139). — The tow-boat Iron City was blown to pieces December 2d, while stuck on the bar at the head of Herrs Island in the Allegheny river at Pittsburg, Pa. The crew, numbering six, were blown into the river. The engineer, George Ashton, was instantly killed. Fred Jackson was fatally injured, and the others seriously hurt. The vessel was burned to the water's edge and was a total loss. The Iron City in running down the river was swung on to the bar where she went badly aground just over the main pipe of the Philadelphia Gas company. All the evening and up to the time of the explosion the vessel tried to back off into deeper water. Shortly before two o'clock a final effort was made to get off. The engines were forced to their fullest capacity, but the boilers could not stand the pressure and collapsed. The concussion from the explosion was terrific, and awoke the upper end of the two cities. Pieces of the vessel were blown from the middle of the river where the boat was grounded to the Allegheny shore, 500 yards away. A part of the cabin alighted on the roof of Gerdes' tannery, directly opposite the Allegheny side.

The survivors were taken to the Allegheny shore, where all possible was done for them. Their names are Robert Jackson, fireman, badly bruised and scalded; Joe Richardson, badly injured; ex-councilman Smith Walker, seriously hurt; Billy Wentley, leg broken; James Omslaer, the owner, said to be severely injured.

TUG-BOAT (140). — The steam tug-boat Dora Emory, towing a stone barge, proceeding up the East river, N. Y., December 3d, was blown up at Fifty-eight street, by the explosion of its boiler. The five men who were aboard her were killed. The shock of the explosion shattered windows on the New York shore. Pieces of debris were hurled as far as First avenue. The crew of the tug consisted of captain Garret Morris, engineer Louis Capperata, cook Charles Davis, fireman Thomas Van Hausen, and a deck-hand Garret Morris, Jr.

LOCOMOTIVE (141). — The boiler of a locomotive on the Upson county railroad exploded December 4th, four miles from Barnesville, Ga. Engineer Hooker was instantly killed, and the fireman was badly scalded.

FLOUR-MILL (142). — The boiler of Eaton & Parks' flouring mill at Sullivan, Ind., exploded December 5th with terrific force, tearing the mill all to pieces, seriously injuring three persons: Charles Parks, injured about the head; Michael Ambrose, injured on the head and side; Jed Eaton, leg bruised and side injured. The explosion resulted from carelessness. The damage was from $2,000 to $3,000.

SAW-MILL (143). — The boiler in the saw-mill of Joseph A. Taft, seven miles east of St. Paul, Minn., exploded December 10th, with the following casualties: Jerry Markee, of Minneapolis killed. John Breton, fatally injured. William Burgess of Superior, ankle broken. William Barlow of Superior, arm broken.

IRON FOUNDRY (144). — The boiler at the Colorado Foundry, Austin, Tex., exploded December 11th, with terrific force, demolishing the building and killing Charles Jones, the proprietor, and Lewis Preston, the engineer. Two other employees were slightly wounded. The loss on the building is between $4,000 and $5,000. The boiler was a very old one. The immediate cause of the explosion is unknown.

Rendering Tank (145).—A terrific explosion occurred in North Nashville, Tenn., December 17th, shaking the houses on both sides of the river with such violence as to throw people out of bed. It was at Hart & Hensley's pork-packing house, where the immense grease tank in the boiler-shed exploded. The slaughter pens and the gable on the end of the main building was torn away, and the lumber and brick thrown in every direction. A piece of the tank weighing 500 pounds was dashed through four partition fences into Powers's slaughter yard, where a brick wall was thrown down and two men were caught under it, and were crushed and saturated with boiling grease. Henry Warnacke was killed and James McWhirtier was fatally injured. Warnacke leaves a a widow and twelve children. The noise of the explosion was heard four miles away.

Saw-Mill (146).—A special from Owensboro, Ky., states there was a boiler explosion ten miles east of there on December 18th, at Williams & Jolly's saw-mill, by which Henry Parish, an employee, was killed, and engineer Burton, John Peck, and James Williams were wounded.

Distillery (147).—A boiler explosion occurred December 21st, at Trebins, Ohio, a small place ten miles east of Dayton in Greene county, by which two men were killed and two seriously injured. The accident occurred at the Trebin distillery. The large brick boiler-house was blown to pieces. Two stores which adjoined the boiler-house were wrecked, and 15,000 bushels of malt destroyed. The killed are Thomas Gordon and Wayne Potter. The former leaves a wife and five children, and the latter a wife and three children. Both men were scalded severely, but especially Potter, whose flesh in places fell from the bones. There was not a spot on his body that was not scalded, in addition to which he was bruised and had several bones broken. Isaac Wolf, one of the coal haulers, was hurled through the air with the flying parts of the building and dropped into the river where he was picked up. Harvey Tumbling, the other injured person, was struck on the head with a brick. His injury is serious. The cause of the explosion is said to be low water. The entire damage will be $6,000.

Rolling Mill (148).—While testing the boilers at the Lochiel Rolling Mill, Harrisburg, Pa., December 23d, prior to starting up the works which had been idle for years, one of them exploded and scattered steam and debris in every direction. Over 100 persons were in the vicinity at the time, and six were injured, two seriously. Thomas Welsh had his head badly cut, and was terribly scalded about the legs. William Pickens was struck in the stomach with a heavy piece of iron, and received internal injuries that may result fatally. Thomas J. Rice and Richard Chollen were bruised and slightly cut.

Water-Works (149).—The bursting of one of the boilers at the Spring Valley Water-Works situated on the banks of Lake Merced, a short distance from San Francisco, Cal., December 24th, caused the other five boilers in the building to explode, completely demolishing the works. John Ryan, a coal passer, and Peter Duffy, a fireman, was instantly killed, and George Hunt, a fireman, and Christopher Whaten, a coal passer, were dangerously wounded. The damage is estimated at $150,000. At the time of the accident the engine was running at low pressure, and no cause can be assigned for the explosion.

Tow-Boat (150).—The tow boat Jumbo exploded her boiler December 26th at Pensacola, Fla., fatally wounding the engineer, William Tourt, and the colored fireman, J. C. Peterson. A passenger threw the captain and a deck hand overboard and then jumped into the water and saved both, although badly scalded himself.

Agricultural Engine (151).—By the explosion of a steam boiler at the Winchester farm, Southboro Centre, Mass., December 26th, William A. Gould, the farm foreman, received serious injuries to his leg and arm. The barn where the boiler was located was considerably damaged. Frozen pipes caused the accident.

OIL WORKS (152). — Just after midnight, December 29th, one of the boilers in the Gulf City oil works, Mobile, Ala., exploded with terrific force, blowing out the east and west walls of the building and destroying the adjoining sheds. At the time of the explosion I. S. Staunton of Social, Ga., the firemen, and twenty four colored hands were at work. Eight men were killed or injured, as follows: J. S. Staunton, fatally injured: Israel Brasey, fatally scalded, has since died: Archer Hicks, fireman, fatally injured; F. P. Jones, fatally scalded. Morris Wallace, Willis Black, Daniel Jackson, and Peter Chastyon were burned to death, their charred bodies being found in the debris. Richard Hunter and William Border were also seriously injured. The explosion is attributed to lack of water in the boiler.

THRESHING ENGINE (153). — The boiler of a threshing machine in a barn near New Providence, Pa., exploded December 29th, killing two young men named respectively Christian Hildebrand and Edward Helm. Hildebrand was hurled thirty feet, and was instantly killed; as was also Helm. Frank Edwards was seriously scalded. The barn was burned with its contents, consisting of fifteen head of young cattle, eight head of steers, two mules, two horses, seven colts, three cows, ten head of hogs, 1,800 bushels of corn, 500 bushels of wheat, and a large amount of hay. The loss is $7,000, partially insured.

TUG-BOAT (154). — The residents in the vicinity of the dock, foot of Boune street, Brooklyn, N. Y., and the sailors in the ships in the Atlantic dock were startled at midnight December 30th, by a loud explosion. On hurrying to the Boune street dock they found it literally strewn with the debris of the tug boat Niagara, which had been made fast to the dock early in the evening. The engineer had let off the steam and the firemen banked the fires early in the evening, and everything was then thought to be safe. It is thought the safety valve of the boiler must have been out of order, for about midnight the dome of the boiler, weighing over 500 pounds, went skyward, a distance of about 150 feet, and when it came down it went crashing through the roof of the Grain Warehousing Company. The pilot-house was blown to pieces, and a portion of the cabin and upper part of the boat went overboard, and a large portion was strewn along the dock. The fireman, Michael Corcoran, was seriously injured, and the deck hand, Daniel Moriarty was fished out of the river. He escaped uninjured. All that was left of the tug was the hull.

CAR HEATER (155). — A Baker heater in a New York, New Haven & Hartford railroad car, exploded with great force while the car was standing in the yard at Springfield, Mass., December 30th. The fire was started as usual and everything seemed all right. The car was considerably damaged.

New Size.

A new glue size for paper-makers' use, which is nearly 50 per cent. cheaper than the old kinds and more suitable for the purpose, is prepared as follows: Dissolve in a copper pan, heated by indirect steam, 20 to 22 kilogs. (44 to 48.4 lbs.) of soda, in 90 to 110 kilogs. (198 to 242 lbs.) of boiling water; then add, stirring constantly, 140 kilogs. (308 lbs.) of powdered rosin, keeping the whole boiling constantly until all the rosin is dissolved, which is generally accomplished in three or four hours. The soda-rosin composition is mixed together with a glue solution made by dissolving 50 kilogs. (110 lbs.) of glue in 140 to 150 kilogs. (308 to 330 lbs.) of water. Boil both solutions together for about ten minutes, after which run the mixture through a fine sieve or filter, and it is then ready for use. The best proportions for mixing the vegetable and animal sizes are, for one and a half parts of rosin add one part of glue, or for some purposes equal parts of each can be taken. An addition of starch, if required, can be made as usual, also the mixing of this improved size with the pulp. — *Paper Trade Review.*

Boiler Explosions in 1885.

Below will be found our usual classified list of the explosions which have occurred in this country during the past year, so far as we have been able to obtain them, together with the number of persons reported killed and injured thereby.

The total number of explosions reported to us was 155, which caused the instant death of 220 people, and the serious injury of 288 others, many of the latter being mortally injured.

CLASSIFIED LIST OF BOILER EXPLOSIONS IN THE YEAR 1885.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total per class.
Saw-mills and wood-working shops,	5	2	4	3	3	2	2	2	3	4	1	2	33
Locomotives,	..	4	..	..	..	1	..	..	1	2	1	1	10
Steamboats, tugs, etc.,	2	..	2	..	1	1	1	..	..	3	2	4	16
Portables, hoisters, and agricultural engines,	..	..	..	..	1	2	4	2	3	..	2	2	16
Mines, oil wells, collieries, etc.,	2	5	3	2	1	1	..	3	..	1	1	1	20
Paper mills, bleachers, digesters, etc.,	1	..	..	..	..	..	1	1	..	..	..	..	3
Rolling-mills and iron-works,	1	2	1	..	..	1	1	1	..	1	..	2	10
Distilleries, breweries, sugar houses, dye houses, rendering establishments, etc.,	3	1	..	..	3	1	1	..	3	..	4	2	18
Flour-mills and elevators,	..	3	1	..	..	2	..	..	1	..	2	1	10
Textile manufactories,	..	..	..	..	1	..	..	..	..	..	..	..	1
Miscellaneous,	..	3	3	2	2	1	..	..	..	3	2	2	18
Total per month,	14	20	14	7	12	12	10	9	11	14	15	17	155
Persons killed, total 220; per month,	24	22	20	9	18	14	7	11	11	19	34	31	...
Persons injured, total 288; per month,	35	30	28	9	32	6	21	21	13	40	22	21	...

As usual, the greater number of explosions have occurred among boilers used in saw mills, 21.3 per cent. of the total being in this class.

Mines, collieries, and similar boilers stand second in frequency, 20 being the recorded number.

Distilleries and similar establishments are third, with 18 explosions to their credit.

Marine boilers, and those of a portable type come next, with 16 in each class.

Locomotives, rolling-mills and iron-works, and flour-mills and grain-elevators follow with 10 each to their credit.

As was the case the preceding year, but one explosion in a textile manufactory of any kind was reported. Taking into consideration the large number of boilers of this class in the country, two things would seem to be proved thereby: First, that boiler explosions *might* be almost entirely prevented by proper means; and second, that as a general rule, boilers in this class of manufacturing establishments have most excellent care.

A CEMENT to fix labels to tin boxes: Either of the following will answer. 1. Soften good glue in water, then boil it with strong vinegar, and thicken the liquid during boiling with fine wheat flour, so that a paste results. 2. Starch paste with which a little Venice turpentine has been incorporated while warm. — *Paper World.*

The Locomotive.

HARTFORD, FEBRUARY, 1886

J. M. ALLEN, *Editor.* H. F. SMITH, *Associate Editor.*

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 *cents per year when mailed from this office.*
Bound volumes one dollar each.

The Commercial Rating of Steam Boilers.

The commercial rating of steam boilers is a subject which is attracting considerable attention at the present time, and efforts are being made by the members of various engineering societies to fix upon and adopt some method of rating which shall not only express, approximately at least, the actual power of the boiler under ordinary conditions, but which shall be sufficiently definite in its provisions to enable buyers and sellers of boilers to make contracts for any given boiler capacity without fear of misunderstanding. Various so-called standards have been proposed at different times, and used to a greater or lesser extent, but thus far nothing seems to have been proposed which was sufficiently definite in its nature to fulfill the requirements of the case, or to enable disputed points to be settled.

The latest and most sensible views on the subject are embodied in a paper read at the last meeting of the American Society of Mechanical Engineers, the paper in question being the joint production of Professors Wm. P. Trowbridge of New York, and C. B. Richards of New Haven, Conn.

In the paper referred to, it is proposed in determining the rating of a steam boiler, to take into consideration the fuel burned, and, in our opinion, no method of rating boilers which shall insure justice to all parties concerned can be devised without taking this very important question into consideration. Let us briefly consider the matter of boiler power.

A *horse-power*, or the unit of work which is so called, is the exertion of a sufficient force to raise 33,000 pounds vertically against the action of gravity at the rate of one foot per minute, or its equivalent. It matters not by what agency this power is developed, or the nature of the work which is to be performed by it, the unit is the same in every case. There is no ambiguity in regard to its magnitude.

This being the case, it is self-evident that if one person buys of another a machine to generate or furnish a certain amount of power, and the nature of the machine is such that its capacity for generating or furnishing power may vary greatly under different conditions to which it may easily be subjected, or under which it may be operated, it is absolutely essential that the conditions under which the machine is to be operated to furnish the required power, should be exactly stated, and perfectly understood by both parties to the contract, otherwise disputes will be quite likely to occur.

A steam-boiler is a machine, the capacity of which to furnish power, or what is the same thing, to generate steam, may vary to a great extent under different conditions of management, and vexatious disputes and law-suits are of constant occurrence between boiler-makers and their patrons concerning the capacity of boilers purchased and put to use, and which fail to meet the expectations of the purchaser, or to fulfil promises of the builder. All this arises from the absence of some *definite* standard of performance by which to determine the power of the boiler. In the establishment of such a definite standard the first thing to be considered is, how much dry steam of a given pressure should a boiler furnish, or what is the same thing, how much feed-water of a certain temperature should be converted into steam of a given pressure to constitute one-horse power? We shall see that it will be necessary to fix upon an arbitrary standard for this unit, owing to the fact that outside of the influence of the boiler, the quantity of steam required to develop an actual horse-power varies greatly.

Steam after its generation in a boiler may, or may not, be used in an engine to furnish power to drive machinery. Even if it were, different engines, owing to differences in construction, and various other causes, or even the same engine running under different conditions, require widely varying quantities of steam to produce the same actual power; the amount of steam so required may vary from eighteen to upwards of one hundred pounds of steam per horse-power per hour.

It has been found as the result of many tests that engines of ordinary size and fairly good construction, consume about thirty pounds of steam per hour to yield one indicated horse-power, under conditions that are easily attained in ordinary practice. This may be regarded as a fair average steam consumption, and the evaporation of thirty pounds of water from a temperature of 100 degrees into steam having a pressure of seventy pounds per square inch above the atmosphere, was fixed upon by the committee having charge of boiler tests at the Centennial Exposition at Philadelphia, in 1876, as the standard for one boiler horse-power, whether the steam was used to drive an engine or not. This standard has come to be quite extensively used throughout the country, and there seems to us no valid reason for changing it. A lower duty would be an injustice to the builders of many excellent engines, while a higher one would be equally unjust to boiler-makers in general. We would strongly urge the retention of this unit, or its equivalent, as the measure of the commercial horse-power of steam boilers.

Now, a boiler of any given size may be made to perform almost any required duty, or develop almost any power, by simply varying the amount of fuel burned under it in a given time, but it may be stated as a general rule, that the greater the amount of work a boiler is made to do, the lower will be its economical performance, hence, it will be seen that justice to the purchaser or user of a boiler, demands that the rating of a boiler shall be based upon a rate of combustion that shall not, under ordinary conditions, be incompatible with a good degree of economy.

To aid us in gaining an approximate idea of what would be a proper rate of combustion of fuel in a boiler furnace, upon which to base a rating for commercial purposes, let us assume that we have a horizontal tubular boiler sixty inches in diameter by sixteen feet long. Such a boiler will have about 900 square feet of heating surface, and should have about 22.5 square feet of grate surface, the ratio of grate to heating surface being about 1 to 40. This form of boiler is selected for comparison because it is so generally used for land stationary purposes in this country, that it may be regarded as a standard type, and also because it is easy to build, economical in first cost and maintenance, and, when set properly will evaporate as much water per pound of coal as any form of boiler which has been devised.

With the above boiler, set well, clean, and in good order, burning an average coal, with not over 12 per cent. of refuse, at the rate of six pounds per square foot of grate surface per hour, there will be no difficulty in evaporating $9\frac{1}{2}$ pounds of water per pound of coal, from a temperature of 100 degrees into steam of seventy pounds pressure per square inch above the atmosphere, or its equivalent. This would give by the above standard, $\overline{22.5 \times 6 \times 9\frac{1}{2}} \div 30 = 42.75$ horse-power.

Increase the rate of combustion to twelve pounds per square foot of grate surface per hour, the evaporation will be about nine pounds of water per pound of coal, from and at the same temperatures as before, and we have $\overline{22.5 \times 12 \times 9} \div 30 = 81$ horse-power.

Again under the same conditions burn eighteen pounds of coal per square foot of grate surface per hour. The evaporation per pound of coal would be about eight pounds, and we should have $22.5 \times 18 \times 8 \div 30 = 108$ horse-power.

The foregoing results are what can be readily attained in practice under ordinary every-day conditions. Under especially favorable conditions they might be exceeded; under unfavorable conditions, much lower results might be expected.

Thus it will be seen that the power of any given boiler may vary greatly, so that unless the method of rating adopted fixes all the conditions involved, and leaves nothing to any man's judgment, one boiler-maker's horse-power may be a very different thing from another's, and unless the intending purchaser is posted on all these points, and knows just what he wants, and governs himself accordingly, he will be, to a great extent, at the mercy of the most unscrupulous bidder for his work.

A rate of combustion of ten pounds of coal per square foot of grate surface per hour is readily attainable with ordinary draught, and with the above proportions of grate and heating surface will give most excellent results. We would not advise a lower rate of combustion in ordinary practice, as we believe that a tolerably sharp fire is essential to economy.

But the proportions of grate to heating surface varies greatly in different cases, and in the practice of different boiler-makers, hence the governing factor in the rate of combustion should be the amount of heating surface of the boiler.

To illustrate this point: — The boiler whose performance we have been discussing has 900 square feet heating surface and 22.5 square feet of grate surface. If we burn ten pounds of coal per square foot of grate surface per hour, we have 225 pounds, or one-fourth of one pound per hour for each square foot of heating surface.

If now we reduce the grate surface to 11.25 square feet, and burn twenty pounds of coal per hour on each square foot, we burn exactly the same amount of coal, in all, and exactly the same amount per square foot of heating surface, and the evaporative results in the two cases will be almost identical.

We would recommend, therefore, the adoption of a system of rating the commercial horse-power of steam boilers, based upon a certain economic evaporation when burning a certain quantity of an average quality of coal per square foot of heating surface per hour.

By the adoption of such a standard, all makers of boilers who may bid upon a contract are put on exactly the same footing, the rating of the boilers is taken from their hands, and the purchaser of the boiler has a guarantee both for economy and capacity.

H. F. S.

The most carefully edited journal is fallible. On the *New York Herald*, proof readers have been suspended for weeks. In spite of this severe discipline the *Herald* once made the astonishing announcement that "a long line of scorpion's feathers filed into the church," instead of "surpliced fathers." A reporter on that paper had occasion to quote a verse from a familiar hymn in which the word "herald" occurred. The proof-reader dutifully underscored the word, and the verse appeared: "Hark, *The Herald* angels sing!" It was in the *New York World's* report of a political meeting that the word "shouts" was so ludicrously misprinted as to make the blunder famous: "The snouts of ten thousand Democrats rent the air," read the report. A few years ago the journalist who is widely known as "Gath" wrote a Fourth of July article. With fervid eloquence he told how the effete monarchies of the Old World trembled in their boots when they read the immortal words penned by Thomas Jefferson: "Thrones reeled," wrote the impassioned "Gath." The next morning he saw in type "Thomas reeled." The story is told that Ernest Renan once had occasion to telegraph across the British channel the subject of a proposed lecture of his in Westminster Abbey. The subject as written by him was "The Influence of Rome on the Formation of Christianity." It was published in England as, "The Influence of Rum on the Digestion of Humanity."

THE Catalogue for 1885-6 of the *Massachusetts Institute of Technology* has just been received, and is a very interesting volume. It contains a brief account of the establishment of the school, lists of the members of the corporation, and of the Executive and Visiting Committees, Officers of Instruction, statement of the courses of study, requirements of graduation, etc., and in fact, all necessary information relating to the Institute.

J. M. ALLEN, president of The Hartford Steam Boiler Inspection and Insurance Company, delivered an address at Sibley College, Cornell University, January 15th, on the influence of steam power in developing the resources of our country, with some remarks on the construction and management of steam boilers with a view to economy and safety.

Fifty Per Cent. Saved.

A peculiar case happened recently, which we believe of sufficient interest to owners of steam-boilers to put on record. We therefore give the simple facts in the case, omitting, of course, all names.

One of our solicitors called at a certain manufacturing establishment for the purpose of insuring their boilers if possible. He first looked the boiler over and had a long conversation with the engineer, in the course of which the engineer stated that when he took charge of the boiler, a battery of plain cylinders, the grates in use were six feet long, and a certain amount of wood, that being the fuel used, was burned each month. He being convinced that the amount burned was excessive for the power developed made the grates *twelve feet long*, and stated that the consumption of wood was only about *one-half* of what it had been with the six foot grate. This was, in the opinion of our solicitor, who was an engineer of broad experience, an anomalous result, and in conversation subsequently with the owner the matter was discussed. The owner praised his engineer, and pointed with pride to the saving of fuel he had made. Our solicitor being desirous of getting at the exact facts in the case, asked him what the precise amount of saving in fuel amounted to. The owner did not know, but called to his book-keeper, "Jones, how much was our bill for wood during the month of April last year?" Jones looked the matter up and replied, "One hundred and thirty seven dollars, sir." "And how much was it for the same month this year?" "Two hundred and fifty dollars, sir," was the reply. This brought the owner to his feet in an instant. "Why, sir, you must have made some mistake, Mr. ——", naming the engineer, "told me that he had burned only about one-half as much wood since changing the grates." "Can't help it, sir," replied the clerk, "there are the bills." "I'll see about this matter," said the owner.

The next time our man called around that way, the owner said, "I'm running this thing myself, now."

In the absence of any facts to explain the action of the engineer in this case, we can only suppose that he was getting a percentage on the amount of wood burned. But the incident, which is strictly true, shows that the details in some manfacturing establishments are not looked after quite so closely as they should be.

Incorporated 1866.

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.
HARTFORD CONN.

Charter Perpetual.

Issues Policies of Insurance after a Careful Inspection of the Boilers,

COVERING ALL LOSS OR DAMAGE TO

BOILERS, BUILDINGS, AND MACHINERY.

ALSO COVERING

LOSS OF LIFE AND ACCIDENT TO PERSONS

ARISING FROM

Steam Boiler Explosions.

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The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

NEW SERIES—VOL. VII. HARTFORD, CONN., MARCH, 1886. No. 3.

Forms of Test Pieces for Boiler Plates.

It is much to be desired that some standard form of test piece could be adopted by plate manufacturers and others who have occasion to make tests for the purpose of determining the tensile strength and ductility of boiler plates, for the form and dimensions of the test specimen have considerable influence upon the results obtained, so that it will readily be seen that unless they are reduced to some standard the results given in different cases might lead to much confusion. Different forms of test pieces show such different results that it is impossible to compare results obtained by tests on such varying forms and obtain an exact idea of the relative qualities of the various plates.

The form of test piece adopted by the U. S. Board of Supervising Inspectors of Steam Vessels, is 8 inches long, 2 inches wide, and is cut out at the center so that for all thicknesses of plate under $\frac{5}{16}$ of an inch the area of the section under test is one fourth of one square inch, and for all thicknesses over $\frac{5}{16}$ of an inch, the area must equal the square of the thickness. In order to be exact we reproduce here the diagram of test piece from the Proceedings of the Board, and also their rules from the same source.

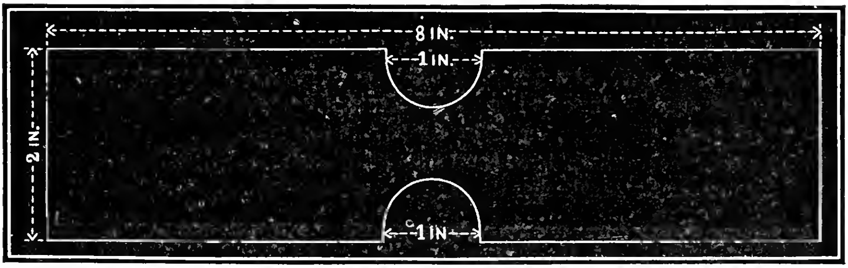

FIG. 1.

"To ascertain the tensile strength of plates, a piece shall be taken from each sheet to be tested, the area of which shall equal one quarter of one square inch, on all plate $\frac{5}{16}$ inch thick, and under; and on all plate over $\frac{5}{16}$ inch thick the area shall equal the square of its thickness; and the force at which the piece can be parted in the direction of the fibre or grain, represented in pounds avoirdupoise — the former multiplied by four, the latter in proportion to the ratio of its area — shall be deemed the tensile strength per square inch of the plate from which the sample was taken; and should the tensile strength ascertained by the test equal that marked on the plates from which the test pieces were taken, the said plates must be allowed to be used in the construction of marine boilers: *Provided always*, that the plates possess homogeneousness, toughness, and ability to withstand the effect of repeated heating and cooling; but should these tests prove the plates to be overstamped, the lots from which the test-plates were taken must be rejected as failing to have the strength of the stamped thereon. But nothing herein shall be so construed as to prevent the manufacturers from restamping such iron at the lowest tensile strength indicated by the samples, provided such restamping is done previous to the use of the plates in the manufacture of marine boilers.

"To ascertain the ductility and other lawful qualities, iron of 45,000 pounds tensile strength, and under, shall show a contraction of area of fifteen per cent., and each additional 1,000 pounds tensile strength shall show one per cent. additional contraction of area, up to and including 55,000 T. S.

"In the following table will be found the widths—*expressed in hundredths of an inch*—that will equal one-quarter of one square inch of section, of the various thicknesses of boiler plates. The sign + (plus) and — (minus) indicate that the numbers against which they are placed are a trifle *more* or *less*, but will not, in any instance, exceed one one-thousandth of an inch.

"The gauge to be employed by inspectors and others, to determine the thickness of boiler-plates, and the widths in the table, will be any standard American gauge furnished by the Treasury Department.

$\frac{3}{16}''$ = 133 —	.26 = 96 —	.35 = 71 —
.21 = 119 —	.29 = 86 —	$\frac{3}{8}''$ = 67 +
.23 = 109 +	$\frac{5}{16}$ = 80	$\frac{7}{16}''$ = 57 —
$\frac{1}{4}''$ = 100	.33 = 76 +	$\frac{1}{2}''$ = 50

"All samples intended to be tested on the Riehle, Fairbanks, or other reliable testing-machine, must be prepared in form according to the above diagram, viz.: eight inches in length, two inches in width, cut out at their centers in the manner indicated."

The reduction of area required for steel plates is as follows:

Tensile Strength.	Reduction of Area,
70,000 pounds, - - - - -	43 per cent.
65,000 " - - - - -	50 "
60,000 " and under, - - - -	55 "

In our opinion, the above form of test piece is defective, from the fact that the portion under test is too short. In fact, if a piece is cut out as shown, the actual portion under test is a mere line, and the only way its ductility can be measured is by the contraction of its area, when, as a matter of fact, the elongation of the sample in a certain length is a much more definite and reliable measure of its ductility and homogeneity.

In a very short specimen, made by cutting out or "nicking" a wider piece, the strains under test are confined to so short a length that there is very little chance for the metal to flow and indicate whether its quality is uniform or not.

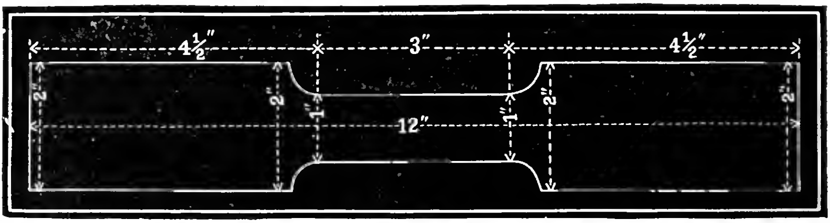

FIG. 2.

For it has been found by careful experimenters, that iron or steel may be so lacking in this latter quality that in a test piece of say eight inches long, a short portion of the length will be so soft and ductile that it shows a great reduction of area, while the remaining portion has so little ductility that the elongation *in the whole length* is very small, so much so that if the reduction of the area solely were made the test of quality, the specimen would be excellent, and might be fully up to the requirements of the specifications, while if the total elongation in a length of eight inches were made the test, the specimen would be rejected, as its lack of homogeneity would be more likely to be shown by the long specimen than by a short one.

A better form of specimen, in our estimation, than that adopted by the Government Board, is shown in Fig. 2. The numerals sufficiently indicate its dimensions and proportions. It is a form which is considerably used, but the portion affected by the strains in testing is still too short.

If a test-piece is to be prepared by cutting out a wide piece, the length of the parallel sides of the piece should not be *less* than eight inches, we would recommend nine inches, and that the piece be marked with a scratch-awl, and at intervals of one inch as shown in Fig. 3, which is drawn one-fourth natural size.

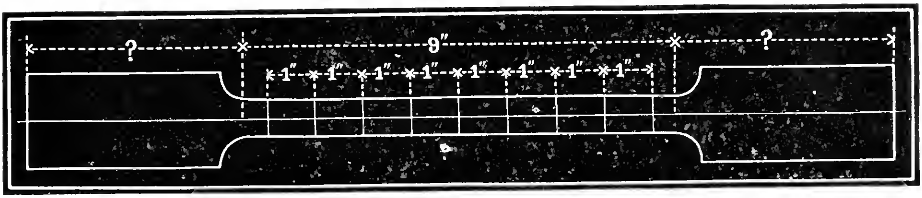

FIG. 3.

In a test specimen of this form we have a clear length of eight inches of uniform section in which we can observe the effect of the stresses upon each portion of its length, and thus form an excellent idea of the quality.

The shorter the specimen under test, the greater will be the percentage of elongation. This is most plainly shown by the following figures, 4 and 5, which show the

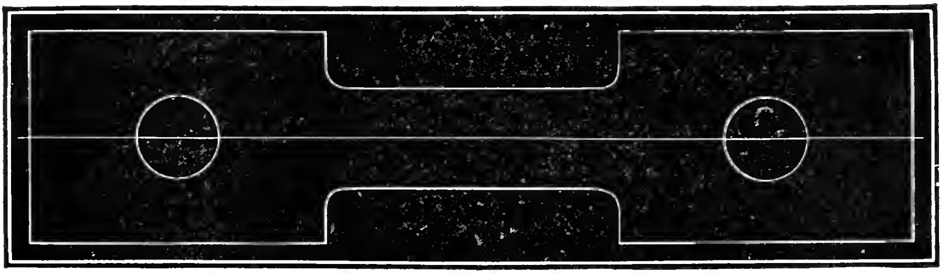

FIG. 4.

effect of stress upon a test bar. Fig. 4, the bar before stress is applied; Fig. 5, at the instant of fracture. The drawings are made from an actual specimen. It will be seen that at and near the point of the fracture the bar is drawn out and down much more than it is a short distance away. Hence, the greater *percentage* of elongation in the short specimen, while the *real* elongation will be less than in the longer one.

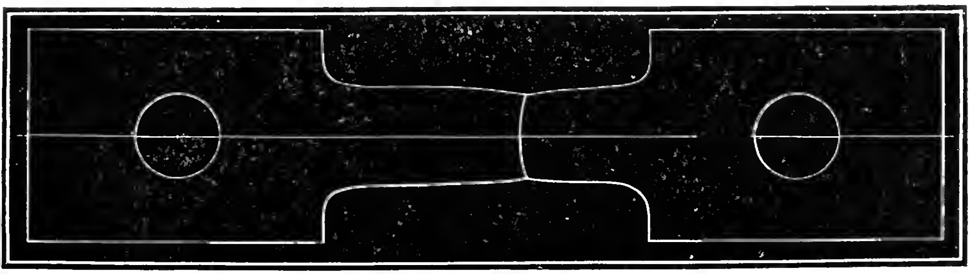

FIG. 5.

The best form of test-piece for boiler-plate, all things considered, is what is known as the "parallel test-piece." This is simply a straight piece of the plate to be tested, with its sides planed parallel with each other. They are the easiest and cheapest to prepare of any form, no "nicking in" or "gouging out," or fitting up ends for special holders being required. Much less metal is required for a test-piece, although this is a matter of little consequence, so far as cost is concerned; it is a matter of great convenience many times when pieces are cut from old plates, or portions of them, when it will be found difficult to obtain a piece more than an inch and a half or two inches wide.

For ordinary thicknesses of plate a strip from 1¼ to 1½ inches in width makes a very convenient piece for testing. Wider pieces may be used if the capacity of the machine is sufficient to pull them apart easily.

A Committee Report for *Lloyd's Register*, gives the following percentage of elongation for long and short specimens of homogeneous steel plates of the same quality.

8 inch specimen, - - - - -	20 per cent.
6 " " - - - - -	25 "
4 " " - - - - -	32 "
2 " " - - - - -	37½ "

These percentages are somewhat lower than are given by good American steel plates. In a table now before us showing the results of tests made on brands of steel marked respectively "Shell," "Firebox," and "Flange," we find the following average.

Grade.	T. S.	Elongation in Eight Inches.	Elongation in Two Inches.	Reduction of Area.
Shell, ...	58,529	23.22 per cent.	42.43 per cent.	57.81 per cent.
Firebox, ...	58,191	24.74 "	45.2 "	56.35 "
Flange, ...	56,224	26.46 "	47.5 "	59.88 "

An average of twenty tests of steel from another maker gives a

Tensile strength of - - -	58,777 lbs. per square inch.
Elastic limit, - - -	38,723 " "
Reduction of area, - - -	57.85 per cent.
Elongation in 8 inches, - -	25.52 "
" " 5 " - -	31.1 "
" " 1 inch, - -	62.7 "

Both of the above series of tests were made upon parallel test pieces, which show a lower tensile strength than the form adopted by the U. S. Board of Supervising Inspectors, and a greater reduction of area.

Inspectors' Reports.

January, 1886.

There were made during the opening month of the year 3,320 inspection trips, 6,681 boilers were examined, 2,310 were inspected internally, 331 others were tested by hydrostatic pressure, and 46 were condemned.

The total number of defects reported foots up 3,485, of which 848 were considered dangerous, as per the following detailed statement:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	362	29
Cases of incrustation and scale,	515	60
Cases of internal grooving,	16	5
Cases of internal corrosion,	116	22
Cases of external corrosion,	177	37
Broken and loose braces and stays,	84	30
Settings defective,	114	19
Furnaces out of shape,	149	26
Fractured plates,	146	64
Burned plates,	127	39
Blistered plates,	166	36
Cases of defective riveting,	291	177
Defective heads,	48	11
Serious leakage around tube ends,	607	176
Serious leakage at seams,	160	32
Defective water-gauges,	95	19
Defective blow-offs,	30	8
Cases of deficiency of water,	14	6
Safety-valves overloaded,	30	16
Safety-valves defective in construction,	48	12
Pressure-gauges defective,	188	23
Boilers without pressure-gauges,	2	1
Total,	3,485	848

Safety-valves, it is almost needless for us to repeat here, should be kept in perfect order, even though all other fittings are not in the best condition. Yet the state in which our inspectors sometimes find them is astonishing. It is strange that such utter disregard of the most elementary precautions against danger can exist.

Not long ago one of our inspectors, while examining some boilers on which application had been made for insurance, found the safety-valves weighted to a pressure of several hundred pounds. This weight had been on, and held the valves immovable for so long a time, that when it was removed it was found a difficult matter to start the valves in consequence of the corrosion which had taken place. After loading the safety-valves as above described, the very careful man in charge, evidently fearing that some steam might get away, had carefully capped the ends of the escape pipes, so that even had the valves been in perfect order, and lifted at the proper pressure, it would have been impossible for the steam to have escaped. Although we find many valves in bad condition, this was about the worst case we ever encountered.

We have many times given, through the columns of the LOCOMOTIVE, what we consider the proper way to connect safety-valves, but the subject is one which will bear repetition. In all cases, where possible, and this includes a very large majority of cases, no escape pipe should be used or allowed. The valve should be free to blow directly into the boiler room. In *all* cases where a boiler has a room to itself, this is possible. In cases where the boiler stands in a room used for other purposes as well, and for any reason it is not *allowable* to let the steam escape directly into the room, a pipe may be run to the nearest convenient point of discharge, but *never* out of doors where it can freeze. This pipe should be of ample size, and should always pitch downward away from the boiler. If this is not possible it should always be provided with a cock, as close as possible to the valve, for the purpose of keeping it free from the water which will *always* collect there, and will inevitably cause the corrosion and destruction of the valve if it is allowed to stand on it. Then the valve should be lifted *every day* to make sure that it is in good condition.

Boiler Explosions.

January, 1886.

Locomotive (1).—A fatal accident occurred January 3d, on the Philadelphia and Reading Railroad. As engine No. 525, drawing a heavy freight train, was passing the Danforth avenue, Jersey City, station at 12.55 a.m., an explosion of one of the water grates occurred, and a dense volume of steam and hot water was forced back over the tender, striking the front of the forward car, where William H. Crate and Edward McDonald, two brakeman, were standing. Crate either fell or jumped from the platform and was instantly killed, and McDonald was badly scalded about the face and head. The engineer and fireman both escaped injury. The grate was directly under them and the steam and scalding water shot backward, thus missing them. The locomotive was disabled, and was sent to the repair shop.

Saw-Mill (2).—The boiler of a saw-mill on the Walker lot, south of Webb City, Mo., exploded January 5th. Judge Cook, a lawyer, was instantly killed. John Rosenthal, the engineer, was badly scalded, and two brothers, named Moberly, were scalded and bruised.

Machine Shop (3).—The boiler in the machine shop of M. J. Russell, at No. 47 Essex street, Jersey City, N. J., exploded January 11th, while about twenty employés were getting ready to go to work. The men were on the second floor and could not see their way out through the blinding volumes of steam that arose from below. All were horribly scalded, and when found were lying on their backs unconscious upon the floor. Among the most seriously injured are Thomas Miller, aged 47 years, Bernard Brady, and James Monroe.

Heating Boiler (4).—The boiler used in a patent apparatus for heating with steam the St. Mary's Roman Catholic Church, Fort Wayne, Ind., exploded with fearful effect, January 13th, destroying the building. The janitor, an old man named Anthony Crane, was blown from the cellar to the top of the roof, and fell to the floor an unrecognizable mass of humanity. The church, which was one of the largest and finest in the city, is a complete wreck. The loss will not be less than $65,000, with an insurance, perhaps, of half that amount. The roof of Rev. Father Oechtering's residence was entirely demolished, while the Catholic school-building immediately south of the church, which was filled with children at the time, was terribly shaken up though none of the inmates were badly injured. Miss Alberta Willard, a thirteen-year-old girl, on her way to school, was passing the ill-fated church at the moment the explosion occurred. One of the large doors suspended just above the main entrance gave way and fell, crushing her beneath its weight, killing her instantly. Fifteen minutes before the explosion, one hundred and fifty children of the parochial school, next door, had been at prayer in the church.

Rolling Mill (5).—A terrible boiler explosion occurred at Harper's rolling mill in Newport, Ky., Jan. 15th, by which several persons were seriously injured, and property damaged to the amount of $2,000. The belt slipped from a large fly-wheel in the engine-room, causing the wheel to burst; a piece weighing a ton or more struck the two boilers near by, causing them to blow up. Fully 100 men were in and around the mill at the time, and it seems miraculous that the casualties are so few. James Swift, living on Elm street, had his right leg broken and was seriously burned. Christ Risch had his back broken. Wm. Golden, injured in left leg and several bad cuts in the head. Edward Onions, slightly cut on the head. Several others were slightly injured.

Flouring Mill (6).—The boiler in Walter's flouring mill, Butler, Pa., exploded January 16th, wrecking the structure and seriously injuring two small boys who were in the mill at the time.

Tug-Boat (7).—The tug-boat *Modoc* was blown to pieces January 18th, at the foot of Cherry street, Alleghany, by the explosion of its boiler. On the tug at the time of the accident were Captain Evans, fireman Michael Higgins, pilot Joe Davis, and engineer Zach Evans. The captain had given the order to swing clear of some barges, and after a few turns of the wheels were given the boiler burst. Mixed up with the flying debris were the bodies of those who were on the boat. The fireman was found on a barge seriously hurt. Captain Evans was rescued, bleeding from several cuts in the head made by flying pieces of the wreck. The pilot, Davis, could not be found. The pilot-house was completely demolished, and its occupant must have been blown high in the air, and his body likely fell in the water, to be carried away by the swift current. The wharf was strewn with fragments of the wreck, and pieces of the boiler were thrown to points hundreds of feet distant from the wrecked steamer. The safety valve was found lying in the yard of a house some distance from River avenue. The injured men were at once removed to the house of Captain Evans, where they received the best of medical attention.

Rendering House (8).—A large tank in the rendering house of Short & Cooley, Creston, Iowa, situated a mile east of the town, exploded January 18th, totally demolishing the building and machinery, and scattering the debris of the wreck for 300 yards around. Six men were working in the building at the time. Two of them were killed outright, and the others were more or less bruised and scalded. The men killed were Nelson Cone, who leaves a widow and children, and H. M. Sevier, fifteen years of age. The injured men are E. J. Short, badly scalded and bruised; Thomas G. Clark, foreman, slightly bruised and scalded; William R. Fiskins, a machinist of Chicago, who was setting up a new boiler, skull fractured and otherwise bruised and dangerously scalded; John Boyer was slightly injured. The tank was a new one, guaranteed to stand 100 pounds pressure, but exploded at fifty. The loss is $2,000.

——— (9).—The explosion of a boiler in a three story brick building, No. 1,210 Bingham street, southside, Pittsburg, Pa., caused $500 damages and injured two men slightly.

Distillery (10).—At Terre Haute, Ind., January 21st, a terrific boiler explosion took place at the distillery of Fairbanks & Duenwegs. Frank McNellis and George Otterman were killed. Charles Welker, Michael Ryan, Riley Evington, Frank and Joe Parsons were among the injured. The entire engine-house was torn down.

Agricultural Engine (11).—At Sherburne, N. Y., January 22d, Russell Palmer, aged forty-five, and Charles Newton, aged fourteen, were killed by the explosion of a boiler employed for baling hay.

Locomotive (12).—An explosion of a locomotive boiler in the round-house at the Chicago, Milwaukee & St. Paul depot, Madison, Wis., occurred January 22d. Peter Burke, wiper, was instantly killed, the top of his head being blown off. John Dutenbell, wiper, had both legs and one arm broken, and was badly scalded. S. A. Wilmot, fireman, was scalded about the head and shoulders. John Clute, wiper, had his arm broken and legs badly bruised. Joseph Parish, fireman, was scalded, and sustained several severe sprains; Henry Gleason, machinist, hands and face scalded. Thomas Callahan, fireman, eye badly hurt, and head and face scalded; Frank Titus, fireman, head scalded and cut; George Patterson, fireman, hands and face scalded; Patrick Doris, stationary engineer, back hurt. The explosion completely destroyed the boiler and engine; the roof and all the upper portion of the middle section of the round house, which contains six stalls, were completely demolished, and the heavy timbers falling upon the five other engines in that section, injured them to a greater or less extent. The shock of the explosion was felt all over the city, a mile from the scene of disaster.

TUG BOAT (13).—A despatch from Lake Charles, La., says, "The boiler of the tug *Ednos*, belonging to the North American Land and Timber Company, exploded January 23d, killing a German cook named Fred Smith, aged seventeen years. Captain B. F. Moss was thrown a distance of nearly four hundred feet and received fatal internal injuries. The only other person on the boat was J. J. Bullock, the engineer, who escaped uninjured.

PUMPING ENGINE (14).—The boiler of an old engine which was being used in pumping out an old hull at McConnellsville, Ohio, exploded January 26th, the main portion being carried sixty yards. Frank Demy, a boy of fourteen, was so badly injured that he died during the night. Wharf-master Samuel Paxton, was seriously injured about the breast and head, and Captain Morgan burned and scalded. Pilots Richardson of the *Cassell*, George Wallace, of the *Derol*, James Patterson, engineer of the sash factory, and Marion Murphy were all more or less injured.

DISTILLERY (15).—A terrific boiler explosion occurred at the distillery of John B. Thompson, Harrodsburg, Ky., January 27th. The engine-room and rear building were completely wrecked. One of the boilers was blown 300 yards. The fireman, Alex. Tasker, had both legs broken and was badly scalded. The loss is estimated at $4,000.

SAW-MILL (16).—A terrific explosion occurred at Clapp's mill, operated by C. E. Glasspoole, and located four miles southeast of Baldwin, Wis., January 28th, whereby one man was severely injured. Engineer Timothy Crowley, who in order to more rapidly fill the two outside boilers, shut the water off from the middle one, and, it appears, forgot he had done so. Upon discovering that there was no water in the gauge of the middle boiler he turned it on, and no sooner did the water touch the boiler than it exploded with tremendous force, carrying away a portion of the roof and completely wrecking the foundations of the boilers and engine.

SAW-MILL (17).—There was a terrific boiler explosion at a saw-mill four miles southeast of Breckenridge, Mo., January 28th, by which Spencer Reed, the engineer, and S. Adams, his step-son and fireman, were instantly killed, and a boy eleven years old was badly wounded. The engineer was blown against some rocks twenty feet distant with such force that his head was split open and his brains scattered over the snow. The fireman was literally torn to pieces, and fragments of the body were scattered around for thirty yards. Spencer Reed was thirty years old, and leaves a wife and six children. The mill was owned by Morrison Reed. The boiler was much out of repair, and was considered unsafe.

GAS WELL (18).—A boiler exploded at the gas well on the Montour road, thirteen miles from Pittsburg, Pa., January 30th, with serious results. One of the drillers, John Eagleson, had his right arm broken in two places, and two colored men, named Samuel and John Butler, were badly bruised and cut about the body. The explosion was caused by a defective seam in the boiler. A large fragment of iron struck a tree twelve inches in diameter near the derrick, and severed it in twain. The well was being drilled by the Enterprise Drilling Company, and Burd Garrett, in charge of the party, was standing near the boiler just two minutes before the explosion, and had only walked a few yards away when the explosion occurred.

SAW-MILL (19).—The man-head in the Shingle mill engine boiler of Perry & Baker, Cheboygan, Mich., lately blew out, and made a hole in the roof of the building twenty feet in diameter. No other damage was done.

The Locomotive.

HARTFORD, MARCH, 1886.

J. M. Allen, *Editor*. H. F. Smith, *Associate Editor*.

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Subscription price 50 *cents per year when mailed from this office.*
Bound volumes one dollar each.

Technical Impairment.

As considerable comment has been made by various journals about the manner in which the re insurance fund, or unearned premium liability, should be estimated in the case of boiler inspection and insurance companies, we deem it important that the matter be fully explained so that there shall be no misunderstanding. It has been argued that before estimating the unearned premium liability, the expense of inspections should be deducted from the entire premium receipts. This opinion has arisen honestly, no doubt, from a misapprehension of the facts in the case. It seems to have been assumed that one inspection is made before the boiler or boilers are insured, and that that is the end of the inspection part until the policy matures. The fact is, that the inspections are made at stated periods during the life of the policy. We agree to make a certain number of inspections, and, besides, respond to any calls upon us by the assured without additional expense to him, if his boilers show distress or weakness. Thus we receive pay for these inspections in advance, and they are not earned until the policy expires. They are a part of the contract, and a very impoitant part. If term policies are issued, the premium paid in advance covers the inspections for the whole term; and the inspection portion of the premium is not earned until the policy expires, any more than the portion paid for insurance is. If the premium, including inspections, is paid in advance for three years, those inspections must be kept up during that entire period; and for this work nothing additional is paid, and, further, the inspection part of the premium is not earned until the policy expires. We have, under the instructions of the various insurance commissioners, estimated our unearned premium liability on this basis, which we believe to be correct. It may be called unearned inspections, or, with the entire premium, unearned premium. We are not unfrequently called upon to make five or six inspections a year, and these we feel obligated to make whenever called upon during the life of the policy, whether it be for one year or for three years. We agree to make quarterly inspections annually, but we often make additional ones besides. Our inspection expenses average about thirty per cent. of the premium receipts; but in our statements the amount is made up from the expense account of our inspection department. Now it will be seen that writing policies for long terms at very low rates, and paying excessively high commissions, will put the balance on the wrong side of the account, for all the expenses incident to running the business, aside from the inspections, must be provided for. We have studied the methods of conducting this class of insurance for nearly twenty years, and we have always aimed to so manage our business that when the end of the year came round, and we were weighed in the official balances, we should not be found wanting. If the inspection expenses were to be deducted from our entire premium receipts, and the unearned premium liability estimated on the balance, it would largely increase our net surplus; but we have received the money for making these inspections in advance, and it will not be earned until the inspections are made and the policies expire.

The following appeared in the *Boston Advertiser*, February 26, 1886:—

Commonwealth of Massachusetts,
Insurance Department,
Boston, February 25, 1886.

By a recent official examination of the affairs and condition of the American Steam Boiler Insurance Company of the city and State of New York, it appears that the original stock of the company is impaired more than twenty-five per cent., to wit: in the sum of $63,010.61. While I do not anticipate a failure of the company to fulfill its existing policy contracts, I am obliged by its condition to revoke all certificates of authority granted in its behalf, or to its agents, to transact new business in this commonwealth, of which revocation the said company and its agents will take notice.

John K. Tarbox, *Insurance Commissioner.*

The directors of the American Steam Boiler Insurance Company held a meeting last week and voted to increase the company's capital to $500,000. The day before this action was taken the American's license to do business in Massachusetts was revoked. The effect of the additional capital will be to reduce the percentage of impairment, and permit the company to do business in States which allow an impairment of only twenty or twenty-five per cent. How wise the increase of capital is, time and future dividends alone can tell.—*The Chronicle, March* 4, 1886.

Query. If a semi-annual dividend of 3½ per cent. on $200,000 was replaced by direction of the Insurance Department of New York, what encouragement is there for investors to put up $500,000 capital? Will votes count as cash with Insurance Departments?

The annual report for 1885, of Mr. John Waugh, Chief Engineer of the *Yorkshire Boiler Insurance and Steam Users Co., Limited*, has been received. This company is in a very prosperous condition, and during the thirteen years of its existence not a single boiler under its inspection has exploded, and no loss of life has happened in connection with its boilers. This attests the complete success of the company, and justifies its work and position as a preventive of boiler explosions, by prompt, regular, and efficient inspection.

We have received the new Catalogue of the Holly Manufacturing Co., Lockport, N. Y., which contains cuts of various styles of the Gaskill Pumping Engine, with descriptions, much valuable information relating to the Holly System of water supply for cities and towns, and reports of great value on the duty attained by various pumping engines in different places.

It is gratifying to observe signs of returning prosperity in the industrial world, as evidenced by the numerous paragraphs in the daily press announcing a voluntary increase of wages by the proprietors of various establishments.

We wonder if it is possible for an Englishman, in England, to comment upon, or criticise with fairness, or even with an ordinary degree of intelligence, any product of the United States of America? Judging from a comparison of English and American Locomotives in a late issue of *Engineering*, we are forced to believe that it is impossible for one to do so. And yet, we exist, and will probably continue to do so, for some time to come.

Few ever give a thought to the way in which some of the most common and useful articles are manufactured, or the effect on the health of the workmen engaged in their manufacture or of some of the necessary operations thereof.

Statistics show that the average duration of life in some of the more common occupations are as follows: Grinders of forks, 29 years; of razors, 31 years; edge-tool grinders, 32 years; knife and file grinders, 35 years, and saw grinders, 38 years.

In every 100 sick among needle makers, 70 are consumptive; among file-makers, 62 are consumptive; and the average of steel-grinders of all kinds, over 40 in every 100 are consumptive.

Flint cutters and glass polishers have an average life of less than 30 years, and 80 out of every 100 die of consumption.

It is very generally supposed that small boilers used for special purposes are safe against explosion, but such is not always the case. A short time ago we chronicled an accident from the explosion of a small boiler used by a dentist in Bridgeport for vulcanizing purposes, and now a correspondent in Coldwater, Mich., sends us an account of one which occurred on the 19th of November last, at that place, which was attended by very serious results. The boiler, or more properly speaking, vulcanizer, was but six inches in diameter by twelve inches long. We clip the following account of the explosion from a Coldwater, Michigan paper:

An Arm Blown Off.— A terrible accident, by which Dr. A. Cope, the dentist, lost an arm and received other injuries, occurred last Thursday afternoon. He was looking at his vulcanizer — a sort of boiler of copper and iron, used to cook the rubber on false teeth,— when, without an instant's warning, it exploded with a tremendous noise, hurling the Doctor backward, completely shattering his left arm between the shoulder and elbow, inflicting a severe wound in the chest, as well as other slight bruises. Rising to his feet, he ran through three rooms, and out into the hall, where he fell into the arm of Dr. Brown, who had heard the explosion and started to learn the cause. As soon as possible the sufferer was taken to his home on Harrison street, where Dr. Baldwin, assisted by Dr. Brown, amputated the arm about two inches below the shoulder, dressed the other wounds, and made him as comfortable as possible. At first his recovery seemed very doubtful, but with a vigorous constitution, and the very best of care, it now looks as though he would be able to be out again in a few weeks. He is a member of the A. O. U. W., and his wife, who was temporarily prostrated by the terrible shock, is receiving valuable assistance from the order. A subscription-paper was started a day or two after the accident, and $100 subscribed in a short time — demonstrating the doctor's popularity and sympathy felt for him in his distress. Dr. Andrews very kindly volunteered to finish the work taken in and not yet completed by Dr. Cope, but we understand Dr. Goodrich will attend to it. Just the cause of the accident is not known, but it was doubtless the result of the thermometer attached to the vulcanizer failing to register properly the enormous heat and consequent pressure within. Dan Sone, the doctor's assistant, was in the room at the time and escaped without injury, although had he not changed his position a moment before the explosion, he would have been instantly killed. The force of the explosion tore out part of a partition, blew a hole through a door, and threw it from its hinges.

Dentists should never use these instruments without knowing how much pressure they will bear safely, and a pressure gauge should always be attached to them.

Safe Working Pressure for New Boilers.

The following short table which we use in our own practice in fixing the working pressure of new boilers may be of use to our readers. We also give in connection with it, the proper pitches for different thicknesses of plates, both single and double riveting.

The pressures given by the table are not so high as are allowed by the rules of the United States Board of Supervising Inspectors, but those in our opinion are somewhat greater than can be safely carried after a boiler has been in use for some time.

The pressures are based on a tensile strength for steel of 60,000, and of iron 50,000 pounds per square inch of section.

Thickness of Plates.	Diam. of Rivets.	Pitch.		Material.	Safe working pressure in pounds per square inch for shells with longitudinal seams double-riveted.						
		Single Riveting.	Double Riveting.		36″ Diam.	42″ Diam.	48″ Diam.	54″ Diam.	60″ Diam.	66″ Diam.	72″ Diam.
$\frac{1}{4}$″	$\frac{5}{8}$″	2″	3″	Iron Steel	115 135	100 115	85 100	70 85			
$\frac{5}{16}$″	$\frac{11}{16}$″	$2\frac{1}{16}$	$3\frac{1}{8}$	Iron Steel	135 160	115 135	100 120	85 105	80 95		
$\frac{3}{8}$″	$\frac{3}{4}$″	$2\frac{1}{8}$	$3\frac{1}{4}$	Iron Steel	160 190	135 160	120 140	105 125	95 115	85 100	80 95
$\frac{7}{16}$″	$\frac{13}{16}$″	$2\frac{3}{16}$	$3\frac{3}{8}$	Iron Steel	190 220	155 185	135 160	125 145	110 130	100 120	95 110
$\frac{1}{2}$″	$\frac{7}{8}$″	$2\frac{1}{4}$	$3\frac{1}{2}$	Iron Steel	210 250	170 205	150 180	140 165	125 150	115 135	105 125

We do not advise making 60-inch shells less than $\frac{5}{16}$, and 66 and 72-inch shells less than $\frac{3}{8}$ of an inch thick, and for each thickness of steel plate, the rivets if of iron, would better be $\frac{1}{16}$″ larger than are given in the table.

The Production of Pig Iron in the United States in 1885.

The American Iron and Steel Association have just completed their returns of the production of pig iron. The following tables give the returns in detail:

Production According to Fuel Used.

FUEL USED.	Production. Tons of 2000 lbs. (Includes spiegeleisen.)		
	First half of 1885.	Second half of 1885.	Total for 1885.
Anthracite,	703,217	751,173	1,454,390
Charcoal,	186,291	213,553	399,844
Bituminous,	1,261,308	1,414,327	2,675,635
Total,	2 150,816	2,379,053	4,529,869

PRODUCTION OF ALL KINDS OF PIG IRON BY STATES.

Production of Anthracite Pig Iron.

New York,	67,226	78,249	145,475
New Jersey,	28,014	45,653	73,667
Pennsylvania,	607,977	727,271	1,235,248
Maryland,	....	....	....
Total for 1885,	703,217	751,173	1,454,390
Total for 1884,	831,721	754,732	1,586,453

Production of Charcoal Pig Iron.

STATES.	Production. Tons of 2,000 pounds. (Includes spiegeleisen.) First half of 1885.	Second half of 1885.	Total for 1885.
Maine,	....	440	440
Massachusetts,	....	869	869
Connecticut,	7,017	10,483	17,500
New York,	7,965	6,717	14,682
Pennsylvania,	4,080	8,068	12,148
Maryland,	5,761	4,671	10,432
Virginia,	2,896	9,752	12,648
North Carolina,	820	970	1,790
Georgia,	644	5,153	5,797
Alabama,	31,304	46,269	77,573
Texas,	1,000	843	1,843
West Virginia,	....	....	....
Kentucky,	1,100	3,607	4,707
Tennessee,	13,410	17,763	31,173
Ohio,	10,061	7,957	18,018
Michigan,	66,557	76,564	143,121
Wisconsin,	17,867	1,762	19,629
Missouri,	12,147	9,638	21,785
Minnesota,	....	....	....
Oregon,	1,805	2,027	3,832
California,	....	....	....
Washington Territory,	1,857	....	1,857
Total, 1885,	186,291	213,553	399,844
Total, 1884,	205,371	253,047	458,418

Production of Bituminous Coal and Coke Pig Iron.

Pennsylvania,	555,798	642,302	1,198,100
Maryland,	2,622	4,245	6,897
Virginia,	71,731	79,403	151,134
Georgia,	7,000	20,127	27,127
Alabama,	86,882	62,983	149,865
West Virginia,	35,965	33,045	69,007
Kentucky,	15,668	17,178	32,846
Tennessee,	65,734	64,292	130,026
Ohio,	262,999	272,946	535,945
Indiana,	3,594	3,040	6,634
Illinois,	141,476	186,501	327,977
Michigan,	....	....	....
Wisconsin,	....	5,003	5,003
Missouri,	6,358	23,265	29,623
Colorado,	5,481	....	5,481
Total, 1885,	1,261,308	1,414,327	2,675,635
Total, 1884,	1,229,929	1,314,813	2,544,742

Total Production of Pig Iron.

STATES.	Production. Tons of 2,000 pounds. (Includes spiegeleisen.) First half of 1885.	Second half of 1885.	Total for 1885.
Maine,		440	440
Massachusetts,		869	869
Connecticut,	7,017	10,483	17,500
New York,	75,191	84,966	160,157
New Jersey,	28,014	45,653	73,667
Pennsylvania	1,167,855	1,277,641	2,445,496
Maryland,	8,383	8,916	17,299
Virginia,	74,627	89,155	163,782
North Carolina,	820	970	1,790
Georgia,	7,644	25,280	32,924
Alabama,	118,186	109,252	227,438
Texas,	1,000	843	1,843
West Virginia,	35,965	33,042	66,007
Kentucky,	16,768	20,785	37,553
Tennessee,	79,144	82,055	161,199
Ohio,	273,060	280,903	553,963
Indiana,	3,594	3,040	6,634
Illinois,	141,476	186,501	327,977
Michigan,	66,557	76,564	143,121
Wisconsin,	17,867	6,765	24,632
Missouri,	18,505	32 903	51,408
Minnesota,			
Colorado,	5,481		5,481
Oregon,	1,805	2,027	3,832
California,			
Washington Territory,	1,857		1,857
Total, 1885,	2,150,816	2,379,053	4,529 869
Total, 1884,	2,267,021	2,322,592	4,589,613

STOCKS OF ALL KINDS OF PIG IRON ON DECEMBER 31, 1883, DECEMBER 31, 1884, AND JUNE 30 AND DECEMBER 31, 1885.

Total Stocks of Unsold Pig Iron.

STATES.	Tons of 2,000 pounds. Dec. 31, 1883.	Dec. 31, 1884.	June 30, 1885.	Dec. 31, 1885.
New England,	12,437	11,433	8,222	8,997
New York,	65,901	69,347	47,242	32,796
New Jersey,	25 615	11,809	10,200	4,126
Pennsylvania,	195,804	221,849	257,358	117,209
Maryland,	10,899	7,637	8,604	10,145
Virginia, North Carolina, and Georgia,	30,601	41,226	37,722	31,311
Alabama,	9,531	21,436	31,209	17,693
West Virginia,	1,900	1,168	5,360	4,300
Kentucky,	8,216	9,724	10,150	5,819
Tennessee,	30,047	29,240	34,891	18,667
Ohio,	73,136	53,038	99,947	39,946
Michigan and Indiana,	36,405	60,715	69,068	68,479
Illinois,		4,200	5,906	3,834
Wisconsin,	6,340	7,366	13,154	9,425
Missouri,	21,641	37,588	48,175	38,058
Pacific States,	5,327	5,224	5,708	5,707
Total,	533,800	593,000	692,916	416,512

— *The Iron Age, Jan. 28th.*

A Long-Felt Want.

(NOT YET SUPPLIED. — *Editor Locomotive.*)

"This engraving is worth the price of the book alone, sir."

"Oh! it is, eh? What does it represent?"

"It shows how a boiler looks after it has exploded."

"Nonsense, man! What is there practical about that? Get up a picture showing how a boiler looks about an hour and a half before it is going to explode, and you can sell a copy to every engineer in the country."—*Phila. Call.*

Boxwood, which is almost exclusively used for wood engraving, is becoming more and more scarce. The largest wood comes from the countries bordering on the Black Sea. The quantity exported from Poti direct to England is immense; besides this, from 5,000 to 7,000 tons of the finest quality, brought from Southern Russia, annually pass through Constantinople. An inferior and smaller kind of wood, supplied from the neighborhood of Samsoun, is also shipped at Constantinople to the extent of about 1,500 tons annually. With regard to the boxwood forests of Turkey, the British Consul at Constantinople reports that they are nearly exhausted, and that very little really good wood can be obtained from them. In Russia, however, where some little government care has been bestowed upon forestry, a considerable quantity of choice wood still exists; but even there it can only be obtained at an ever-increasing cost, as the forests near the sea have been denuded of their best trees. The trade is now entirely in English hands, although formerly Greek merchants exclusively exported the wood. In the province of Trebizonde the wood is generally of an inferior quality; nevertheless, from 25,000 to 30,000 cwt. are annually shipped, chiefly to the United Kingdom.—*Paper World.*

An Iron Cement.

Usually certain proportions of pulverized sal ammoniac in crystals, sulphur, iron filings or drillings, and urine or water, has been deemed as quick and adhesive a cement for two iron surfaces as any that could be made. But this mixture sets slowly and requires days or weeks to get in its perfect work. The object of this cement is to oxidize the surfaces of the iron, so that close contact will unite the rust, and thus hold the two surfaces as one. Natural specimens of oxidizing of iron as cement are not uncommon. Almost all specimens of bog iron ore show aggregations of iron by rust, sometimes quite large masses being held in one firm embrace by this means; the writer saw in Nova Scotia lumps of bog iron ore aggregated by rust so that there was a conglomerate globe of separate globes of at least thirty inches diameter. In fact, the "rusting" of joints is an old trick with mechanics. But in place of sal ammoniac let the jointer use chloride of lime, one of the common disinfectants, and the fixity of the joint will surprise him. Two joints of 3-inch cast-iron pipe, with flanges sufficiently wide to take in three-fourth-inch bolts, were secured with a mixture (in the usual proportion) of cast-iron filings, water, and chloride of lime. The actual proportions were: Fine filings, ten parts; chloride of lime, three parts; water, enough to mix to a paste. These joints were bolted together after the mixture was placed between them, and after being left one night, when broken apart the cement scaled off a portion of the solid iron of one of the flanges. This cement has stood the action of sixty pounds of steam in a pipe connection to a steam boiler where rubber glands and canvas and white lead failed!—*The Iron Age.*

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY

NEW SERIES—VOL. VII. HARTFORD, CONN., APRIL, 1886 No. 4.

Defects of Various Kinds Discovered by Inspection.

The work of corrosion is insidious, whether it is external or internal. A boiler that is set in brick-work may leak at the seams, and corrode the plates adjoining, and yet there may be no indication of danger. So, by the use of impure water, a very dangerous process may be going on inside the boiler. In boilers covered more or less with scale its presence is often detected by red streaks where the scale is cracked. It attacks the edges of plates at the joints, and around the rivet heads. Sometimes it will attack two boilers working side by side. One will

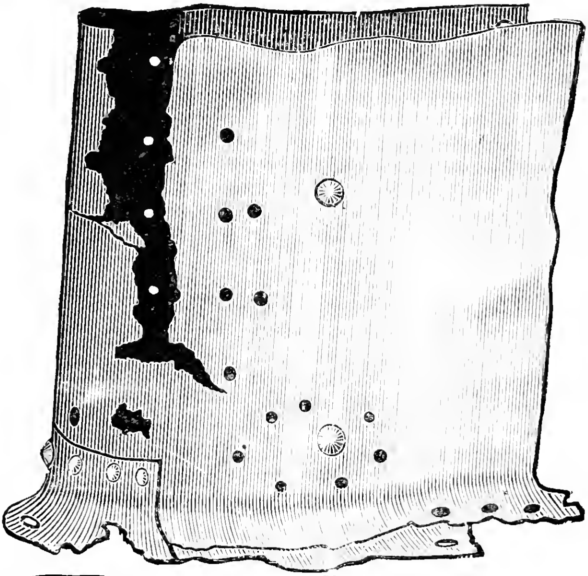


Fig. 1.

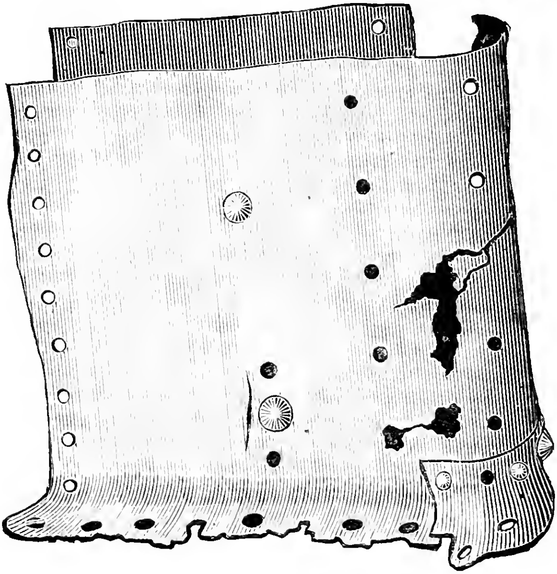


Fig. 2.

be corroded in the front part, and the other in the back part. Sometimes different sheets in the same boiler will be corroded, while others remain intact.

The accompanying cuts show some of the results of corrosion. Figs. 1 and 2 show a portion of the water leg of a steamboat boiler, the condition of which was discovered by inspection. The piece from which the drawings were made can be seen in our office. It is corroded through in spots, as may be seen from the cut, while a large portion of it is as thin as paper. It had been patched, but there was a very insufficient ground work for the patches. This steamboat was used in summer as an excursion boat, and thousands of people rode over the boilers in the condition shown.

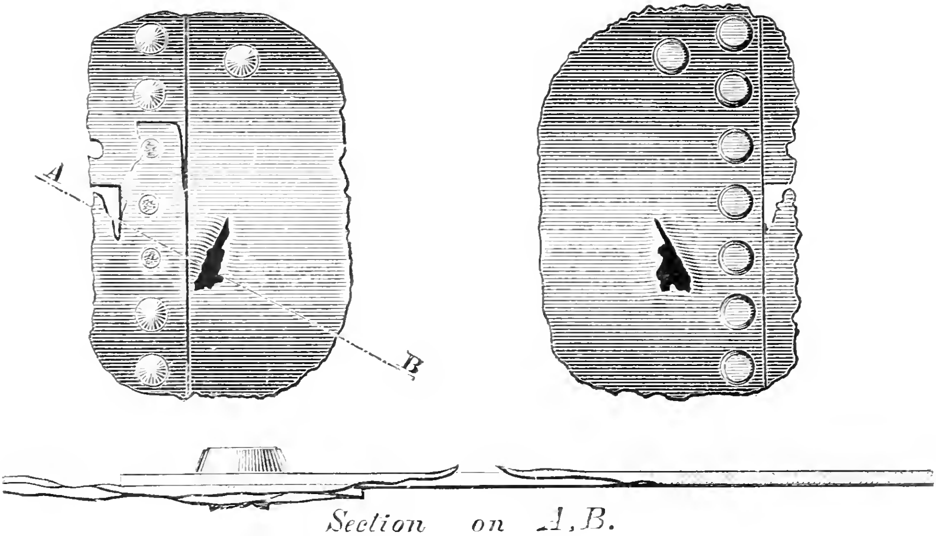


FIG. 3.

Fig. 3 shows another case of corrosion, of a type that is very common. The cut shows both the inner and outer sides of the sheet, and also a cross section. The hole shown was made by the inspector's chisel.

Again, boilers are often found in what is known as a pitted condition. This is manifested by small spots in close contact being eaten into the sheet. It looks like a pock-marked face and is sometimes confluent; and what is strange about this is, that

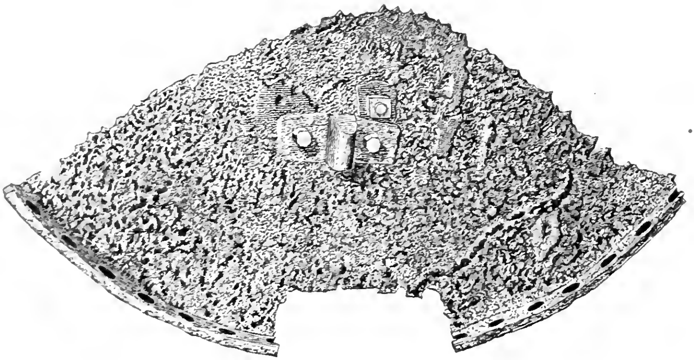


FIG. 4.

often certain sheets in the boiler will be attacked while others will remain sound, and the iron will bear the same brand on each plate. It is well known that iron ore even from the same mine is not always chemically the same; certain impurities will be found in some places which do not exist in others. And in the manufacture of boiler iron there is no doubt but that the sheets *may* be chemically slightly different, hence, when the boiler is in operation the presence of water may excite galvanic action. This would account for the manner in which some boilers are affected, while in other cases the cause of the trouble may be easily traced to a different source.

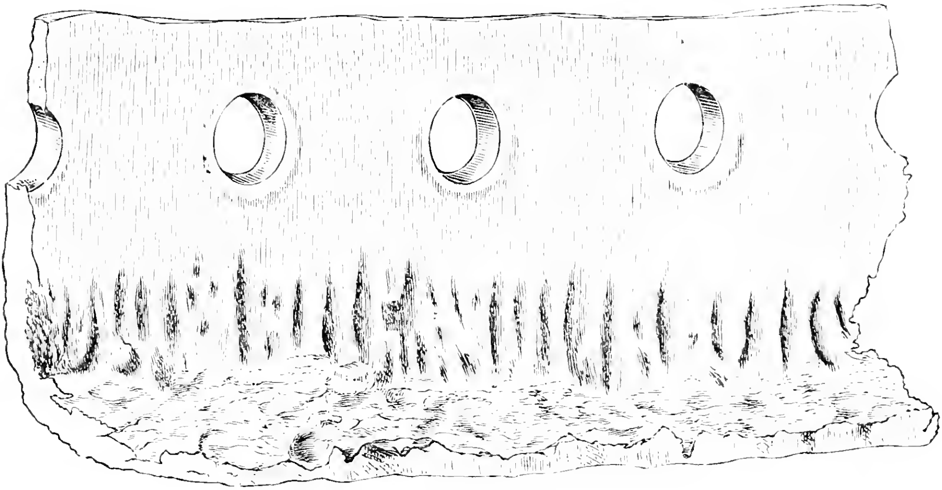


Fig. 5.

These peculiar cases of pitting are almost wholly confined to localities where the water is not of the best quality. The accompanying Figures 4 and 5 show a portion of the lower head of an upright boiler which was fed with water whose source was in a swamp. Figure 4 shows the entire piece, and Figure 5 an enlarged view of the small piece cut out as shown on the lower edge of Figure 4.

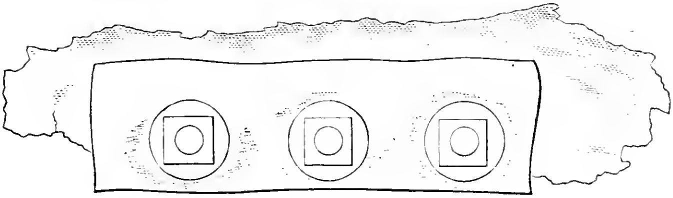


Fig. 6.

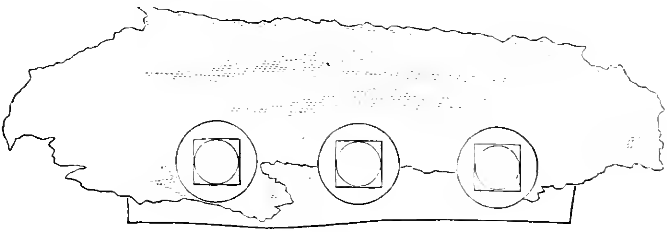


Fig. 7.

When a weak or corroded spot is found in a boiler, it should be carefully examined with reference to the best means of repairing it. If the sheet is found to be corroded so thin that there is not strength enough to hold the rivets necessary in patching, the sheet should be entirely removed and a new one substituted. Or, if the defective spot is confined to only a portion of the sheet, the iron should be cut away until the sound metal is reached, and the patch should be riveted thoroughly to the sound portions of the sheet. Soft patches are not to be recommended in any portion

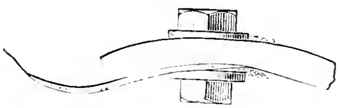


Fig. 8.

of a boiler, and should only be allowed in exceptional cases, and on those portions of a boiler remote from the fire.

Figures 6, 7, and 8 show what may happen when soft patches are allowed. The rectangular piece is a patch, the thickness being one-fourth of an inch. The drawings are made to scale from the specimen now in our office. From an examination of Fig. 8, a very clear idea may be gained of the very small thickness of metal left in the sheet to which the patch was bolted. It is difficult to express the character of such work, and yet it is done every day.

Inspectors' Reports.

FEBRUARY, 1886.

During the month of February our inspectors made a total of 2,848 inspection trips, examined 5,961 boilers, 2,090 both externally and internally, and tested 275 by hydrostatic pressure.

4,085 defects were reported, of which number 640 were considered dangerous, and led to the condemnation of 29 boilers. Our usual summary of defects is given below.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	349	18
Cases of incrustation and scale,	516	22
Cases of internal grooving,	19	12
Cases of internal corrosion,	131	15
Cases of external corrosion,	367	33
Broken and loose braces and stays,	62	36
Settings defective,	151	13
Furnaces out of shape,	199	10
Fractured plates,	147	75
Burned plates,	101	32
Blistered plates.	181	18
Cases of defective riveting,	728	68
Defective heads,	35	17
Serious leakage around tube ends,	392	102
Serious leakage at seams,	227	61
Defective water-gauges,	107	14
Defective blow-offs,	60	10
Cases of deficiency of water,	18	11
Safety-valves overloaded,	21	13
Safety-valves defective in construction,	48	15
Pressure-gauges defective,	223	44
Boilers without pressure-gauges,	2	0
Defective feed,	1	1
Total,	4,085	640

Defective settings are probably responsible for as great a proportion of wasted fuel as any one thing about the boiler-room. With the ordinary tubular boiler, the setting is a very important matter, and unless it is well done, and kept in good order, great waste of heat will ensue.

Settings may be defective in design, in the execution of the mason work, or they may be badly out of repair, either from the effects of long use, or bad management. Of a somewhat different nature from the above defects are many of the various clap-trap arrangements which enterprising and glib tongued inventors continually foist upon misguided steam-users, but the results are about the same, when the attachments are complete, the plant, as a whole, is defective and many times dangerous.

As a general rule it may be stated that the simpler the design of a boiler setting is, the more efficient and durable it will be found in actual practice. The walls should be laid up with good hard burned bricks with close joints. The furnace should be lined from the front end to a short distance back of the bridge wall with fire brick laid in a thin fire clay paste, just enough of it should be used to fill up the inequalities of the bricks, and give them a good bearing. This lining should begin a few inches below the grates and extend up to where the setting is closed in to the boiler-shell. Where it can be afforded, the entire surface of the setting exposed to fire may be lined with fire brick with excellent results, but it is not absolutely necessary.

The grate-surface should be from one-fortieth to one-fiftieth of the heating surface of the boiler, and the tops of the grates should, under ordinary conditions, be about two feet from the lowest point of the boiler-shell. This gives ample room for combustion with any ordinary fuel, and *more* than this is detrimental, for, the further the fire is from the boiler-shell, the less will be the intensity of the radiant heat, a very important thing. The writer does not believe in any sort of a detached furnace arrangement, except in special cases. They have uniformly proved themselves failures wherever they have been tried, which is what might naturally be expected.

Setting walls should be so designed that they will have a chance to expand when the boiler is fired up, without tearing themselves to pieces. This is one of the most difficult things to guard against that is met with, but it can be successfully met if due care is exercised in designing and executing the work.

After long use, however, any wall of masonry exposed to intense heat will become shaky, this is unavoidable from the nature of the materials used, and when a boiler setting attains this condition, it should be at once re-laid. When a setting is full of cracks, the loss of heat and efficiency through leakage of air is greater than is generally supposed.

Boiler Explosions.

FEBRUARY, 1886.

Saw-Mill (20).—P. J. Peterson, near Cokato, Minn., February 1st, left the engine of his saw-mill in charge of his son aged about fifteen years, and shortly after the boiler exploded throwing pieces of it for over twenty rods, and with such force as to cut off quite large limbs of trees which the fragments struck. Oscar Calendar was scalded about his face and neck; John Calendar had his left arm and hip quite badly burnt; A. L. Cooley had his right shoulder bruised considerably, and S. T. A. Anderson got his right leg pretty badly scalded, and his arms and face somewhat bruised. It was a narrow escape for all.

Cotton Press (21).—A serious boiler explosion occurred February 2d, at Penn's cotton press, on Terpsichore street, between Tchoupitoulas and Levee streets, New Orleans, four men and a boy being badly scalded. The men were all at work when the steam drum head blew out, followed by a stream of hot water and escaping steam. Patrick Bowen, the engineer; Charles Schneider, captain of the gang; Peter Deal, his son Henry Deal, a boy about seventeen years of age, and Ernest Smith, truckers, were around the boiler and received the full stream of boiling water in their faces. The scalded men were taken to the hospital, where their injuries were found to be: — Bowen, scalded about the head, face, and hands; Schneider, Peter Deal, and Smith, about the face, arms, and hands. The boy Henry Deal, was badly scalded on the body, arms, face, and head, and is thought to be fatally injured.

STEEL WORKS (22).—One of the boilers of No. 1 battery at the Homestead Steel Works, Pittsburg, Pa., exploded February 3d. The whole top of the boiler for about four feet was taken out and lapped over. Part of the brick stack was torn out, and in the roof of the building was a hole 30 feet square. Pieces of the roof were found scattered in all directions. The "water-tender," John Close, was severely cut about the head, but no one else was injured.

HOT WATER BOILER (23). — While the family of Reinhold Schumann of No. 226 Market street, Newark, N. J., were at breakfast, February 5th, they were bombarded by bricks, buckwheat cakes, and dishes which came flying through the dining-room wall. The waterback in the kitchen exploded, and $200 damages was done before the firemen could extinguish the fire caused by the live coals.

PENITENTIARY (24).—There was a terrific boiler explosion at the Onondaga County Penitentiary, Syracuse, N. Y., February 6th. The shock was very heavy, and houses near by were shaken and windows broken. The explosion took place in the shops of the Syracuse Bolt Company, who employ convict labor at the prison. One of their large boilers exploded and demolished one building, which stood by the side of and opened into the main shop, where eighty men were at work. The boiler was lifted fifty feet and landed forty feet distant. The shop where the convicts were at work was filled with steam and dust and the men were thrown down and trampled on each other in their fright. Engineer John Bauman was buried in the ruins, but was taken out alive. Jack Boyd, a convict, was cut about the head, and many others met with slight bruises. Every window in the main shop was blown out, and the walls were cracked. It was a narrow escape for the prison and its inmates.

RESTAURANT (25).—A boiler explosion occurred February 5th, in the cook-room of a restaurant at 65 Wall street, N. Y., whereby Annie Robben, the cook, was badly bruised about the head and face. Herman Ey, an employee, was also badly burned about the head. Damage to property slight.

CAR-HEATER (26).—The pipes having become frozen, the heating apparatus in a Pullman car at Washington, D. C., February 5th, exploded, tearing out the end of the car, and throwing pieces as far as the sidewalk. Some of these struck houses on Virginia Avenue, damaging the fronts to the amount of about $150. It will cost $500 to repair the car.

FEED-MILL (27).—By the blowing up of the boiler in the feed-mill of Follett & Stanley, Oshkosh, Wis., February 10th, the mill was entirely wrecked, some of the fragments being thrown a dozen rods away. Walter Follett, one of the proprietors of the mill, who happened to be examining some of the machinery near the boiler, was instantly killed. His body was thrown one hundred and fifty feet or more into the air, and fell in mutilated fragments a block away from the mill. Reinhold Steinke, an employee in the mill, was blown several rods away, his body falling in many pieces. Edward Corcoran, who happened to be driving by the mill at the time of the explosion, had one arm and one leg broken, and suffered other serious injuries. He is not expected to live. A young man named William Clements, who was outside, had an arm broken and was otherwise injured. Several other people received injuries more or less severe.

STEAMER (28).—A terrible accident occurred on the steamer *Mariposa*, February 14th, which resulted in the instant death of two men and the horrible scaldiug of three others. The vessel left Honolulu at 9 A. M., and at ten stopped outside to discharge her pilot.

The latter had scarcely left the steamer when two of the tubes exploded in the boiler. Five men were in close proximity at the time, and were deluged with hot water and steam. John Whitmarsh and Richard Carroll were instantly killed, and firemen Thomas Hanson and George Riley and a water-tender named Brown were scalded. Hanson and Riley were seriously injured, the former probably fatally.

LOCOMOTIVE (29). — A flue of a Boston and Albany engine boiler blew out February 15th, badly scalding Engineer Brackett's face and hands.

STEAMER (30). — John O'Donnell, an oiler on the steamer *Cape Charles* was dangerously scalded by the blowcock of the boiler blowing out at Norfolk, Va., February 19th.

RUBBER WORKS (31). — At the Akron Rubber Works, two vulcanizers exploded February 19th, one while the men were at dinner. Several hundred dollars' worth of damage was done. By the second explosion a female employee was badly scalded about the head and face.

GRAIN ELEVATOR (32).—The boiler in the Minneapolis & Northern elevator at Hamilton, Dakota, blew up February 22d, with fifty pounds of steam, completely demolishing the boiler-room. The agent and engineer narrowly escaped, as they had just left the room. No one was hurt.

FLOURING-MILL (33).—The boiler in Stokes Brothers' flouring mill Wyoming, Ont., exploded February 23d, instantly killing David Service, the engineer, and dangerously wounding Robert Brown. The building was completely wrecked. A number of millwrights, who were engaged at the time in putting up machinery in the mill, miraculously escaped injury.

LOCOMOTIVE (34).—The boiler of an engine on the Chicago & St. Lawrence railway exploded near Kernan, Ill., February 24th. Engineer Ashling was thrown a distance of seventy-five yards over the telegraph wires and killed. Fireman Cunliff received a few dangerous bruises.

SAW-MILL (35). — The boiler in Davis & Deitzel's mill, near Piotona, Miss., exploded February 25th, one end being thrown 150 feet, cutting down the trees in its course. No one was injured.

OIL WELL, PORTABLE (36).—The boiler of a portable engine used at the Belfont gas well, Ironton, Ohio, exploded with terrific force, February 27th, the boiler being hurled high into the air, and came down, crushing through the roof of the Belfont Nail-Mill, and alighting among the operatives. Luckily the day's work was done, and only a few of the workmen were in the factory at the time of the accident, the rest having just left. Had the accident happend forty minutes sooner, the loss of life would probably have been great, as the collapsed boiler fell in the part of the factory where a large number of men and boys generally work. As it is, only one man was injured, and his wounds are not dangerous. The damage to the Belfont Iron-Works Company will be about $300. The engine was owned by Henchberger & Taylor, who were drilling the gas well, and is nearly a total wreck. It is supposed that the water in the boiler got too low, causing the explosion.

PORTABLE (37).—A steam-boiler, used for the purpose of hoisting material to the upper stories of some new buildings on 10th avenue, between 74th and 75th streets, N. Y., blew up with terrific force, February —, scattering large pieces of iron in every direction. Fortunately, there was no one near at the time of the explosion, and but little damage was done.

The Locomotive.

HARTFORD, APRIL, 1886.

J. M. ALLEN, *Editor.* H. F. SMITH, *Associate Editor.*

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 *cents per year when mailed from this office.*
Bound volumes one dollar each.

OUR monthly list of boiler explosions is made up principally from Associated Press dispatches; therefore, when our readers find reported a fearful explosion which never occurred, we beg them to be lenient and "let us down easy."

For instance, the tow-boat *Iron City* was reported blown up at Pittsburg, Pa., by the explosion of her boilers on the 2d day of December last. Our account of this explosion, which will be found in the February LOCOMOTIVE, page 24, was the regular Associated Press dispatch. The U. S. Inspector of steamboats at Pittsburgh, writes us that it was not a boiler explosion at all, but an explosion of natural gas that did the mischief. The boat grounded near the gas main, where it crosses the Alleghany river, and finally it was supposed, broke it and allowed the gas to escape. This finally ignited and exploded with the result given in the dispatch.

FOR several months past there has been more or less discussion in several of the engineer's papers concerning the temperature of exhaust steam, and the temperature to which it is possible to heat feed-water by means of this exhaust when a closed heater is used. Although we think much of the discussion, as it has been printed, has been put forth for advertising purposes merely, and is therefore out of place in the columns of THE LOCOMOTIVE, a few words on the general principles involved may not be amiss.

The average pressure of the atmosphere at the surface of the earth in these latitudes is about 14.7 pounds per square inch. Steam, before it can escape from the water, when formed in an open vessel, must attain this pressure. The corresponding temperature is 212° on Fahrenheit's scale. This is a fact which has been proved experimentally, and any one can demonstrate it for himself with a twenty five cent thermometer, and a tea-kettle. But be sure the thermometer is correct. Ordinary thermometers are quite apt to be a degree or two in error at this point. For all pressures of saturated steam there is a certain definite temperature. In fact it is the *temperature which determines* the pressure. The two are inseparably connected. When the exhaust-valve of an engine opens, the terminal pressure in the cylinder may be at a much higher pressure than the atmosphere, but the instant the valve is opened, if there is no obstruction, the pressure of the steam falls to that of the atmosphere, and its temperature falls at the same time to 212° Fah. The second law of thermodynamics is: — Heat cannot pass from a cold body to a hot one by a purely self-acting process. In ordinary cases people express the same thing by saying, "Water cannot run up hill." This being the case, and we do not think it needs any demonstration, it will be seen that it is highly improbable that steam having a temperature of 212° *can* heat water to a temperature above 212°. If the exhaust passages are choked so that the steam cannot readily escape, it may show a temperature above 212° Fah., but if it does, its pressure will be above that of the atmosphere. This would manifest itself in the cylinder of an engine as back pressure.

Without back pressure, 212° is the highest to which it is possible to heat feed-water with exhaust steam, when the barometer stands at 29.92, this is the limit, which cannot be exceeded; 210° should satisfy any one, and 200° to 206° are excellent results.

The Know-it-alls in technical literature, more especially that part of technical literature which pertains to steam engineering, steam engines, boilers, etc., are legion, and their number is increasing daily. What they would do if they did not have some medium through which to "blow-off," as it were, their high pressure wisdom, it is difficult to say; probably the community would suffer more than it does now, if such a thing be possible. One of the most amusing things is the ease with which some of these chaps handle the subject of the expansion of steam. People who have studied this matter thoroughly, and have made many careful experiments, are ready to admit that there is yet something to learn about it, but the case is far different with some others. Only a short time ago one of them gave utterance to the following: "Why! I thought that any one who had studied this matter *at all* (referring to the expansion of steam) knew *all about* it!" It is safe to say that a man who would make such a statement as this, knows *nothing* about it himself.

Hand-hole plates should always be carefelly packed, and the engineer should be sure they are perfectly tight before starting his fire, for their location, especially the one in the back head of the boiler, renders work on them, while there is any fire on the grates, a very disagreeable and sometimes impossible piece of work.

Any slight leakage around hand holes, when continued for a considerable time, is sure to result in corrosion of the tube-sheet to such an extent that it will be a difficult matter to pack the plates. When this state of affairs is reached, a patch is necessary. With ordinary care, however, such measures will never be required.

Some manufacturers of boilers object to putting a hand-hole in the back head of the ordinary tubular boiler, giving as a reason therefor, that the hand hole plate is exactly the same thing, in such a location, as a soft patch, and is equally liable to give trouble. We do not share in this opinion. A hand-hole should always be put into the back head of a boiler unless there is a man-hole in the front head below the tubes. In this case the hand-hole will not be absolutely necessary, but it will do no harm. The idea that it will give trouble is a wrong one. Properly cared for and packed so that no leakage can occur there never will be the slightest trouble with a hand-hole in this location. Four inches by six inches is the best size for a hand-hole, this allows very effective cleaning to be done through it. Very small sizes are difficult to clean out through, and should be avoided in tubular boilers of the larger and better kind. In small, vertical boilers three inches by five inches is a very good size to put in at the bottom of the water leg, and at the level of the crown sheet. But each boiler should have three hand-holes at bottom of water-leg, and three at the level of the crown sheet. The distances to be reached for scale in these cases are so short that small hand-holes answer very well to work through.

A carpet merchant in Vienna has a curious collection of ancient woolen and linen cloths, including more than 300 specimens. Many of them have been taken from tombs, and are stretched on to folios of cardboard to preserve them. Some of the fragments are only a foot square, but the larger ones make up an entire Roman toga, which is said to be the only one in the world. There are a great many embroidered dresses and a deal of knitting and crewel work. Double chain stitch seems to have been as familiar to the Egyptian seamstress, sewing with bone needles, as it is to modern women. There are some very quaint and unusual designs in the old collection of cloths, but there are also some very common things. It is curious to find that the common blue check pattern of our dusters and workhouse aprons was in general use among the Egyptians more than a thousand years ago.—*Boston Journal of Commerce.*

Average prices of Commodities for the past Forty Years.

The report of Mint Director Kimball, on the production of the precious metals in the United States in 1885, contains the following interesting tables, showing the prices of the principal commodities in the New York market for various years between 1845 to 1885:

AVERAGE PRICES IN NEW YORK.

	For the six-year period—1845–1850.	For the year 1882.	For the year 1883.	For the year 1884.	For the year 1885.
Flour, superfine, bbl.,	$5.450	$3.958	$3.410	$2.859	$3.205
Rye flour, bbl.,	3.597	3.247	3.723	2.691	3.677
Corn meal, bbl.,	3.205	3.918	2.922	3.038	3.040
Wheat, Northern, bush.,	1.167	1.277	1.206	1.016	.970
Rye, bush.,	.734	.333	.700	.691	.709
Oats, bush.,	.416	.575	.503	.368	.361
Corn, bush.,	.662	.796	.644	.016	.528
Coal, anthracite, ton,	5.465	4.335	3 350	4.106	3.825
Coffee, Rio, lb.,	.074	.098	.104	.109	.093
Java, lb.,	.083	.160	.177	.165	.125
Copper, pig, lb.,	.176	.185	.160	.141	.112
Sheathing, lb.,	.223	.280	.240	.200	.160
Cotton, upland, lb.,	.084	.118	.103	.109	.082
Fish, cod, cwt.,	2.851	6.574	6.311	5.267	4.274
Mackerel, bbl.,	10.469	18.790	17 520	21.534	20.419
Hops, lb.,	.120	.458	.562	.245	.134
Iron, Scotch, ton,	31.072	26.753	24.000	21.618	20 630
Lead, pig, cwt.,	4.217	4.960	4 340	3.822	3.925
Leather, lb.,	.147	.237	.232	.237	.221
Molasses, New Orleans, gall.,	.281	.587	.529	512	.507
Nails, cut, lb.,	.043	.041	.039	.038	.022
Wrought, lb.,	.104	.053	.052	.051	.035
Naval stores, turpentine, gall.,	.366	.515	.428	.324	.343
Resin, bbl.,	.832	2.115	1.623	1.351	1.137
Paint, red lead, cwt.,	5.790	6.300	5.800	5.700	5.490
Pork, mess, bbl.,	11.499	17.040	16.690	16 363	11.645
Prime, bbl.,	9.299	. . .	14.540	14.851	10.076
Hams, lb.,	.084	.140	.139	.131	.108
Lard, lb.,	.073	.119	.100	.083	.068
Rice, cwt.,	3 485	5.900	6.400	6.100	5.384
Salt, Liverpool, sack,	1.352	.750	.710	.700	.732
Sugar, Cuba, lb.,	.072	.073	.068	.053	.053
Loaf, lb.,	.097	.099	.091	.074	.069
Tallow, American, lb.,	.075	.083	.078	.071	.056
Tobacco, manufactured, lb.,	.144	.176	.180	.210	.185
Wool, common, lb.,	.274	.306	.302	.265	.343
Merino, lb.,	.355	.455	.440	.409	.266
Pulled, lb.,	.279	.386	.381	.339	.298

COMPARISON OF PRICES OF 1881 AND SUBSEQUENT YEARS WITH THE AVERAGE PRICES OF 1845–50. EXPRESSED IN 1000.

	For the year 1881.	For the year 1882.	For the year 1883.	For the year 1884.	For the year 1885.
Flour, superfine, bbl.,	$814	$726	$626	$525	$588
Rye flour, bbl.,	980	903	757	749	1,022
Wheat, Northern, bush.,	1,120	1,094	1,033	871	831
Rye, bush.,	1,395	1,135	994	941	966
Oats, bush.,	1,163	1,382	1,209	885	868
Corn, bush.,	944	1,202	973	931	798
Coal, anthracite, ton,	771	791	795	751	700
Coffee, Rio, lb.,	1,568	1,324	1,405	1,473	1,257
Java, lb.,	2,084	1,928	2,133	1,988	1,506
Copper, pig, lb.,	1,040	1,051	909	801	636
Sheathing, lb.,	1,121	1,256	1,076	896	717
Cotton, upland, lb.,	1,369	1,405	1,226	1,298	976
Fish, cod, cwt.,	1,911	2 306	2,214	1,847	1,499
Mackerel, bbl.,	1,814	1,795	1,670	2,057	1,950
Hops, lb.,	1,675	3,816	4,683	2,042	1,117
Iron, Scotch, ton,	787	861	772	696	664
Lead, pig, cwt.,	1,152	1,176	1,029	906	931
Leather, lb.,	1,592	1,612	1,578	1,612	1,503
Molasses, New Orleans, gall.,	1,694	2,089	1,883	1,822	1,804
Nails, cut, lb.,	860	953	907	884	512
Wrought, lb.,	471	510	500	490	337
Naval stores, turpentine, gall.,	1,284	1,407	1,169	885	937
Rosin, bbl,	2,484	2,542	1,951	1,624	1,367
Paint, red lead, cwt.,	1,086	1,088	1,002	984	948
Pork, mess, bbl.,	1,504	1,482	1,451	1,423	1,013
Prime, bbl.,	1,696	. . .	1,564	1,597	1,084
Hams, lb.,	1,381	1,667	1,655	1,560	1,286
Lard, lb.,	1,644	1,630	1,370	1,137	932
Rice, cwt.,	1,779	1,693	1,837	1,751	1,545
Salt, Liverpool, sack,	515	515	525	518	541
Sugar, Cuba, lb.,	1,069	1,014	944	736	736
Loaf, lb,	1,031	1,021	938	763	711
Tallow, American, lb.,	933	1,107	1,040	947	747
Tobacco, manufactured, lb.,	1,354	1,222	1,250	1,458	1,285
Wool, common, lb.,	1,058	1,117	1,102	967	1,252
Merino, lb.,	1,279	1,282	1,239	1,152	749
Pulled, lb.,	1,305	1,384	2,366	1,215	1,068
Average,	$1,282	$1,371	$1,308	$1,161	$1,009
Average, exclusive of copper, the recent decline of which is believed to be mainly a result of increased production,	$1,293	$1,384	$1,325	$1,179	$1,027

The Effects of Blue Heat on Steel and Iron.

At a meeting of the British Institution of Civil Engineers, January 26th, Mr. C. E. Stromeyer read a paper on the above subject from which we make the following extracts.

It was stated that in spite of the many excellent qualities possessed by mild steel, and in spite of its extended use for shipbuilding and for marine boilers, many engineers considered it a treacherous material. They were able to adduce numerous instances in which steel plates and bars had failed, in their opinion, in an unaccountable manner. In nearly all such cases a cursory examination brought out the fact that the plates in question had been subjected to bending or hammering while hot, and there could be little doubt that while these plates were being worked they were at a blue heat, or as smiths and boiler-makers termed it, a black heat. It should, by this time, be well-known that such treatment was the most injurious to which steel could be subjected, and therefore that such failures could not properly be regarded as unaccountable. Iron possessed the same peculiarity, but being less ductile than steel, similar failures were not so glaring.

The author then mentioned cases in which plates, both of iron and of steel, had failed without this treatment, although the quality of the material was good according to the usual tests. Three hundred and thirty experiments had been made in connection with the subject of the paper, and consisted mainly of bending and of tension tests. The results were contained in tables and in diagrams.

It appeared that the limit of elasticity of both iron and steel was raised by repeated tension testing. In some cases the limit rose above the original breaking stress, although the ultimate breaking-stress was only slightly affected. The total elongation was reduced by previous mechanical operations, while the contraction varied considerably. A test piece which had been shortened when cold, showed a reduction of the elastic limit, but another piece, which had been shortened when hot, showed an increase.

By the expression "blue heat" the author meant to include all those temperatures producing discoloration, ranging from light straw to blue, of the surface of bright steel or of iron.

The author showed that steel which had been bent cold, either once or twice, would stand almost as many subsequent bends as the original test pieces, but if the same material was bent once while blue-hot, it lost a great deal of its ductility. Out of twelve samples, in which two preliminary hot bends were made, nine broke with a single blow of a hammer, and the other three only stood one or two subsequent bends. Thin Lowmoor iron did not break quite so easily, but supported about one-half the original number of bends. The following table contains some of these results:

	Medium hard steel, $\frac{3}{8}$ in.	Mild steel, $\frac{3}{8}$ in.	Very mild steel, $\frac{3}{8}$ in.	Lowmoor iron 3 16 inch.
Unprepared or annealed,	21	$12\frac{1}{2}$	26	20
Broken hot (blue),	$2\frac{1}{2}$	$1\frac{1}{2}$	$2\frac{1}{2}$	3
1 preliminary hot bend,	3 mean	$2\frac{1}{6}$ mean	11 mean	12 mean
2 " " bends,	$\frac{1}{3}$ "	$\frac{1}{3}$ "	$\frac{2}{3}$ "	10 "
1 preliminary cold bend,	20	$9\frac{1}{2}$		
2 " " bends,	$19\frac{1}{2}$	$8\frac{1}{2}$	19	13
4 " " "			13	11
8 " " "			15	6

The experiments all pointed unmistakably to the great danger incurred if iron and steel were worked at a blue heat. The difference between good iron and mild steel seemed to be, that iron broke more readily than steel while being bent; that iron suffered more permanent injury than steel by cold working, but that if it had successfully withstood bending when hot, there is little probability of its flying to pieces when cold, like mild steel.

It was a common practice among boiler-makers to "take the chill out of a plate" if it required a little setting, or to set a flanged plate before it was cold. This was nothing else than working it blue hot, and should not be allowed. All hammering or bending of iron and steel should be avoided, unless they were either cold or red hot. Where this was impossible, and where the plate or bar had not broken while blue-hot, it should be subsequently annealed. It was satisfactory to learn that since the introduction of mild steel, a practice had been gaining ground among boiler-makers, which must have the effect of guarding against such failures, and should be encouraged. It consisted in the cessation of work as soon as a plate which had been red-hot became so cool that the mark produced by rubbing a hammer-handle on another piece of would, would not glow. A plate which was not hot enough to produce this effect, yet too hot to be touched by the hand, was most probably blue-hot, and should under no circumstances be hammered or bent.

The theory that local heating of a plate sets up strains which sometimes caused failures, did not appear to be supported by the experiments. But it was doubtful whether the proposal to locally re-heat a plate, which had been worked while hot, in order to anneal this part, should be carried out. Several test-pieces were made red-hot, or blue-hot, and then were slowly cooled by holding one of their edges in cold water. As might have been expected, the medium hard steel lost much of its ductility. The other steels, and the iron, were not greatly affected, as will be seen from the following table:

	Medium hard steel.	Mild steel.	Very mild steel.	Lowmoor iron.
Unprepared or annealed, ...	21	12½	26	20
Quenched red hot in boiling water, ...	24	10		
" " " cold "	1	10	19	20
Red hot, quenched edge in cold water, ...	3	8	25	27
Blue hot, " " " "	3	6½	19, 19	21, 14

The author concluded by suggesting that the question should be further investigated, and that steel manufacturers should endeavor to ascertain whether every quality of steel was made permanently brittle by being worked at a blue heat, or whether this was independent of the various impurities contained in it; and also whether prolonged exposure to a blue heat could produce the same effect.

Comparative Value of different kinds of Wood and Coal for Fuel.

The following table shows the weight of one cord of various kinds of wood, dry, and their relative values for fuel, red oak being taken as the standard:

Kind of Wood.	Weight of one Cord in pounds.	Relative Value for Fuel.
Red Oak, ...	3,254	1.00
Shell-bark Hickory, ...	4,469	1.45
Chestnut White Oak, ...	3,955	1.25
White Oak, ...	3,821	1.17
White Ash, ...	3,450	1.12
White Beech, ...	3,236	.94
Black Walnut, ...	3,044	.94
Black Birch, ...	3,115	.91
Yellow Oak, ...	2,919	.87
Hard Maple, ...	2,878	.87
White Elm, ...	2,592	.84
Large Magnolia, ...	2,704	.81
Soft Maple, ...	2,668	.78
Soft Yellow Pine, ...	2,463	.78
Sycamore, ...	2,391	.75
Chestnut, ...	2,333	.75
White Birch, ...	2,369	.70
Jersey Pine, ...	2,137	.70
Pitch Pine, ...	1,904	.62
White Pine, ...	1,868	.61

The values given above are from Knapp's *Chemical Technology.*

The following table, useful in connection with the preceding one, is reproduced from our issue of May, 1883. It shows the value of different coals for fuel purposes, the comparison being made with oak wood as the standard:

	Designation of Coal.	Mine, where located.	Percentage of combustible in coal.	Number of lbs. of water evaporated per lb. of coal from atmospheric pressure and 212°.	Equivalent in lbs. of coal per one cord of standard oak.
1	Semi-bituminous, Standard Coal Co.,..	Brothers Valley, Somerset County, Pa........	88.99	9.85	1.521
2	Semi-bitu'nous, Philson Iron Coal Co.,	Berlin, Somerset County, Pa	90 92	9.75	1,537
3	Forest Improvement anthracite,......	Richardson colliery, Schuylkill County, Pa.,..	79 43	9.37	1,598
4	Wilkesbarre anthracite,..	Black Diamond, Northumberland County, Pa.,	80 77	9.37	1.598
5	Scranton anth'cite, Del. & H. Canal Co..	Luzerne County, Pa.,..	77.3	9.28	1.614
6	Lykens Valley anthracite,.....	Dauphin County, Pa.........................	83.97	9.07	1,651
7	Bitu'nous c'l, Simpson Horner & Sons,	Monongahela River, Pa......................	92.15	9 07	1,653
8	Los Cerrillos anthracite,..	Ortez grant, New Mexico,................ ...	88.25	9.04	1,657
9	Scranton anth'cite, D., L. & W.R.R Co.,	Luzerne County, Pa.,.......................	82.85	8 87	1,687
10	Bituminous coal, T. Fawcett & Sons,..	Near Pittsburgh, Pa...	94.04	8.78	1,706
11	Los Cerrillos bituminous,.....	Ortez grant, New Mexico....................	86 74	8.60	1.742
12	West Virginia splint......	Paint Creek, West Virginia......	91.90	8.34	1,796
13	Free-burning medium hard...........	Raven Run mine.....	81.20	8.24	1,818
14	McAllister coal....	Tobosky Co., Choctaw Nation, Indian Territ'y.	94.20	7.68	1,950
15	Scotch splint (Duke of Hamilton	Glasgow..	93 28	7.61	1,970
16	Davison, West Hartley...............	West Hartley district, ...	94 01	7.60	1,970
17	South Wellington coal,..............	S.Wellington col'y, Departure Bay, Vanc'v's I.,	91.83	7.59	1.974
18	Cowpen, West Hartley,...............	Cowpen colliery, Newcastle-upon Tyne,......	93.89	7.52	1,993
19	Bituminous coal, Mitchell & Co.,.....	La Plata mine, near Fort Lewis, Colorado,....	89 10	7.49	2.000
20	Indiana cannel coal....	Daviess County, Indiana,.....	75.18	7 32	2,040
21	Nanaimo coal.	Chase River, Nanaimo, Vancouver's Island,..	86.76	7.30	2,070
22	Cowpen Cambois, West Hartley.......	West Hartley district..........	93 79	7.04	2,129
23	Wellington coal......................	Wellington mine, Departure Bay, Vancouv's I..	90.62	6.71	2.233
24	Bituminous Leavenworth coal,........	Leavenworth coal shaft, Leavenworth, Kans..	88.91	6.49	2,307
25	Bituminous cañon coal...............	Coal Creek colliery, Fremont County, Col	90.	6.45	2,323
26	Bituminous coal.....................	Chestnut mine, Rock Creek Cañon, Montana..	67.57	6.07	2.466
27	Rocky Mountain coal,.	Rock Spring mine, Nebraska..	93.50	6.01	2,491
28	Eastport, Coos Bay coal,.............	Mine at the head of the Coos Bay, Oregon,....	91.16	5.24	2,859
29	Pittsburg coal,......................	Pittsburg Mount Diablo mine, Somersville, Contra Costa County, Cal.,....	89.	5 05	2,965
30	Weber coal.......................	Chalk Creek, Summit County, Utah..........	89 98	4.73	3.168
31	Lignite coal,.........................	Military Reservation, Fort Stevenson, Dakota,	93.77	4.03	3,712

The two tables enable a comparison of the comparative values of any wood and coal to be made.

The latter table is from a report on Fuel for the Army, by Quartermaster-General M. C. Meigs.

The value of wood as a fuel depends greatly on its dryness. After two years of "natural" seasoning it may contain from 20 to 30 per cent. of water, the amount of seasoning depending greatly on the condition of the wood, whether sawed, split, or left in its natural state.

The calorific power for equal *weights* of all woods is substantially the same, being about 7,200 thermal units for one pound of dry wood, and 6,400 units when it contains 20 per cent. of water.

A Long Freight Train.

A "long freight train" performance is reported this week which, if authentic, is apparently what is claimed for it, the greatest on record. The report is of a train on the "Mississippi Valley" (Louisville, New Orleans & Texas) Railroad, which started from a point 122 miles north of New Orleans with 62 cars of cotton and two caboose cars, and at the two succeeding stations picked up 88 cars more, going into New Orleans with 150 *loaded freight cars and two caboose cars*, all hauled with one locomotive. Of these cars 134 were loaded with cotton, 10 with staves, and 6 with miscellaneous loads.

The length of the train was 5,370 ft., or 90 ft. over one mile of loaded cars, being (if correctly given) about 35 ft. per car, which is a large average; and the slack is stated to have been 235 ft., which, as it would amount to something over a foot and a half per car, we take the liberty of questioning. The total weight of the train is stated to have been:

	Total tons.	Tons per car.
Load (4,627 bales of cotton), - -	922.42	6.15
Dead weight engine and train, - -	1,799.00	11.45
Total, - - - - - -	2,721.42	17.60

Sixty tons being allowed for the engine.

The line runs through the Mississippi River bottom, nowhere (south of Vicksburg) very far from the river, and is probably as nearly on a dead level as any equal length in the country (the bluffs reaching the river only at a few points), but with a very slight down grade. The whole average fall of the Mississippi from St. Louis is only some 5 in. per mile, and near the mouth of the river it is much less. The utmost probable fall for long stretches of this line is about 1 foot in 10,000, or say 0.2 lbs. per ton assistance from gravity.

Calling the line level, a resistance of 5 lbs. per ton would demand an adhesion of 13,607 lbs., which, for a maximum adhesion of one-third of the weight on drivers, would require the latter to be only a little over 40,000 lbs. Unfortunately, the class of engine is not stated, but it was probably of the ordinary 8-wheel type, with at least 60,000 lbs. on the drivers, so that it will be seen that there is nothing inherently impossible or improbable in the performance, so far as mere haul is concerned, if the grades at stations were reasonably favorable for stopping and starting. In Zerah Colburn's early experiments on the Erie, for example, made in 1854 with an engine having but 40,050 lbs. on the drivers, a train of 100 loaded cars weighing 1,711.6 tons was hauled up a grade of 6.14 ft. and over a 1-degree curve, at five miles per hour, without help from momentum. Gravity here added 2.4 lbs. per ton to the rolling friction, and taking the lightness of the engine into consideration. it was a more remarkable performance, in one sense at least, than that reported from New Orleans.

But this performance on the Erie was only for a mile or two, with an engine or train behind to add or take off cars as from point to point it was found necessary, and with no question of stopping and starting involved. To handle a train under ordinary operating conditions is a very different matter, and for a train so handled we can discover no record at all approaching this performance, even if the locomotive were much heavier than we suppose it to have been. One mile and 90 ft. of loaded cars hauled on a level grade for over 100 miles, and probably making one or two stops in that distance, if it is not the greatest performance on record, must be very close to it.

Certainly it is far in advance of anything which has appeared in these columns, although we have recorded at various times some very remarkable performances. Perhaps the greatest heretofore was recorded in our issue of July 15, 1881, on the Northern Central, where 183 empty box cars, 1 loaded car, 2 cabooses, and 1 dead engine were hauled a considerable distance (some 20 miles, we believe) with the assistance of a slight down grade. Another, in the same issue, was of 175 cars, 80 loaded, hauled by one Consolidation engine between Harrisburg and Columbia; but this also was with favoring grades. A year ago (Aug. 29, 1884) a record of 105 cars, 82 loaded, was given for Morgan's Louisiana & Texas road, hauled by one 16×24 Baldwin engine, which was justly regarded by the makers of the engine as very remarkable. March 23, 1883, a record of 200 empty coal-cars, 70 of them 8-wheel, appears for a consolidation on the Lehigh Valley, and it is also alleged that the Lehigh Valley on one occasion handled 593 empty 4-wheel coal cars in one train, although how and where it handled them we have not been able to discover. Aug. 5, 1881, a record appears from the wilds of northern Michigan, for the Chicago & Northwestern, of 101 loaded cars, carrying 800 tons, hauled down hill for 63 miles, which is with cheerful confidence "set down as the heaviest train ever hauled on this or any other road a distance of 63 miles by one engine."

These are the best, but in the past few years many other such records have appeared. Recently (Aug. 22, 1884) some one thought 76 stock cars (empty, we infer), hauled by a 15×22 engine, remarkable enough to put on record. But none of them compare even approximately with this latest record from the Louisville, New Orleans & Texas, when all the circumstances are taken into account. The difficulty in starting so long a train must have been great, and it would have been all but impossible to handle it over many breaks of grade, even had the motive power been sufficient, without its breaking in two. — *Railroad Gazette, Dec.* 11*th.*

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY

NEW SERIES—VOL. VII. HARTFORD, CONN., MAY, 1886 No. 5

Accidents Resulting from Low Water.

Shortness of water in steam boilers may result from various causes, chief among which are defects in the feeding apparatus, leakage of valves and fittings, defective indicators of the water level, whereby the attendant is deceived as to the actual amount of water in the boiler or boilers, or when all the appliances are in order, the carelessness of the attendant may be the means of bringing it about. In many cases also, it is the result of pure accident, for which no one can justly be held responsible. But whatever may be the cause of low water the effects are generally of such a serious nature that every available precaution should be used to guard against it.

Fig. 1 shows one of a battery of three horizontal tubular boilers, set up and connected in the usual way. The boiler shown in the illustration was the middle one of the battery. From some cause the blow-off valve of this boiler was not perfectly seated one night, and the water leaked out. When the engineer arrived in the morning, he tried the gauge on the first boiler, and finding it all right, took it for granted that it was all right in the other boilers, and started his fires. When the pressure reached 48 pounds per square inch, the plates in this boiler had become so softened by heat that they ruptured over the fire as shown in the cut.

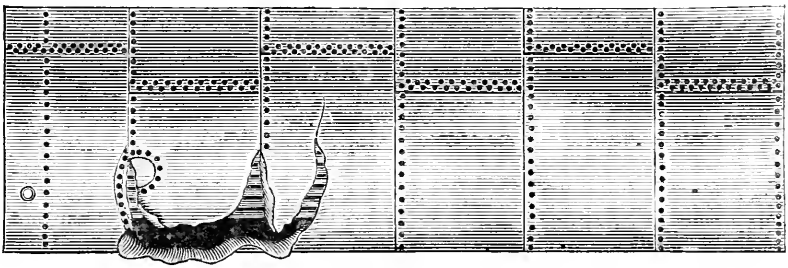


FIG. 1.

Too much care cannot be exercised to make sure that everything is all right before commencing a day's work. The first duty of the engineer when entering the boiler-room in the morning, is to ascertain the state of the water in each and every boiler. Do not touch the fires until this is done.

Fig. 2 shows a boiler of the vertical type, 48 inches in diameter, 8 feet 6 inches long, having about 80 tubes. The shell was $\frac{5}{16}$ of an inch thick. The boiler had all the necessary attachments, which were in good condition. The mill for which this boiler supplied steam was shut down on Saturday night, and the fires were banked. The boiler was visited once on Sunday, when the water was found very low. It being necessary to start the whole mill to start the feed pump, it was not done, it not being thought to be absolutely necessary. At half-past ten, Sunday evening, the boiler exploded, and the building in which it was situated was set on fire by the explosion and burned. The boiler was thrown nearly three hundred feet. An examination of the fragments by our inspector showed the furnace very badly overheated. It is not best to take any risks under such circumstances, no matter how much trouble is involved in taking suitable precautions. A boiler when fed by a power-pump driven from the shafting of an establishment of any sort should have in addition either a steam-pump or an injector to supply it with water when the mill is not running; then there will be no shadow of an excuse for such an accident to happen.

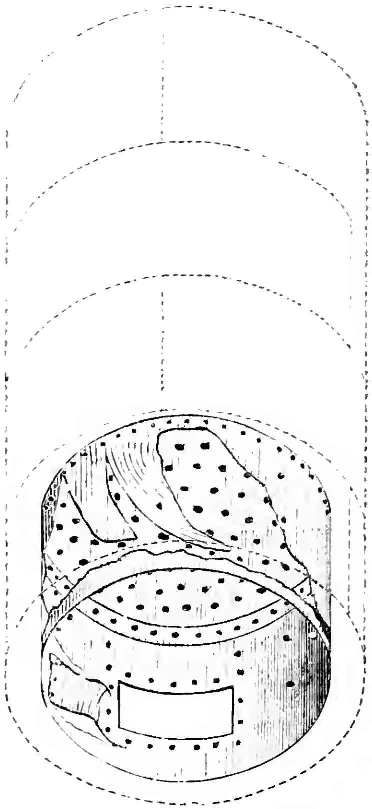


Fig. 2.

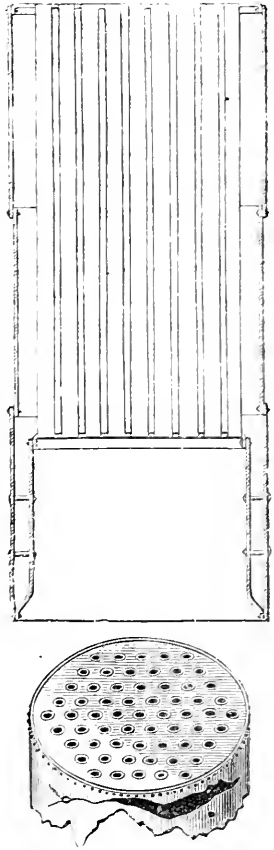


Fig. 3.

Fig. 3 shows another boiler of the upright pattern, which exploded a short time since. The feed-pump was out of order and the gauge-cocks stopped up and seldom used. The force of the explosion was sufficient to throw the boiler 300 feet high and 1,000 feet away from its original position. The furnace or fire-box was torn entirely out of the shell. The figure shows the construction of the boiler, and the appearance of the fire-box after the explosion.

The wreck shown by Fig. 4 was the result of placing sole reliance upon the glass water-gauge where the water was bad. The glass indicated the proper amount of water a short time before the explosion occurred, but an examination of the fragments after the explosion showed the sheets to be badly burned. Glass water-gauges should never be depended upon solely, and especially where the water is bad should the gauge-cock be kept in good condition, and frequently tested.

Figs. 5 and 6 show the original form and the appearance after the explosion, of a boiler of the locomotive type which exploded some years since. The following account of the explosion is given in the words of the inspector who visited the scene of the wreck shortly afterwards:

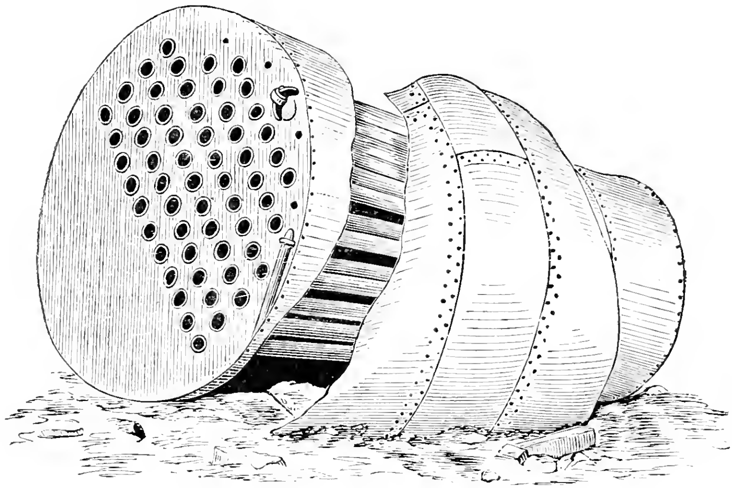


Fig. 4.

"The boiler was of the locomotive type — a variety used in the oil regions of Pennsylvania — having a narrow base to the fire-box and a tapering waist; base, 26 inches wide by 4 feet 4 inches long; fire-box, 20 inches wide by 3 feet 10 inches long; front 4 feet high by 3 feet wide at axis; dome, 22 inches diameter, by 30 inches high, measured from crown of shell; length over all, about 12 feet; diameter of barrel, 30 inches, containing 28 tubes 3 inches diameter by about 8 feet long; thickness of shell, dome, and

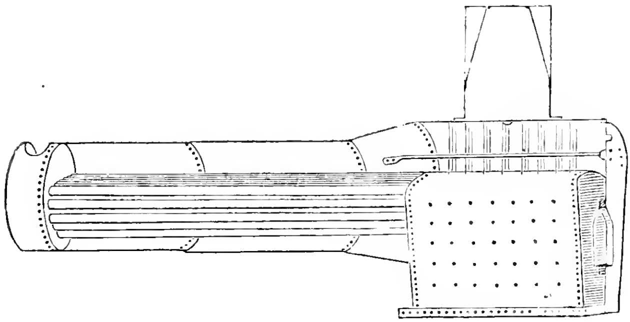


Fig. 5.

fire-box, $\frac{1}{4}$ inch iron; tube-sheets, $\frac{5}{16}$. The boiler was located in an open field some distance from the works, and covered by a shed; it was used to furnish steam for a small pumping-engine in a large well which was in process of excavation.

"The boiler as it originally appeared is shown by the following figure:

"When the accident occurred — Sunday, about 3 A.M. — two men were in or near the shed; one was instantly killed, and his body thrown a distance of 120 feet from the shed; the other, who acted as engineer, was thrown a considerable distance and fatally injured. He died the following Wednesday morning. He said he had just started the injector to feed water into the boiler when 'she blew up.'

"The shed was literally reduced to kindling wood and scattered over several acres of ground. The boiler was torn into twelve principal fragments, besides small pieces of plate, stay-bolts, and braces, which were scattered in all directions. The barrel of the boiler containing the tubes was thrown end over end, nearly in the line of its axis when in position, a distance of about two hundred feet, the tubes left bare by the tearing off of the waist, plunging into the ground, whence it bounded some distance further near the place where the taper-sheets that formed the waist had alighted.

"Most of the other parts were strewn in a curved line to the left, each piece going further until the most remote and largest landed about 1,500 feet to the left. The crown and sides of the furnace were composed of one sheet, which seems to have been flattened down upon the grate-bars, then turned once over upon the ash-heap, with its fire side up.

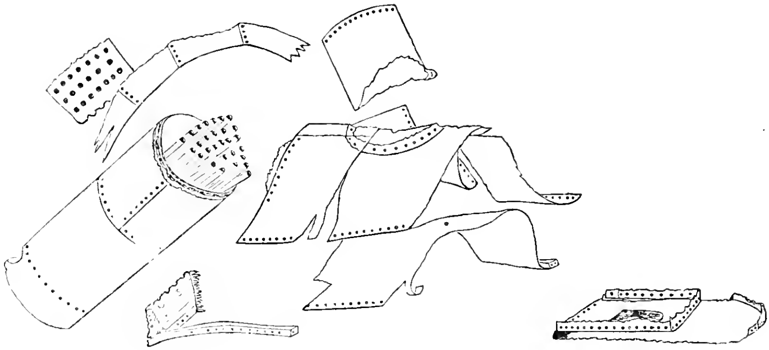


FIG. 6.

"A part of the tube-sheet, with half the wrought-iron base-sill attached, was dropped upon the tool-box of the diggers. The front of the shell, with the front of the fire-box attached, was thrown about 600 feet in a direction nearly opposite to that taken by the barrel.

"Nothing remained to mark the spot where the boiler stood except the grate-bars, which were forced into the ground that formed the floor of the ash-pit.

"The boiler was nearly new, and fitted with a common lever safety-valve and three gauge cocks. Fire-box was stayed to shell by screw-stays, spaced about 5½ inches apart, and headed over inside and outside. About 20 of those that supported the furnace-crown were attached in the same way to the 24-inch circle of the shell enclosed between the flange-rivets of the dome.

"The whole load upon a 24-inch circle of the center of the crown-sheet, at 120 pounds per square inch (a pressure that the safety-valve, with the weight at the end of the lever, even allowing it to be in working order, would have permitted), was 54,000 pounds, or 27 tons. The body of the safety-valve was tapped to receive the steam-pipe from the boiler, also the steam-pipe to the engine and the escape-pipe from the space above the valve, in the usual manner. The wings of the valve fit nicely into the chamber, and the tendency of the long steam-pipe, perhaps not properly supported or twisted out of its natural easy position, acting as a long lever on this valve-body, is to distort the parts and pinch the wings so that no ordinary force would move the valve from its seat. It is said that this boiler had been worked at a pressure of 130 pounds, which would probably be quite sufficient to weaken this weak part of the boiler, and the disaster may have occurred from want of strength to sustain such a load any longer.

"The pump, which was located a considerable distance from the shed, may have stopped from accumulation of (water) condensed steam in the steam-chest. The steam would rise until the weakest part let go, and with an inoperative safety valve no warning would be sounded to rouse the drowsy attendants."

The wreck is shown in Fig. 6.

In addition to such severe accidents as the foregoing, innumerable minor accidents have occurred, and are constantly occurring. We have no space in this issue to describe any of them in detail, but will endeavor to do so in an early issue.

Quite a diversity of opinion exists among engineers of experience as to whether gauge-cocks or gauge-glasses are the more reliable indicators of the height of water in a steam boiler. Some favor gauge-cocks, and go so far that they will not permit a glass-gauge to be placed upon boilers under their care; while others are equally strong in their belief that gauge-glasses are the only reliable indicators, and are opposed to the use of gauge-cocks. As is usual in cases where diametrically opposite views are held by different persons, the truth is found on the intermediate ground between the conflicting opinions.

Every steam boiler should be provided with both gauge-cocks and a gauge-glass. Neither should be relied upon exclusively, both should be referred to constantly, as, if this is done, the risk of being deceived in regard to the amount of water in a boiler is reduced to a minimum.

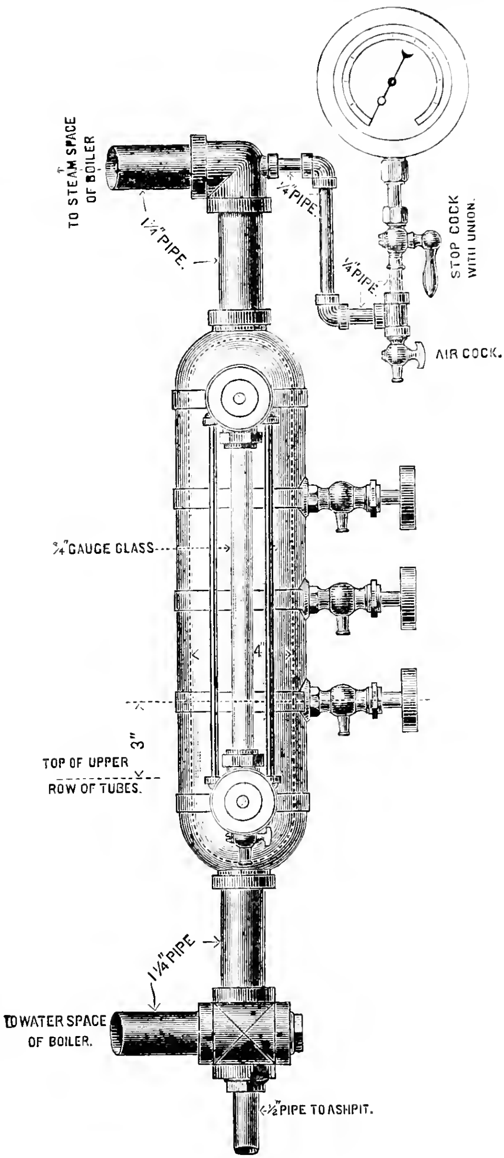


Fig. 7.

The best way to connect gauge-cocks or glass-gauges is to connect each one independently of the others, and run the pipe straight through the front connection of the boiler. The connecting pipes should be of ample size, and that portion of them be exposed to the heat of the escaping gases in the smoke-box, covered with some good fire-proof non-conducting covering, to prevent ebullition and foaming of the water, and burning on of sediment in this portion of the pipes.

Where gauge-cocks and glass are both put on to the same connection, or where a water-column or combination is used, the connecting pipes should be larger, not less than $1\frac{1}{4}$ inch pipe should be used, and the body of the water-column should have a clear diameter inside of at least $3\frac{1}{2}$ inches; four inches would be better. The connecting pipe should be arranged with T's at each bend (bends should be as few in number as possible), so that by taking out a plug the pipes can be scraped free from scale or sediment without disconnecting them. This enables the connections to be kept perfectly clean, when the worst water is used, without any trouble.

We insert here a cut, Fig. 7, reproduced from our issue of December, 1883, to show what our experience has shown us is a good form of connection for a "combination" water-column.

Inspectors' Reports.

March, 1886.

The summary of the work of the Inspection Department for the month of March is given below, and to those interested in the management and operation of steam boilers it is as interesting and instructive as usual.

The number of inspection trips made foot up 3,021, the whole number of boilers examined, 6,038, of which number, 2,004 were examined internally, 372 tested by hydrostatic pressure, and 65 were condemned.

The whole number of defects reported, foots up 4,503, of which number, 691 were found to be dangerous. Our usual tabular statement of defects is appended.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	363	28
Cases of incrustation and scale,	560	34
Cases of internal grooving,	49	14
Cases of internal corrosion,	210	27
Cases of external corrosion,	281	45
Broken and loose braces and stays,	68	14
Settings defective,	135	28
Furnaces out of shape,	135	18
Fractured plates,	134	67
Burned plates,	97	29
Blistered plates,	214	16
Cases of defective riveting,	680	125
Defective heads,	50	17
Serious leakage around tube ends,	668	116
Serious leakage at seams,	418	33
Defective water-gauges,	121	21
Defective blow-offs,	48	6
Cases of deficiency of water,	18	7
Safety-valves overloaded,	23	7
Safety-valves defective in construction,	40	15
Pressure-gauges defective,	188	24
Boilers without pressure-gauges,	3	0
Total.	4,503	691

Defective pressure-gauges are met with about as often as any class of defective fittings that come under our notice. Sometimes we find them wholly inoperative, either through some injury to the mechanism of the gauge itself, or because of some defect in the connections, or obstruction in the pipes leading to the boiler or to whatever the gauge may be connected. Cases of this kind, when the gauge utterly fails to register the pressure, are not so uncommon as one might suppose.

Generally, however, the most serious trouble we find in testing pressure gauges is an error of a few pounds in their indications of the pressure. So long as this error does not exceed five to ten pounds, either fast or slow, no *danger* is incurred at ordinary pressure if the boiler on which it may happen to be is a decently good one, and is running with a reasonable margin of safety, but when the error is as much as twenty pounds, or more, it begins to approach what we consider the danger limit.

As a rule, when a standard gauge is at hand it is a very easy and simple matter to correct any ordinary errors in the reading of a steam-gauge; but a correct gauge for comparison is a necessity, and this is not usually at hand in the majority of manufacturing establishments.

All the test gauges carried by our inspectors are tested at frequent intervals on our mercury column, and kept adjusted correctly. Gauges sent to this office by our patrons for correction, are always tested in the same manner.

While there may be some excuse or palliation of the fact that the cheapest gauges made do not, after short service, indicate pressures with that exactness which is very desirable, if not absolutety necessary, in ordinary use, there is none for the fact that gauge manufacturers make and send out gauges intended for standard test gauges, and graduated by pounds up to 200 pounds per square inch, which are as much as two pounds in error; fast in some parts of the scale, and slow in other parts. There is generally no haggling about prices for such articles as these, therefore one would naturally suppose that no manufacturer would send out a piece of work of this kind with his name on it unless it indicated pressures within, at least, a fraction of one pound. There certainly is no good reason why they should, but the fact remains that they *do*.

Boiler Explosions.

March, 1886.

Steel Works (38). — The mud-drum of a boiler in the bar mill of Hussey, Howe & Co.'s steel works, Pittsburg, Pa., exploded March 4th, badly wrecking the building and machinery. Timothy Hickey was knocked down, but not seriously hurt. Loss $12,000.

Saw-Mill (39).—The flues of the boiler in Hafford's saw-mill, Carrolton, Ky., collapsed on the 6th of March. The boiler was hurled through a pile of rubbish and through a stone wall supporting a part of the mill, wrecking the boiler-shed. A little girl named McKinney was badly scalded. No one else hurt. Loss about $800.

Tug Boat (40). — The boiler of the tug-boat *John Markee*, of the Commercial Wharf Towboat Company, Boston, exploded March 10th, when off Long Island Head, blowing the vessel in atoms, and killing the entire crew, which included the captain and four men, as follows: Captain, C. A. Nickerson; Mate, Charles F. Hoskins; Engineer, Denison H. Crocker; Fireman, F. W. Crocker; Steward, Albert D. Smith. Eye-witnesses state that the *Markee* was standing still at the time, and that the fireman was unloading ashes. He had just entered the fire-room when the explosion occurred. First a column of black smoke arose, then a cloud of steam, and in an instant the upper works of the vessel were hurled 200 feet in air and shivered in fragments. The hull was blown to pieces, and when the tugs *Fremont* and *William Sprague*, which were in the vicinity, reached the spot, there was nothing left of the boat but floating pieces of timber, among which were found the mangled bodies of Captain Nickerson and Fireman Crocker. No vestiges of the other men were found. The owners know nothing as to the cause of the accident. Captain Dolan of the *Fremont* states, that in the ascending blast of steam, smoke, and debris he saw an object, which was probably the boiler. It described a parabolic course, rose nearly 150 feet into the air, and fell into the water some 200 yards from the wrecked steamer. The *Markee* was a fine tug about eight years old, about twenty tons, and valued at $10,000; insured. The accident is the first of the kind that has ever happened in Boston harbor.

FERRY BOAT (41). — The crown sheet of one of the boilers of the ferry-boat *Julia* gave out while she was lying at the wharf in Vallejo, Cal., March 3d. Damage slight.

INSANE ASYLUM (42). — At the State Insane Asylum, Napa City, Cal., March 3d, five of the cast-iron circulating chambers of one of the four boilers used for heating and power exploded. No one was hurt.

STEAMER (43). — The steamer *Ike Bonham* exploded her boiler when eleven miles below Vicksburg, on the Mississippi River, March 11th. Wm. St. Andrews, the mate, and five colored men of the deck crew, were blown overboard and drowned. E. P. McElroy, the pilot, and Chas. Girard, the engineer, both white men, were severely scalded and bruised. Engineer Charles Girard had just tried the water in the boiler and found scant two gauges. He left the wheel and went back in the cabin to dinner, leaving St. Andrews steering. In an instant the shock came. He was knocked down, and hot bricks from the furnace almost covered him. The explosion tore away the office, pilot house, chimney, and forward part of the cabin, throwing them into the river. On deck the result was equally disastrous. Six deck hands were blown overboard, a number of the colored passengers seriously injured, and all on board were scalded except Mrs. Sargent; the debris around the boiler caught fire, and she seized the draw bucket, drew water from the river and quenched the flames, after which she took a shovel and threw the red-hot furnace brick overboard. Mrs. Sargent saved the wreck from burning, and the lives of the wounded on board.

COAL SHAFT (44). — The boiler used at the Hicks coal shaft, near Arthur's Station, on the Pittsburg and Western railroad, exploded March 15th. William Banes, engineer, and Joseph Elsener, flat trimmer, were in the boiler-house, and were buried in the debris. Elsener, who had his head and side crushed, died in a short time. Banes was terribly scalded, severely cut on the head, and his skull fractured. He cannot recover. The boiler was of cylinder pattern, 20-horse power, and was only put into the works last August. The cause of the explosion is unknown.

PUMPING BOAT (45). — At Limetown, Penn., March 15th, the boiler of the pumping boat at the Hilldale Coal Works exploded, fatally scalding William Ferre the engineer. The boat was badly damaged.

PORTABLE (46). — On the lands of Mr. R. J. Dunlap, near Yorkville, S. C., the boiler of a traction steam engine, of twelve-horse power, attached to a portable saw-mill, exploded March 16th, killing the fireman, James Sigman, a white man, and slightly wounding D. P. Holman, also white, who was employed as a sawyer. The explosion was of such force as to completely wreck the boiler and engine. The dome and a part of the boiler to which it was attached, weighing 700 pounds, was blown a distance of 225 yards. Mr Sigman's skull was fractured, and he was blown some sixty feet from the engine. The engine was comparatively new, and originally cost $1,120.

SAW-MILL (47). — The engine in W. W. Cate's steam saw-mill in North Wolcott, Vt., exploded March 16th, instantly killing Mr. Tinker of Morristown. Messrs. Douglas of Stowe, Amsden of Greensboro, W. W. Cate and Pike of Wolcott, were seriously injured, the latter probably fatally.

LOCOMOTIVE (48). — An accident on the Texas and Pacific railroad at Iona station, fourteen miles west of Fort Worth, Texas, March 19th, resulted in the instant death of Engineer W. H. Metcalf and Fireman Dick Clark. The train was the through passenger from El Paso to St. Louis. The engineer was running at a slow rate when the pilot of the locomotive struck something, and the shock throwing the fire-box out of position, caused the boiler to explode. Metcalf was hurled sixty feet, and Clark about two hundred feet back of the engine. Metcalf was instantly killed, and Clark lived an hour. The explosion ploughed out a huge hole beneath the engine, into which the locomotive and tender fell, completely wrecked.

SHINGLE MILL (49) — By the explosion of a boiler, March 23d, at the shingle mill of E. S. Hoyt, one mile from Tionesta, Penn., E. S. Hoyt, Luke Hoyt, and Wm. Perry were badly scalded.

COKE WORKS (50). — The engine-house at the Hecla Coke Works, four miles north of Mt. Pleasant, Penn., was burned down March 24th. During the progress of the fire one of a battery of boilers blew up, creating quite a panic, but injuring no one. The engines are badly injured, and the loss to the owners — Messrs. Thaw & Dorsey, of Pittsburgh — will be about $15,000.

PORTABLE SAW-MILL (51). — A fatal boiler explosion occurred March 24th, at Harvey's saw-mill, about three miles north of Centralia, Ill. The engineer had left the engine in charge of the fireman, a young man about 19 years old, who allowed the steam pressure to go too high, thus causing the explosion, which blew the engine about a hundred feet. William C. Harvey, the owner and superintendent of the mill, was struck in the head by the flying boiler and instantly killed. Edward Lordan, the fireman, was scalded and thrown violently against a pile of lumber. He is not expected to live. The mill-building was completely destroyed, as the boiler was thrown up through the roof. The boiler had been recently repaired, but was not in good condition.

SAW-MILL (52). — The boiler of the Calera, Ala., Land Company's saw-mill exploded March 25th. Job Robertson, engineer; Jesse Pilgreen, superintendent, and William Fletcher, laborer, were killed, and J. W. Thomas and three others were badly hurt. All the killed and injured were white. The loss is $5,000; no insurance. The members of the Calera Land Company were making an inspection of the property, and had just passed through the mill. As they left the building the explosion occurred. Their escape from a horrible fate was miraculous.

COAL SHAFT (53). — One of a battery of boilers at the Osborn coal shaft, near Mineral Ridge, Ohio, exploded March 25th. Shortly before the engineer had tried the gauges and found an abundance of water, and it is supposed the boiler was worn out. Several employees were in the vicinity but all escaped serious injury. When the accident occurred the engine was running and the shaft in operation. The damage by the explosion will reach $1,000, aside from stopping the shipments of coal. One hundred and sixty men are thrown out of employment.

STEAMER (54). — Intelligence was received March 30th, of the explosion of the boilers of the steamer *E. H. Barmour*, plying between Morgan City and Abbeville, La. She had entered the Bayou Teche and was returning laden with lumber. When about two miles below Pattersonville, her boilers exploded, killing five or six negroes, and wounding half a dozen others. Some of the crew were drowned, and engineer Johnson was severely scalded.

BATH HOUSE (55). — A remarkable accident occurred at McCook, Neb., March 28th. Judge Lucas had gone into the bath-house of the town, and was comfortably enjoying a hot-water bath, when suddenly a terrible noise was heard, and one end of the bath-room went flying across the street. Lucas was hurled after it and driven head foremost into a huge snow-drift, where he remained a moment completely dazed. The boiler in the basement had exploded, breaking mirrors, furniture, and other articles into fragments, and knocking the chimney to pieces, which fell into the tub so recently occupied by Lucas. The boiler was hurled with terrible force across the street, alighting on the building occupied by the *Democrat*, crashing through the roof, and ruined the forms and other articles on which it fell. The damage was considerable, but no one was seriously injured.

FOREIGN.

Tug Boat. — London, March 8th. — The boiler of the tug *Rifleman* exploded in Cardiff harbor this morning. The vessel and crew, consisting of six persons, were blown to atoms. The cylinder of the engine struck a passing Italian ship, a quarter of a mile distant, and killed the pilot.

Steamer. — By an explosion on March 29th, at the port of Tumaco, off Ecuador, of the boiler of the steamer *Colombia*, a serious loss of life resulted. The *Colombia* had on board fifty-four passengers, of whom fifteen were killed, and nineteen seriously wounded.

A New Use for Electricity.

A Newark, N. J., man has an ingenious electric cat-disperser on his back fence which is a perfect success. Two large plates of zinc are fastened to the top of the fence, and these are connected with a battery in the house. One of the plates he baits with meat, etc., to attract cats. The unsuspecting feline walks along the top-rail, humming his sweetest melodies to himself. He sees the meat, crouches down, crawls up to it and begins to nibble, with what results is best told in the inventor's own words:

"Suddenly the most diabolical yell that ever sprung from the throat of a Comanche startled the peaceful slumbers of the neighbors. It ended in a blood-curdling gurgle, leavened with intense pathos. A large globe of pale, blue fire was seen to dart upward into the gloom and spin around, six feet above the fence, with the terrible velocity of a pin-wheel. Then the remarkable pyrotechnic display descended with a dull thud into the flower-beds, looking like a one-cent comet turning hand-springs. Presently the fire died out, and the garden was again in darkness."

The following conversation shows that one man does not appreciate his neighbor's cats: "You know the little doctor down the street? Well, he had a black tom-cat. He don't loiter here any more. Do you know the courteous judge on the next block? He has a Maltese capon cat. Well, I never saw him but once. But do you know the young lady that lives across the street had the most stubborn cat I ever saw? I had two cells on the battery. The cat went up in the air six feet; rolled around the garden, with its tail as big as my arm; tried to jump the fence; bumped its head half-way; was so awfully persistent it crawled up, and went back, and actually sat down on the zinc. I put on three cells; closed the key; then the cat went up eight feet; fell in the next yard; old lady came out and watched it shake the 'kinks' out of its legs; she then picked it up, and it almost tore all her clothes off; the cat must have been dazed."—*Exchange.*

A Rondout, (N. J.) man says that he bought some green dye, intending to color some eggs for his children for Easter, and laid the package on a bench in the back yard and forgot about it. When he thought to get it he discovered his hens had eaten most of the dyestuff. The next day he found three bright green eggs in the nests; the next day three more a shade or two lighter; the third day the eggs had just the slightest tinge of green; the fourth day they resumed their normal appearance.—*Mfg. Gazette.*

The Locomotive.

HARTFORD, MAY, 1886.

J. M. ALLEN, *Editor.* H. F. SMITH, *Associate Editor.*

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 *cents per year when mailed from this office.*
Bound volumes one dollar each.

WE are indebted to Mr. Frank W. Ballard, insurance editor of the New York *Commercial Bulletin*, for a copy of the Commercial Series on "American Securities." The work discusses the causes influencing investment and speculation and the fluctuations in value from 1872 to 1885.

We are indebted to Mr. James E. Howard of the United States Arsenal, Watertown, Mass., for the following results of tests of pieces of steel plates taken lengthwise and crosswise the direction of rolling. It has generally been claimed that there is a wide difference in the tensile strength and ductility of steel when tested lengthwise and crosswise the direction of rolling, and in this connection it is proper to say that the sheets from which these test pieces were cut were rolled down from slabs about six inches thick. Some of the sheets were rolled both lengthwise and crosswise the slab, hence they got considerable work in both directions. Many steel makers claim that if the rolling is mainly done in one direction, a difference in tensile strength and ductility will be conspicuous. We rather incline to this opinion, but in the absence of tests of steel rolled in this manner, we can say nothing definite. We hope to say something however in the future. Another very interesting experiment made at the Arsenal at Watertown was this: Various bars of different metals were subjected to a hydrostatic pressure of 90,000 pounds per square inch, the samples being placed in a cylinder and having clearance on all sides. After this compressing the samples were tested by tension, and some by compression, and the results compared with tests of the same metals not compressed. A drawn brass sample so compressed showed no change in elastic limit, tensile strength, elongation, or contraction over the untreated metal. The experiments were not completed at the time of our information, but it is probable that other metals will show no change.

Average tensile strength, elastic limit, elongation, and contraction of area of steel strips one and one-half inches by ten inches, taken lengthwise and crosswise the direction of rolling.

LENGTHWISE.

	E. L.	T. S.	Elong.	Cont.
$\frac{3}{16}$ inch plate,	43,740	63,015	20.1	53.4
$\frac{1}{4}$ " "	40,159	60,295	23.6	53.5
$\frac{5}{16}$ " "	36,532	57,708	26.7	56 5
$\frac{3}{8}$ " "	33,027	56,489	26.4	55.4
$\frac{7}{16}$ " "	32,460	58,245	25.3	53.1
$\frac{1}{2}$ " "	31,602	58,557	24.1	50.0
$\frac{5}{8}$ " "	28,227	56,077	26.9	46.8
$\frac{3}{4}$ " "	28,320	58,313	26.9	44.5
Average,	34,258	58,587	25.0	51.6

CROSSWISE.

$\frac{3}{16}$ inch plate,	39,869	62,220	20.3	41.2
$\frac{1}{4}$ " "	46,712	59,876	22.8	47.6
$\frac{5}{16}$ " "	35,280	59,776	23.0	49.2
$\frac{3}{8}$ " "	30,814	56,510	25.1	49.1
$\frac{7}{16}$ " "	32,450	58,790	25.1	49.2
$\frac{1}{2}$ " "	30,270	58,378	25.8	47.1
$\frac{5}{8}$ " "	30,793	56,677	25.5	48.8
$\frac{3}{4}$ " "	34,845	60,185	25.9	53.5
Average,	35,129	59,051	24.2	48.2

Mr. John Dixon of No. 1 Laurence Pountney Hill, London, England, in a letter in *Engineering*, of April 23d, characterizes the Hawkesbury River Bridge to be erected in New South Wales by the Union Bridge Company of New York, as "a cheap and nasty" affair.

In view of the fact that Mr. Dixon was an unsuccessful bidder on the contract for building this bridge, that his price was three-quarters of a million dollars above that of the Union Bridge Company, and the foundations which he proposed to put in were nothing more than hollow cast iron columns 12 feet in diameter, while the American firm propose to put in piers of solid masonry 24 by 52 feet, and that a commission of eminent engineers, all Englishmen, were unanimous in their decision that among all the tenders the plans of the Union Bridge Company for foundations were the *only* ones that could be recommended, we cannot avoid the conclusion that Mr. Dixon's letter is "a nasty affair" whether it is "cheap" or not.

A very interesting account of the method of sinking these piers, which reach a depth or about 185 feet, and will constitute the deepest foundation in the world, may be found in the *Scientific American* of May 8th.

The current number of the *Journal of the Franklin Institute*, contains a very interesting and instructive article by Mr. John M. Hartman, on "The Blast Furnace." It will repay a careful perusal.

A hotel twelve stories high, with accommodations for 500 guests, is to be erected in Minneapo is, at a cost of $750,000. It is the intention to have the dining-room on the tenth floor, the kitchen on the eleventh, and the laundry and servants room on the twelfth.

Fire in a Furnace for Sixteen Months.— The failure of the Kemble Iron and Coal Company, caused the suspension of operations at their works, at Riddlesburg, Pa., in November, 1884. One of the furnaces was then banked up and hermetically sealed, fire being left in. March 5th last, the furnace was opened for the first time, having been closed for nearly sixteen months. The fire was found to be still burning, the coke glowing brightly, and on the admission of air soon became hot enough to melt cinder. It was as easy a matter to start the furnance as if it had been standing but a week. This is believed to be one of the longest instances in which fire has been kept in a furnace without the addition of fuel.

THE statements made by the English Chancellor of the Exchequer that in the last ten years there has been a decrease in the imperial revenue derived from alcoholic liquors equal to $22,500,000, and that last year the receipts from this source were nearly $5,000,000 below the estimate, and more than $5,000,000 below the receipts derived from this source in the previous year, are facts of striking social importance. Sir William Harcourt said that this falling off was due to changes in the habits of the people, and had been concurrent with an enormous increase in revenue derived from tea, tobacco, fruits, and other comforts of life.

Mauch Chunk, and the Switch-Back Railway.

What attracts the visitor at Mauch Chunk is the Switch-Back Railway and the Glen of Onoko. The Switch-Back Railway, now devoted entirely to passenger traffic, was built as an outlet from the coal mine. It commences at a ten-minute walk from the railway station of the Lehigh Valley Railroad. From its terminus the cars are drawn up a precipitous road by a stationary engine and a rear guard called a "Barney." The engine-house crowns the brow of Mount Pisgah; here the cars are detached and run by force of gravity to the foot of another abrupt elevation, which is ascended in the same manner as Mount Pisgah; then on to Summit City, which boasts an armory in hewn stone. This is the upper terminus of the road.

If the ascent was full of pleasure, the return by another grade is still more charming, as the train rushes through forests sweet with the odors of fern and pine. On that part of the road called "The Home Stretch," the velocity attained is very great; Sensation and Leonitus never rushed forward with more seeming desire to reach the goal than does this engineless train speed forward on its way. Lovely as is the mountain road, it has to be left behind, and again descending to the railroad station, we take the train to Glen Onoko, which is reached in ten minutes.

As is sure to happen when men and women seize upon some sweet, secluded spot, the natural beauties of which are too many and too safely placed by the hand of the Creator to be seriously damaged, the entrance is made hideous, defeatured, and rendered grotesque by petty improvements. So it is here. Red geraniums. "Pelergoniums from the Cape," flaunt their gaudy colors where the rhododendrons bloom and smile from their craggy beds in the mountain-sides; however, as yet, improvement has only spoiled a very short distance of this lovely glen, through the centre of which tumbles and foams a mountain torrent which at one point falls in a cascade, then creeps through great boulders over huge fallen logs, to leap again from one rock to another; the upper fall at the head of the glen clears the rocky ledge, and gives the semblance of a veil. Venturesome visitors, animated with the refined essence of vulgarity, have crowded behind its silvery screen, and on the face of the precipice affixed their cards, thus ably advertising their egotism and worship of bad taste. One day, starting from New York or Philadelphia, is ample time to visit the natural beauties of Mauch Chunk, but one week at least should be taken to see the mines and coal docks, to botanize, and to become familiar with the region immortalized by Longfellow, where

"Stood the wigwam of Onoko,
Onoko, chief of Lenni Lenapes.
Sage in council was Onoko,
He it was who slew the Great Bear—
Slew the Great Bear of the Mountains."

One novel and agreeable feature in the trip to Mauch Chunk is the absence of hackmen; there is no need of their services even for the indolent tourist; even the drive from the Mansion House to the railway terminus can be avoided, as the short but steep mountain road can be climbed easily in ten minutes.—*N. Y. Observer.*

Partial Collapse of Flues in Marine Boilers.

Many theories have been advanced regarding the partial collapse of flues in marine boilers, especially of the Scotch type.

First, among the most prominent, is that an accumulation of incrustation is formed on the heated surfaces, thereby causing the part covered by incrustation to become unduly heated and collapse.

Second, that the flue is not strong enough in its construction to withstand the pressure on it. In my experience I have found it a difficult matter to form a deposit of scale in a boiler using water from a surface-condenser, and I know of one case in particular, where the water within the boiler was fresh and showed no indication of a deposit on the flue, but notwithstanding it dropped from $\frac{3}{8}''$ to $\frac{1}{2}''$ in spots. In this particular case the flue was 38 inches in diameter and 12 feet long, constructed in four courses, each course 3 feet long, and united by an Adamson, or flanged seam. It was constructed of best C. H. No. 1 flange-iron, $\frac{1}{2}$ inch thick, and using a working pressure of 60 pounds per square inch. Now, taking the formula for finding the pressure allowed on a flue of these dimensions $\frac{89600 \times .5''^2}{3' \times 38''} = 196.4$ working pressure, we find it gives us a working pressure far in excess of the one used. It would seem from this that the second theory does not hold good in this case.

This, however, is not an exceptional case, as I can cite several similar to it. It is a noticeable fact that when the collapse of a flue takes place it is usually when steam is first generated, either after allowing the water in the boiler to become partially cold, or having pumped up after cleaning boiler.

In my opinion the lubricants used in steam cylinders have much to do with partial collapse. In this manner: The lubricant is carried into the boiler with the feed-water, and a part of it remains there (notwithstanding the boiler is occasionally blown down from the surface) on the surface of the water until the boiler is blown down, when it descends with the water and spreads itself over the tubes and flues in spots, and a portion of it remains, although the boiler may have been cleaned and washed out. Cylinder grease is very hard to remove. When the boiler is again filled with water the grease does not rise to the surface because the water is usually cold, and the grease solidified, but remains on the flues and prevents the water from coming in contact with the iron; as a consequence when fires are started the plates in these particular spots are overheated, and weakened to such an extent that they drop, in many cases, before the maximum working pressure is reached.

To obviate this it is well to pass the feed through a filter before it enters the boiler, and after blowing down, to scrub the crown sheets with strong soda or lye-water, as this is the only effectual way to remove cylinder-grease from iron. Use soda with the feed-water and blow from the surface as often as practicable. I am of the opinion that if this is done, it will in a measure reduce the number of collapsed flues and furnaces in marine boilers — J. H. C. *in Mechanical Engineer.*

The Machinist's Trade Conservative.

Current comment upon improved processes in machine work and systematized methods, leads many to believe that the whole art has been changed, and that the machinist who learned his trade twenty-five years ago would be a sort of Rip Van Winkle in a modern shop, if he had left the trade a quarter of a century ago and suddenly returned to it. We think that such an impression is an erroneous one, for, aside from a few shops where special machines are constructed, the routine of the machine business is the same as it always was. If it were not, shops which make lathes, planers, bolt-cutters, drill-presses, etc., would have no trade. There are many more of these tools made and sold to-day than there were a quarter of a century ago, for the reason that the machine business has increased in volume, and the introduction of other special machines has not dispensed with the need of standard tools. Steam engines are a staple line of machine work, and on these there is but little opportunity for special machines, unless it be in some exceptional pattern or form of the engine. The old machinist, therefore, would not find his occupation gone if he sought for work in modern steam-engine works, for, with few exceptions, substantially the same methods that were in vogue a quarter of a century ago are still used. Every shop has certain special methods which facilitate work and are peculiar to it, but these in no wise overset our belief that the machine trade has not been revolutionized by the introduction of special machines. We know this is contrary to the general opinion, and it is also opposed to our own impressions, until we came to review the subject carefully.

It is true that certain agents are more generally adopted, and very great improvements have been made in special directions. Emery wheels are universal, while in former years they were not, but emery wheels in one form or another have been known ever since emery was discovered; it is only a change in their construction and special adaptation which make them seem new. Dies for screw-threads now cut away the metal rapidly instead of slowly, but the bolt-cutter is still a bolt-cutter, and performs the same office that it always did. These are merely improvements, not change of function, radical innovation, or an abandonment of conservative methods for others widely different.

The old-time machinist can ask for work in modern shops with the certainty of being able to execute it satisfactorily, in spite of special machines or adaptations of those with which he was familiar. His right hand never loses its cunning — if it ever had any.— *The Mechanical Engineer.*

Making a Brass Straight-Edge.

A workman attempted to make a brass straight-edge $1\frac{1}{4}''$ wide, $\frac{3}{8}''$ thick, and 4 long. A strip was cut from a sheet of rolled brass and straightened by hammer and press.

It was clamped to planer table, and one edge planed up. When taken from the planer the brass sprung about $\frac{1}{4}$ of an inch.

It was put under the screw press, straightened, and a light chip taken from the same edge.

Upon turning the straight-edge and planing the other side, the "unexpected which often happens" was apparent. The brass sprung up $\frac{3}{8}$ of an inch in the middle of its length.

The strip was again clamped as it lay loose on the planer, and the "belly" portion planed off. When unclamped the piece of brass again jumped up nearly $\frac{1}{4}''$ in the center.

The material was then abandoned, and another strip cut from the same piece of brass, straightened as the first, and one side planed.

Upon being removed from the planer this strip sprung as the first one did, but instead of straightening it under the screw press it was turned planed edge down, forced down upon the platen, and clamped in a straight position.

When the strip was removed after planing the remaining edged, it did not spring up like the first one, but remained nearly straight.— *American Machinist.*

"He called me an ass," exclaimed an over-dressed, excited dude. "Well, you ain't one," soothingly replied a kindly cop, "you are only a clothes-horse."— *Merchant Traveler.*

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

NEW SERIES—VOL. VII. HARTFORD, CONN., JUNE, 1886. No. 6

The Stability of Chimneys.

After the determination of the proper size and height of a chimney-flue to produce the requisite draft for any given boiler-plant, the next step is to fix upon such dimensions for the stack as shall insure its safety against overturning by the highest winds to which it is likely to be subjected.

The factor which operates to overturn a chimney is the force of the wind acting against the body of the stack; the resistance to overturning is due to the weight of the masonry taken in connection with the diameter of the chimney at the base.

The relation between the velocity of the wind and its pressure against flat or curved surfaces opposed to its force is not very well understood. Proper experiments to determine it exactly have never been made, although it would appear that there is no great difficulty involved in making such experiments at the present time. The pressure is generally supposed to increase as the square of the velocity when the opposing surface is at right angles to the direction of the wind, and in such cases Smeaton's rule is to—

Divide the square of the velocity in miles per hour by 200; the quotient is the pressure in pounds per square foot.

By this rule which is used by the U. S. Signal Service, and engineers generally, but which Trautwine, an excellent authority, considers "probably quite defective," the table on page 82 has been calculated, which will be found interesting.

Whether the rule is correct or not, it is certain that wind pressures of between forty and fifty pounds per square foot have been observed in this country, so it will be well to make allowance for the latter pressure in designing a new chimney. It was the practice of Professor Rankine to provide against a pressure of fifty-five pounds per square foot for such structures in England.

In designing new chimneys we must depend upon the weight of the brick-work alone to prevent the shaft from overturning, for fresh mortar has no amount of tensile strength for several months after it is laid. The theoretically correct outline for a chimney-shaft is a hollow batter,

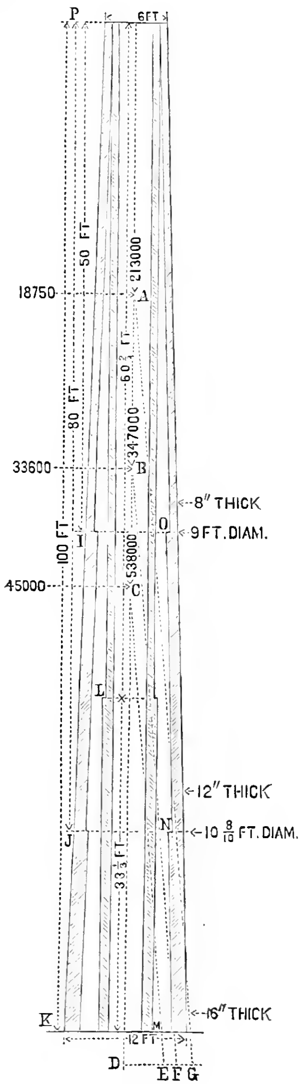


FIG. 1.

nearly straight at the top, and increasing in concavity as the ground is approached, but this form is difficult to build, and in chimneys of ordinary heights the amount of concavity is so slight as to be hardly worth considering, and certainly not worth the extra cost required to build it. For chimneys of four feet in diameter and one hundred feet high, and upwards, the best form is circular with a straight batter on the outside. A circular chimney of this size, in addition to being cheaper than any other form is lighter, stronger, and looks much better and more shapely.

TABLE OF WIND VELOCITIES AND PRESSURES.

Velocity in miles per hour.	Velocity in feet per second.	Pressure in pounds per square foot.	REMARKS.—Character of wind, etc.
1	1.467	.005	Hardly perceptible.
2	2.933	.02	Pleasant.
3	4.400	.045	
4	5.867	.08	
5	7.33	.125	
10	14.67	.5	
12½	18.33	.781	Fresh breeze.
15	22.	1.125	
20	29.33	2.	
25	36.67	3.125	Brisk wind.
30	44.	4.5	Strong wind.
40	58.67	8.	High wind.
50	73.33	12.5	Storm.
60	88.	18.	Violent storm.
80	117.3	32.	Hurricane.
100	146.7	50.	Violent hurricane, uprooting large trees.

Chimneys of any considerable height are not built up of uniform thickness from top to bottom, nor with a uniformly varying thickness of wall, but the wall, heaviest of course at the base, is reduced by a series of steps, as shown in the illustration. It is evident that any given section of the wall is weakest at its lower end, or where the thickness changes: hence, if the stack as shown possesses a sufficient margin of strength at the joints, IO, JN, and at the base, it will be amply strong at all other portions of its height, for the joints mentioned are its weakest points.

To determine the stability of the chimney, it is necessary to consider first, the upper section, from I to P, second, the two upper sections from J to P, and last, the entire chimney from K to P, calculating the weight and pressure of the wind against each separately, as though they were independent stacks and standing by themselves.

In calculating the weight of the brick-work which is available to resist the action of the wind, we can figure in that in the inside stack, for although the two stacks are not bonded together, and the wind-pressure acts only on the outer one, yet the wings built into the outer one, and running in and almost touching the inner one, as shown in Fig. 2, practically make one stack of the two, as far as resistance to a lateral pressure is concerned. The pressure of the wind being practically horizontal and acting uniformly on each square foot of the shaft, we may consider it for the purposes of our calculation as concentrated at the center of the figure of each section. Thus the surface of the upper section from I to P, in the sketch shown would be 375 square feet, and the total pressure against this section, if we allow for a wind-pressure of fifty pounds per square foot, would be $375 \times 50 = 18{,}750$ pounds, which we may consider to be concentrated at A, the center of the surface of this section.

In a similar manner we find that the pressure against that portion of the stack above

J N, to be 33,600 pounds acting at B, while for the whole stack it is equal to 45,000 pounds acting at C.

The centers of magnitude, A, B, and C, of the sections shown, or of any similar pyramidal or conical figure may be found by the following rule:

Divide the difference of the outside diameter at the base and top by three times their sum; subtract the quotient from 1; multiply the remainder by half the height; the product will be the height of the required point above the base.

Thus to find the height of the centre of pressure A, in the example we are considering: the diameter of the outer shaft at I, O, is 9 feet, the diameter at the top is 6 feet. The height of this section is 50 feet from I to P, then the height of A, above the base IO, is equal to $\left(1 - \frac{9 - 6}{3\,(9 + 6)}\right) \times 35 = 23\frac{1}{3}$ feet.

In a like manner we find B to be 36.19 feet above J; and C to be $44\frac{4}{9}$ feet above the surface of the ground.

Having found the heights of these centers above their respective bases, we lay them off on the center line of the chimney, as shown in A, B, and C.

Next, we compute the weight of brick-work in both shafts above the respective joints I, J, and K, the weight of each cubic foot being about 112 pounds. In the example, which represents a square chimney 100 feet high with a 40-inch flue, the weight above I would be about 213,000 pounds; the weight above J about 347,000, and the weight of the whole chimney about 538,000 pounds.

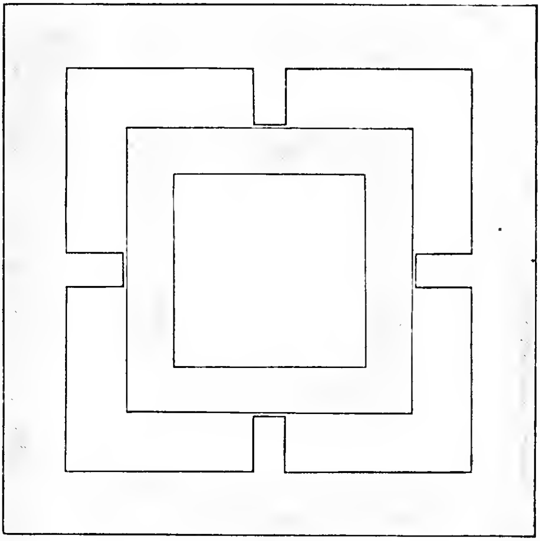


Fig. 2.

Now, with any convenient scale, lay off on the center line of the chimney, from A downward, AD equal to 213,000, and from D, in a horizontal direction, DG with the same scale 18,750, and draw the line AG. This is the resultant of the two forces which may be considered as acting at A, the one, 213 000 pounds vertically downward, and due to the weight of the structure above the joint I, giving it *stability*, and the other, 18,150 horizontally, and due to the force of the wind, and tending to *overturn* it. If their resultant falls within the base of the joint at I, the chimney would stand in a gale blowing with sufficient intensity to cause a pressure of fifty pounds per square foot. As will be seen, it falls *well within* the base, crossing it at O, hence we conclude that the upper section has a good margin of safety.

Proceeding similarly with the other joints where the thickness of the wall changes, using the figures for weight and pressure due to these joints, we find that in each case the resultant lines BF, and CE, fall well within the stack; hence we may conclude that the chimney, as a whole, has an ample margin of safety.

Had the resultant line in either case fallen outside the outer shaft at the respective joints IO, JN, or KM, the chimney would be unsafe, and would fall in any wind blowing with a force of fifty pounds per square foot.

If the chimney shaft has any other form of cross section, the effect of the pressure of the wind against it will be modified. If it is hexagonal in form the effect of the pressure will be about three-fourths, if octagonal about five-eighths, and if it is circular only about nine-sixteenths what it would be on a square stack of the same cross section. Thus in the example given, if the shaft were circular in plan, the force of the wind tending to overturn it, would be but a trifle over one-half of the figures given, while the reduced weight, due to the fact that a lesser number of bricks would be required for the circular construction, would be about three-fourths of that given for the square cross section. Thus we see that the round stack would be, for equal dimensions, considerably stronger than the square one.

Inspectors' Reports.

APRIL, 1886.

The summary of the work of the Inspection Department for the month of April is given below, and to those interested in the management and operation of steam boilers it is as interesting and instructive as usual.

The number of inspection trips made foots up 3,411, the whole number of boilers examined, 6,339, of which number, 2,749 were examined internally, 475 tested by hydrostatic pressure, and 37 were condemned.

The whole number of defects reported, foots up 6,106, of which number, 704 were found to be dangerous. Our usual tabular statement of defects is appended.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	444	23
Cases of incrustation and scale,	648	30
Cases of internal grooving,	29	9
Cases of internal corrosion,	171	18
Cases of external corrosion,	283	31
Broken and loose braces and stays,	64	24
Settings defective,	160	14
Furnaces out of shape,	202	17
Fractured plates,	233	128
Burned plates,	103	28
Blistered plates,	251	19
Cases of defective riveting,	1482	106
Defective heads,	64	23
Serious leakage around tube ends,	796	116
Serious leakage at seams,	634	18
Defective water-gauges,	100	10
Defective blow-offs,	71	16
Cases of deficiency of water,	4	3
Safety-valves overloaded,	35	17
Safety-valves defective in construction,	38	13
Pressure-gauges defective,	294	41
Total,	6,106	704

The great influence which the circulation of the water in a steam-boiler, when it is in operation, exercises upon its efficiency, its tendency to foul up, and its liability to various annoying defects, does not seem to be fully understood or appreciated by many to whom it is of the greatest importance. Were it not for the fact that heat applied to the under side of a body of water is communicated to it, thereby expanding it and causing it to rise through the colder water above, and producing a circulation, it would be practically impossible to generate steam in the ordinary manner. The efficiency of any given area of heating surface depends almost wholly upon the perfection of the circulation of the water in contact with it. This will probably be better appreciated when it is stated that the experiment has been performed of immersing a cubical metalic box in water and heating it from the inside. The horizontal upper surface of the box generated more than twice as much steam per square foot of surface as the perpendicular sides, while the bottom or lower side generated none at all. This was due to the fact that the steam bubbles or vesicles formed in contact with the upper surface, had nothing to interfere with their prompt liberation from that surface, the heated water was equally free to rise, its place being immediately filled by a fresh supply of colder water, thus forming a rapid circulation; the operation went on with greater difficulty in contact with the vertical surfaces, while with the lower horizontal surface, the steam as formed would have a tendency to hug the surface, and prevent the contact of water with it, thus effectually preventing any circulation. When these facts are appreciated it will readily be seen how essential it is to the proper performance of a boiler that the water-spaces should be large, and as free from obstruction as possible; in order that the water may have opportunity to circulate rapidly, and the steam when formed be disengaged as freely and quietly as possible.

Comparatively few years ago, it was the universal practice to crowd as many tubes into a horizontal boiler as could be gotten into it. They were set in zig zag rows, to enable the greatest number to be put into a given space, on the theory that the more heating surface the more steam the boiler would make, and the natural consequence was the spaces between tubes, and between tubes and shells, soon became filled up with scale and sediment, the result being overheated plates, and leaky seams and tubes, while the steaming capacity of the boiler was greatly reduced. Of late years, however, the fact is beginning to be appreciated that tube surface is not heating surface, unless it has plenty of room to act as such, and consequently the number put into boilers of any given size is less; they are arranged in a more rational manner, and as a natural result the boiler steams better, and is more easily kept clean, less rep irs are necessary, and the life of the boiler is greatly prolonged.

Boiler Explosions.

APRIL 1886.

Rendering House (56).—A terrible explosion occurred shortly after midnight, April 2d, in the new tank-house of Swift & Co., a packing firm, near Forty fifth street, Chicago. One of the immense steam rendering tanks containing oils, blew up, completely wrecking the building. The night tankman, Thomas Moorfield, was on the third floor at the time, and he was buried in the ruins. He was rescued in half an hour, and was in an almost unconscious condition. The loss on the building will be about $12,000. Moorfield is unmarried. Two other night tankmen had narrow escapes.

Sash and Blind Factory (57).—A boiler eighteen feet long, weighing 4,900 pounds, in J. A. Church's sash and blind factory at Brattleboro, Vt., exploded April 13th, demolishing the brick boiler-house. The boiler fell 260 feet away in a barn, where it killed a horse. Roofs and windows of dwellings near the factory were broken. The loss is $3,000.

Hat Steaming (58).—A sheet-iron boiler with a capacity for ten or fifteen gallons of water, used for steaming hats at No. 264 East Broadway, New York, exploded April 16th, knocking over the stove on which it stood. The escaping steam or water prevented a fire. The half-dozen men and girls who were at work were badly frightened, and a girl named Lizzie Wulff was scalded slightly in the head by a jet of steam. The damage to the property amounts to about $50.

HOISTING ENGINE (59).—A boiler used to furnish motive power in Shaft 20, on the new Croton Aqueduct, exploded April 17th. Cornelius Sweeney, thirty-five years old, the foreman employed at the shaft, was badly scalded by escaping steam, and Thomas Grace, twenty-three years old, a laborer, had his hand scalded. Beyond the destruction of the boiler, no damage was done to the property.

DISTILLERY (60).—The boiler at the distillery of Wathen, Mueller & Co., one mile west of Lebanon, Ky., exploded April 19th, flying into fragments and demolishing that portion of the house in which it was situated. James Taylor of Louisville, the fireman, was literally roasted alive, and lived only a short time after he was taken from the ruins. Wm. Collins, the coal-heaver, was fatally scalded. Taylor was an old steamboat fireman and was very reckless, and in this instance run cold water in on the hot flues. As there was no insurance against such accidents, the total loss, including temporary suspension of distilling, will amount to over $10,000.

RENDERING HOUSE (61).—Toby & Booth's packing house at the corner of Eighteenth and Grove streets, Chicago, was the scene of a frightful explosion, on April 28th, in which one man lost his life, two were seriously hurt, and six others more or less injured. The casualties are as follows: — killed, James Sanford, aged sixty years. Seriously hurt, Pat Muldoon, aged thirty-seven; Mattie Acton, aged fourteen. At about three o'clock, while a gang of men were working around a large steam rendering lard tank, it exploded. The great tank was rent into pieces, and the flying iron tore up the floor, ceiling, and walls. Not one of the men in the room at the time escaped some injury. Sanford was standing close to the tank. He was thrown against the opposite wall, and when picked up life was extinct. Muldoon and the boy Acton were struck by the flying chunks of iron, and were rendered unconscious, and besides they were burned by the oil, the tank being full at the time. Their burns are very severe. The other men were struck by flying splinters, but none of them were so badly hurt as to cause their removal.

BREWERY (62).—Somewhere near 4 o'clock A.M., on April 30th, Mr. Peter Bobb, engineer for Mr. John Seiler, at the Lewisburgh Brewery, near Covington, Ky., started up his morning fires under the boilers, which were new ones, having been in use but eight months, and equipped with every possible safety appliance. It is claimed that the boiler contained plenty of water. About 5 o'clock Mr. Bobb left the engine-room, which was in a large frame shed in the rear of the main building, and went to the brewery proper to learn something about the work. He had just started back when he was startled by the bursting of the boilers. The building was totally wrecked, and bricks were thrown 300 feet. The heads of the boilers were carried twenty-five feet, and the boilers themselves were torn in two. The rivets were broken off and the destruction was complete. The falling debris crushed in the roof of the beer cellar. The boilers cost nearly $1,000 each, and the building was worth some $1,500, making a total loss of about $3,000. At the brewery it was said that their insurance did not cover a loss of this description. Very fortunately no one was injured. The cause of the explosion is attributed to the inefficiency of the engineer.

HE was a Dutch barber on a coroner's jury, and after sitting quietly for an hour during the inquest, arose, peered into the face of the corpse, and then, turning to the rest of the jury, said: "Mein Gott, dot man ish dead!"

The Locomotive.

HARTFORD, JUNE, 1886.

J. M. Allen, *Editor.* H. F. Smith, *Associate Editor.*

The Locomotive *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 *cents per year when mailed from this office.*
Bound volumes one dollar each.

That the services of the fool-killer are still occasionally needed is made manifest by the fact that there are plenty of engineers (so-called), who firmly believe that it takes less coal to make a given quantity of steam from cold water than it does to make the same quantity from hot water. It seems almost impossible that any man who has run an engine and boiler can know so very little about what he is doing, but such is the lamentable fact in many cases, and, the worst of it is, there are many such men in positions where their belief is carried into effect to the great detriment of their employer's pockets. Such ignorance is equaled only by that of one who erred so far in the opposite direction that he wanted to run a pipe from his boiler out into the creek from which the water to supply the boiler was drawn, and heat the whole stream, so he could have hot water to feed the boiler with. This is a fact, incredible as it may appear.

The very great interest of the subject of tornadoes to the people generally is our excuse for reproducing the copious extracts from Lieut. Finley's lecture. Storms of this character are of such severity that nothing can withstand their force, and any knowledge of them that will enable the occurrence to be predicted with any amount of certainty cannot fail to be of the greatest value to the public, and will result in the preservation of many lives and much valuable property.

The results of the government tests upon steel rivets would indicate that this metal is destined to largely supplant iron in another important field. Steel rivets have been used for special purposes for a long time, but their use up to the present time, in boilers, has been limited. The great amount of ductility, and capacity for local distortion without fracture, taken in connection with its high resistance to shearing, seems to us to render this metal peculiarly adapted for rivets.

The Armington & Sims Engine Co. of Providence, R. I., issue a very neat illustrated and descriptive catalogue of their well-known, high-speed engines. The success of this engine for all purposes where high rotative speed is required, and especially for electric lighting purposes, has been very marked. The catalogue contains much valuable information, testimonials, etc., and should be in the hands of all interested in steam engineering.

The report of Mr. Henry Hiller, Chief Engineer of the National Boiler Insurance Company, Limited, for 1885, has been received, and is interesting and instructive, as Mr. Hiller's reports always are. From it we learn that the total number of boiler explosions in England, in 1885, was 36, which caused the death of thirty persons, and severe injury to fifty-seven others. Much detailed information concerning the causes which led to the explosions, etc., are given, for which we have no space in this issue.

The precise nature and extent of the disturbance of the normal structure of iron or steel boiler plate caused by punching the rivet-holes has always been a fruitful theme of discussion by engineers, boiler-makers, and others interested in the matter. Such discussions have, as a rule, been confined to the question, How much damage is done to the plates, or how much are they weakened through the line of rivet holes by the operation of punching? Somewhat different conclusions have been arrived at by different experimenters on this point, apparently so easy to determine, some claiming that punching entails a great loss of strength, some that the loss is very slight, while others claim that the metal is actually strengthened by the operation, and that this strengthening is due to the fact that the metal around the hole is compressed and thereby rendered denser and stronger. These different conclusions have probably arisen from the fact that the experiments made by the various authorities have been made upon different qualities of iron, and under unlike circumstances. For our part we believe that plates of moderate thickness punched with a good sharp punch, having the proper amount of clearance in the die, will not be materially injured. On the other hand we have seen plates only one-half of an inch thick utterly ruined by bad workmanship. We are not satisfied with the evidence which has been adduced that the strength of plates of any quality is increased by any process of punching, to which they are likely to be subjected in the ordinary course of boiler-making.

Uniformity of Bessemer Steel for Rivets.

[The Iron Age.]

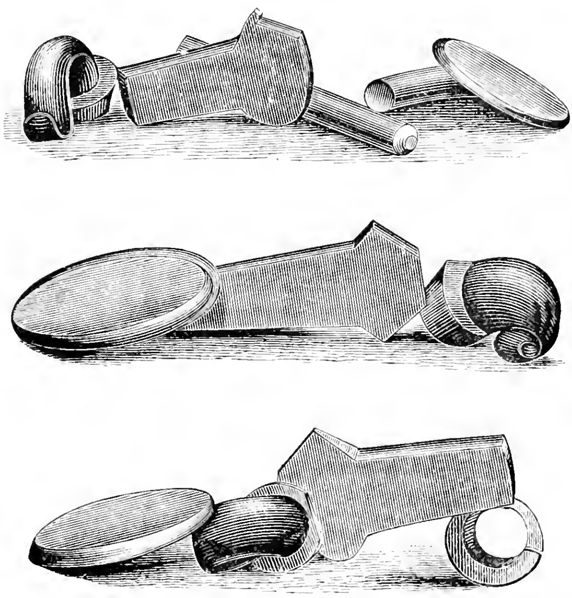
A series of highly interesting figures have been brought out by the tests of mild steel used for the rivets in the construction of the government cruisers. We reprint the following from the report of the Naval Advisory Board on mild steel, published in 1886, omitting, however, the detail of every individual test, for which we refer to the original document. Suffice it to say that 344 tests, representing 326,244 pounds of rivets, gave only the exceptionally low rejection of 3.87 per cent. of the material. We quote as follows from the report in question:

A built-up structure, such as a ship or boiler, depends for strength almost entirely upon the resistance offered at the joints, which resistance, for most conditions of stress, is, or should be, made up equally of the resistances of plate and of rivet. When, in addition, we consider the severe treatment and liability to excessive internal strain to which a rivet is subjected in driving and setting, the necessity for careful selection of material and of quality is very apparent. There are two chief opposing conditions in the selection of rivet metal — the one the great advantage gained in increased strength of joint by using metal of higher shearing strength with fewer, or smaller rivets, the other the brittleness of heads and shanks of rivets developed in hard metal under severe treatment. It is a matter for careful consideration whether the first cannot be obtained in a higher degree than at present without too great development of the second.

The rivets supplied were all of steel made by the Bessemer process. The steel was delivered in billets, marked with the number of the blow, to the rivet manufacturers, each blow rolling out into about 200 rivet bars. The high tensile strength, which from the first tests appeared necessary to obtain the shearing strength of 50,000 pounds per square inch demanded, was looked upon with some alarm for fear of trouble arising from brittle heads as reported in European practice. Somewhat less shearing strength was therefore allowed if accompanied by correspondingly lower tensile strength and greater ductility and reduction of area. The necessity for this, however, soon disappeared, the results of tests being quite up to the original requirements, while the high ductility and the especially high reduction of area showed a metal capable of great local distortion without fracture.

The amount of testing was then reduced, and instead of 20 rivet-bars constituting a lot for tensile test, and 500 pounds of rivets a lot for shearing and hammer tests, two bars of sufficient length for tensile test were required to accompany each 1,000 pounds of rivets, being pieces of the bars from which the rivets in the correspondingly marked kegs were made, and one test of each kind was made for each 1,000 pounds of rivets delivered at the works. As has been mentioned also the shearing specimens were riveted up in single shear instead of double shear, increasing the representative value of the test. The value of the shearing strength in single shear is somewhat greater with iron rivets in iron plates than in double shear in a variable ratio, approximately 10 to 9.5. The invariably low ratios, of shearing to tensile strengths for the double-shear specimens of lots, 9, 13, 33, and 40 in the table appear to show a similar effect in steel rivets, though the single-shear specimens of lot 33 show even a lower ratio than the double shear. It is, however, very difficult to obtain simultaneous shear of the two sides in a double shear specimen. Steel plates of ship or boiler quality and of thicknesses suitable to the length of the rivet were used in the shearing specimens. The board are particularly pleased with the uniformity and high value of shearing strength obtained, as associated also with a high value of those qualities which go to make a rivet work well and safely, and great credit is due the original manufacturers of the steel in producing a quality of metal so especially well adapted to this important purpose.

Tests and Inspection of Rivets.— The rivets, from whatever source, were generally tested at Chester by the inspectors at the Chester Rolling Mills, the shearing specimens being riveted up at the ship-yard. The following table gives a general summary of the various sizes and in total up to September 20, 1884. The amount rejected, 14,100 pounds, 10,000 pounds of which were rejected in the early part of the work, is only 3.87 per cent. of the total amount tested, and the results depart but little from specification. The ratio of shearing to tensile strength is given for each lot in the table, and its average value for each size, as shown by the summary, illustrates well the increase for smaller rivets. The capacity for local distortion, as shown by the low value of the percentage of final area, is more markedly illustrated by the accompanying cuts engraved from photographs of specimens of hammer test pieces, which are not selected for their particular excellence, as these tests were invariably passed in the most satisfactory manner. The fracture of the tensile test piece illustrates that commonly obtained from this material.



ACCEPTED RIVETS.

Nominal size of rivet.	Average ultimate tensile strength per square inch.	Average final elongation.	Average final area.	Number of tests.	Average ultimate shearing strength per square inch.	Number of tests.	Ratio to tensile strength.	Accepted.
Inch.	Pounds.	Per cent.	Per cent.		Pounds.		Per cent.	Pounds.
7/8	65,200	26.35	43.62	34	52,980	34	81.27	29,119
3/4	64,900	28.12	42.25	183	53,260	206	82.08	204,000
5/8	64,552	26.58	41.38	101	54,758	107	84.84	93,925
1/2	60,929	26.01	36.71	7	53,430	7	87.69	4,200
Total	64,740	27.41	42.00	325	53,695	354	82.94	331,244

Tornado Study — Its Past, Present, and Future.

By Lieut. John P. Finley, U. S. Signal Corps.

[*Extracts from a Lecture delivered before the Franklin Institute, November* 27, 1885.]

The systematic study of tornadoes as such, and as the term is now technically applied to severe local storms, is of comparatively recent origin. The funnel-shaped cloud, however, had been observed and described by intelligent persons in this country, so far as our records show, as far back as 1761. The storm in question occurred at Charleston, S. C., and was one of remarkable violence. About two P. M., on the fourth of May, this terrible phenomenon was first seen by many of the inhabitants of Charleston coming down Wappoo Creek, the cloud resembling a large column of smoke and vapor. In the course of its path every tree and shrub was torn up. Great quantities of leaves, branches, and timbers were seen furiously driven about and agitated in the body of the moving column of cloud. The sky was overcast and cloudy all the forenoon. About one o'clock it began to thunder, followed by heavy clouds and more thunder. The day (particularly in the afternoon before the storm) was very sultry and oppressive. Shortly after the storm, the wind was "quite fallen," the sun shone out, and the sky was clear and serene. The direction of progressive movement of the cloud was from S.W. to N.E.

The width of path is given as 300 fathoms (about 1,800 feet). The account further informs us that though such storms were very unusual in Charleston, yet vestiges of the tremendous power of the whirling cloud could be seen in the wooded country about the town, both in that and in neighboring "provinces."

Here we have a most interesting and intelligent account of a tornado occurring nearly 125 years ago, and evidence of the appearance of these storms at a much earlier date in South Carolina.

Another remarkable tornado was observed and described by the Rev. Dr. Stiles of Yale College, as occurring at Northford, Conn., June 19, 1794. The observer was about one hundred yards distant from the cloud while it passed. It was a circular figure whirling most violently upon its center. From the midst of the cloud issued a "vortex of air," much in the form of an hour-glass, which alternately contracted and expanded from ten to twenty rods. The hour-glass form of the cloud at the earth had constant communication with the cloud above. When it contracted it became less violent, but when it expanded, the scene was frightful and destruction filled the air.

In 1842, Prof. Loomis of Yale College prepared and published in *Silliman's Journal*, Vol. 23, a list of nineteen tornadoes, occurring during the years 1823 to 1842, in the following States: Mississippi, 4; Ohio, 3; Tennessee, 2; New York, 4; Connecticut, 1; Rhode Island, 1; North Carolina, 1; New Jersey, 1; and Alabama, 1.

In Europe we find very early records of storms that appeared to possess the characteristics of our tornadoes of to day, In A.D. 793, "dire fore-warnings came over the land of the Northumbrians (England), and terribly terrified the people; these were excessive whirlwinds, with dragon-like tails." Here the spout like form of the cloud is referred to.

In the year 1090, it is recorded that in England a violent tornado overturned 606 houses.

About the first specific date of a storm is the one that occurred on the fifth of October, 1091, in England. It passed from S.W. to N.E., and the sky was dreadfully dark. Many churches fell, and in London over 500 houses were destroyed.

On the eighth of April, 1838, a tornado passed within three miles of Calcutta, British India; width of path, one quarter mile; direction of movement, S. 37° E. The tiles of the terraces laid in the best cement were ripped up as if by suction. As a most extraordinary proof of the lateral force of the wind, a slight bamboo was driven horizontally through one of the raised tiled walks which pierced through the whole breadth, breaking the tiles on both sides. These tiles were made ot baked earth, five feet thick. The tornado formed about two P. M., and passed through twenty-six villages, from Arundpore to Hurreenanbhee, a distance of sixteen miles, destroying 1,245 houses, 215 people, and 533 head of cattle.

At Chatenay, near Paris, in June, 1839, a violent tornado occurred shortly after midday. The cloud assumed the form of a funnel, the small end reaching the earth. Everything in its path was completely swept from the earth.

This record might be greatly augmented had I the time to devote to it in this brief résumé of the subject. . . . .

It will now be opportune to consider, in brief, what the Signal Service has accomplished by observation and investigation. We will now define what we mean by the word tornado, and how we shall distinguish this storm from others which are known to us, and possessed of prominent characteristics.

THE TORNADO.

The general direction of movement of the tornado is invariably from a point in the southwest quadrant to a point in the northeast quadrant. The tornado cloud assumes the form ot a funnel, the small end drawing near to, or resting upon, the earth. This cloud and the air beneath it revolve about a central vertical axis, with inconceivable rapidity, and always in a direction contrary to the movement of the hands of a watch. The destructive violence of the storm is sometimes confined to a path a few yards in width, as when the small, or tail-end, just touches the earth; while, on the other hand, as the body of the cloud lowers, more of it rests upon the earth, the violence increases, and the path widens to the extreme limit of eighty rods. The tornado, with hardly an exception, occurs in the afternoon, just after the hottest part of the day. The hour of greatest frequency is between three and four P. M. Tornadoes very rarely, if ever, begin after six P. M. A tornado commencing about five P. M. may continue its characteristic violence until nearly eight P. M., which means only that the tornado cloud may be traveling after six P. M., or after seven P. M., but it does not develop, — that is, make its appearance for the first time after those hours. Outside of the area of destruction, at times even along the immediate edge, the smallest objects often remain undisturbed, although at a few yards distant the largest and strongest buildings are crushed to pieces.

At any point along the storm's path, where there is opportunity afforded the tornado cloud to display its power, the disposition of the débris presents unmistakable signs of an action of the wind, such as might be called a rotation, from the right through the front to the left around the center. The destructive power of the wind increases steadily from the circumference of the storm to its center.

Observations with a single isolated barometer will not indicate the approach of a tornado, however near the position of the instrument to the path of the storm, but such observations are of value when a number are displayed upon the daily weather map.

THE CYCLONE.

This term was originally employed by Piddington to characterize the typhoon of the China Seas. As employed by the Signal Service, it applies to the broad, violent storms, such as reach the South Atlantic and Florida coasts from the West Indies.

Cyclones have a varying width of path from 100 to 1,000 miles. Their course of progressive movement is a parabolic curve which trends northwestward from the West Indies, under the influence of the northeast trades and the general drift of the atmosphere, until they reach the vicinity of parallel 30° N., when they slowly curve to the northeast, continuing in that direction, either along the coast, or at a short distance inland. The storm finally disappears to the eastward in the vicinity of parallel 50° N.

Within the storm area the air does not actually move or whirl in a circle; there is only a tendency to such a movement about the region of lowest barometer.

Cyclones are otherwise characterized by sudden, rapid, and unusual oscillations of the barometer, heavy precipitation, heavy ocean swells, and high straight wind velocities, which frequently exceed 100 miles per hour. The violence of the storm increases from the circumference towards the center, reaching its maximum about midway between the center and circumference of the storm. At the center of the cyclone nearly a dead calm prevails.

THE HURRICANE.

Although it seems hardly necessary to define the hurricane, it will, perhaps, be well to state that, as here considered, it means a straight wind of extraordinary velocity. They may, and frequently do, occur without the accompaniment of any precipitation. On the summit of Mount Washington, White Mountains, N. H., a measured velocity of nearly 200 miles per hour has been recorded. On the summit of Pike's Peak, Rocky Mountains, Col., a measured velocity has several times exceeded 100 miles per hour. On the coast of the Carolinas, maximum measured velocities have ranged from seventy five to 160 miles per hour. In the Eastern Rocky Mountain slope, and in the lake region, measured velocities are sometimes recorded ranging between sixty and eighty miles per hour. This storm may be known as the Blizzard of the Northwest, the Chinook of the Northern Plateau, the Norther of the Southern Slope and Texas, or the Simoon of the Desert. Hurricanes may occur at any hour of the day or night, and in any month of the year. The most violent, however, take place during the spring and autumn. The width of the path of the storm is very irregular, and may vary from many rods to many miles. In either case, the velocity at all points within the storm's path is not necessarily the same; in fact, such a condition never occurs. The duration of the storm is also extremely variable; it may continue for only a few minutes or for several hours, although in the latter case the maximum velocity is not maintained throughout the entire period. On the contrary, there are periods of recurrence alternating with decided diminutions of the highest activity. There are, perhaps, but few portions of the country altogether free from the possibility of their occurrence. In the low table lands of mountainous regions, where most of the country is extremely broken, the habitable portions are shielded from the power of violent wind storms. No surface currents can attain any great velocity in such regions, although, on the mountain peaks and elevated plateaus, dangerous hurricanes at times prevail.

THE WHIRLWIND.

In defining this phenomenon it will be best, perhaps, that you should be asked to recall the occurrence, on any warm day, of the formation of a dust-whirl, as it suddenly bursts upon you in the open street, fairly enveloping your body with fine particles of dirt, straw, leaves, and the like. Whirlwinds suddenly start up from some barren, sandy spot, unduly exposed to the direct rays of the sun. Over a small surface thus exposed the air rapidly rarifies, and ascensional currents form, which move spirally inward and upward, carrying dust, leaves, straw, and sometimes objects of considerable weight. The air within the whirl moves either from left to right, or in the contrary direction. The whirlwind's path has a diameter of several feet (sometimes rods) and the direction of its course of movement is decidedly irregular, possibly moving toward any point in the compass. On the sandy plains of Arizona, Southern California, and Nevada these phenomena occur with great frequency during the summer months. Columns of whirling sand, sometimes several in a group, move rapidly over the surface. Whirlwinds are harmless, and generally of but a few moments duration. In comparison with the tornado, let it be borne in mind that the former starts from the earth's surface, extending upward and moves onward, not leaving the earth, being solely confined to the region of surface currents. The tornado forms near the superior limit of the lower regions of the atmosphere and between the upper and lower sets of currents prevailing in the upper and lower regions of the atmosphere. The former currents are indicated by the appearance of the fine cirrus clouds, and the latter by the heavy cumulous formation. From this lofty seat of origin, the tornado cloud gradually descends to the earth's surface, increasing rapidly in size and augmenting in power.

WATER-SPOUTS.

These disturbances generally form at a considerable height in the air, although at times they seem to ascend from the water's surface; that is to say, there is no visible agent influencing the ascension of the water, but, of course, in every instance the causative power is from above, and in the latter case near the water's surface. When I speak of the formation of the water-spout at a considerable height in the air, I mean that the embodiment of the whirl, or the revolving current of air, first appears as a dark cloud of minutely divided particles of water, the result of rapid condensation, of course in the air, and, therefore, above the water. The swift passage of the air in a spirally upward motion over the surface of the water raises it in the form of spray, and carries it upward in the center of the whirling cloud, which then presents the appearance of a densely opaque body, and conveys an impression to the eye of the observer that a huge column of water is ascending in the form of a long spout, widening gradually toward the top. There are instances, however, where the force manifested was sufficient to raise a considerable quantity of water several hundred feet in the air. Water-spouts form during periods of excessive heat, generally in the afternoon, and at or near the hottest part of the day. In the temperate zone, they only occur during summer months.

They are of most frequent occurrence in the region of calms between the Tropics, but are not altogether strange sights in the Gulf of Mexico and along the Gulf Stream, south of parallel 40° N. In regard to motions, they possess both a rotary and progressive action, but in neither do they manifest a permanency of direction. Water-spouts cannot be considered as altogether harmless, for there are instances where vessels have been wrecked by them.

HAIL STORMS

Are peculiar atmospheric disturbances, which. in regard to the dimensions of their paths. are, next to the tornado, the most circumscribed of all storms save the whirlwind. They are characterized by a strange cloud formation and a peculiarity of precipitation unlike any other phenomena in the category of storms. The cloud from which the hail falls is basket-shaped, with a dark and portentous exterior, a ragged and ominous looking opening at the bottom, and within, a whirling conglomeration of snowflakes, pellets of snow and ice, partly formed hailstones, the latter of an almost infinite variety of shapes. The hail cloud forms between the currents of the upper and lower regions of the atmosphere, and moves forward in the plane of these currents, either within or just above the upper limit of the lower atmospheric regions, where it finally disappears, and the deposition of hail ceases. The path of the storm, as indicated by the distribution of the hailstones, is, at times, very narrow, although the range of width is decidedly inconstant, varying from one to fifteen miles. The hail storm travels quite rapidly, from thirty to fifty miles per hour; and the length of its path is even more variable than the diameter, ranging, as it does, from ten miles to two or more hundred. The direction of the course pursued by the storm is always from some point west to some point east. It may be from northwest to southeast, or from southwest to northeast. Hail storms may occur at any time of the day or night, although they are most frequent in the afternoon, just after or near the hottest part of the day.

They are the most prevalent in that region of country embraced between the parallels of 30° and 50° N. South of parallel 30° N. hail storms are of rare occurrence at the level of the sea; but at the height of 100 or 200 feet they occur more frequently, and in the mountains of British India they are very common, the hailstones being usually of large size. Hail storms are not necessarily confined to the land areas, but may and frequently do occur over large and small bodies of water.

THUNDER STORMS.

These phenomena are atmospheric disturbances of great variability of extent and power. They are invariably accompanied by such manifestations of the presence of electricity as are ordinarily termed thunder and lightning, the former being entirely consequent upon the existence of the latter. Thunder is but the reverberations of the concussion produced by the inconceivably rapid propulsion through the air of that physical element we are pleased to term electricity. Thunder storms may be a few miles or several hundred in extent, and their length of duration is quite as uncertain, viz.: from a few hours to one or more days. There is no regular time of day for their occurrence, although they are, perhaps, more frequent in the afternoon. However, they may occur at any time during the day or night. As to the season of year, summer is the period of greatest prevalency. There is no month of the year entirely free from them. Whether the precipitation be rain or snow, the presence of electricity has still been manifested in the usual form. With the former character of condensation of vapor, the evidence of electricity is most common, while with the latter it is the rare exception. A valuable paper on this class of storms has lately been published by Prof. Hazen of the Signal Service.

As regards geographical distribution, thunder storms are most frequent between the equator and parallel 40° N. and from thence to parallel 70° N., the average frequency diminishes with considerable rapidity. In the vicinity of parallel 80° N. it is believed they never occur, although this, in the main, is mere supposition. There are certain portions of the United States where thunder storms are unusually frequent, as compared with other parts. They seldom occur in the Pacific Coast States, especially California, and are most frequent and violent in the Eastern Rocky Mountain Slope, the lower Missouri Valley, and in the lake region.

Having briefly outlined the characteristics of the various classes of storms well known to the United States, we will now proceed to consider the subject of our paper, — the dreaded tornado. . . .

Some of the results sought to be obtained by investigation may be briefly given as follows:

(1.) To determine the origin of tornadoes and their relation to other atmospheric phenomena.

(2.) To determine the geographical distribution of tornadoes and their relative frequency of occurrence in different States, and in different parts of the same States.

(3.) To determine the conditions of formation, with a view to the preaiction of tornadoes.

(4.) To determine the means of protection for life and property.

(5.) To determine the periodicity of the occurrence of tornadoes, and their relative frequency by seasons, months, parts of a month, and time of day.

(6.) To determine the prevailing characteristics of tornadoes.

(7.) To determine the relation of tornado regions to areas of barometric minimum.

(8.) To ascertain yearly the loss of life and property in the various tornado districts, and its effect upon the industries of the people.

(9.) To ascertain the influence of topography upon the occurrence and movement of tornadoes.

(10.) To determine the influence of rainfall and forests upon the development of tornadoes.

(11.) To ascertain the relations of tornadoes to hail storms, thunder storms, and hurricanes. . . .

The following are most of the features of map study that must receive consideration in the preparation of a tornado prediction for any day:

(1.) Barometric Trough. Region. Ratio of Axes. Pressure. Departure from Normal.
(2.) Central Area of Barometric Minimum. Region. Pressure. Departure from Normal.
(3.) High Contrasts of Temperature. Region. Gradient.
(4.) High Contrasts of Cold Northerly and Warm Southerly Winds. Region.
(5.) High Contrasts of Dew-point. Region. Gradient.
(6.) Heaviest Lower Cloud Formation. Region. Kind.
(7.) Opposing Movement of Lower Clouds. Region. Directions.
(8.) Coincident Movement of Upper and Lower Clouds. Region. Direction.
(9.) Opposing Movement of Upper and Lower Clouds. Region. Direction.
(10.) Opposing Movement of Lower Clouds and Winds. Region. Direction.

(To be continued.)

The Value of Business Integrity.

The value of well-established business integrity was never better exemplified than it is just now in the machinery business. Buyers expect to buy for little money, but quite as much they are interested in getting exactly what they bargain for. There is every reason why this should be so. No man ever considers anything cheap, in any sense of the word, which is not what it is represented to be. Sharp practice may succeed for once, but not again in the same direction.

Some builders of steam-engines are remarkably busy, having secured orders in spite of lower figures by others in the same line of engines, because their reputation for honest work is undoubted.

In times of low prices and slack orders, the temptation is to build cheap for the sake of naming low prices. At the best this can only secure temporary advantage. In the end those who deliver exactly what they sell, maintaining their character for honest work, will take the orders at fair living profits. No one likes to be humbugged in buying machinery.— *American Machinist.*

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

New Series—Vol. VII. HARTFORD, CONN., JULY, 1886. No. 7.

Hidden Defects.

Many defects of a very ordinary kind can be discovered by the most experienced inspector only with great difficulty, owing to their location or occurrence in some unusual or almost inaccessible portion of a boiler. Sometimes it is simply impossible for the most experienced man to say with *certainty* that a certain defect, the presence of which may be suspected, exists. Such defects are generally of the most dangerous kind, and they form no unimportant proportion of the risk in boiler insurance.

Generally speaking it may be said that any defect which can be seen or felt may and should be readily discovered, when it cannot be seen, either from its nature, location, or when the construction of the boiler is such that it will not admit of it, its presence can only be discovered by the action or behavior of the boiler. When a defect is of such a nature that its action upon a boiler is definite, and incapable of being produced by any other agency, it can be placed with about as much accuracy as if it could

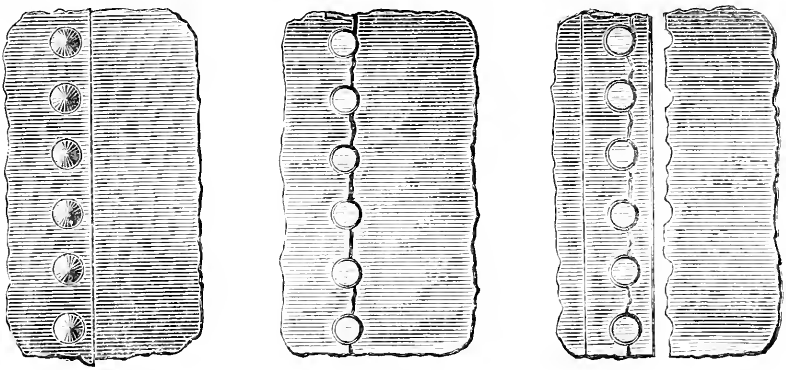


Fig. 1.

be easily seen; when, on the contrary, the signs of its action may be produced by various other causes than that to which they are actually due, then the diagnosis is generally a matter of much uncertainty.

For example, corrosion of the tubes, or upper portion of the shell, internally, of an ordinary tubular boiler can be readily seen by an inspector, and there is generally no difficulty in prescribing measures which will stop it. On the other hand, if the corrosion is external, and the shell is covered in with brick-work, or any other covering not easily removable, it may go on for a long time unsuspected or, if it is suspected, its presence cannot be definitely known without removing the covering. Many owners of boilers are loth to do this, and a great number of very bad accidents have occurred from this cause in consequence.

There are many kinds of boilers which are so designed that an examination of any part of their interior is simply an impossibility. In such cases of course the discovery of corrosion or other defects is next to impossible. Even when it is known to exist, its extent cannot be ascertained without cutting or drilling the sheets. The admiralty rules of some governments require such drilling of plates in boilers of naval vessels, but we are not aware that it is practiced to any great extent in any other class of boilers. It might be done in some cases, however, with very good results.

One of the most difficult things to determine with certainty is the existence of a fracture in the inner lap of the girth-seam on the bottom of the ordinary horizontal tubular boiler. If the boiler has a man-hole in one of the heads below the tubes, which is large enough to admit a man's body, the matter is greatly simplified, and the existence or non-existence of a fracture at this point can always be determined without trouble. If there is no provision made for a thorough examination of the inside of the shell at this point, then the existence of a fracture can generally only be inferred from the behavior of the boiler. If it leaks badly when under steam, it may be assumed that something is wrong, but a leak under these circumstances is quite as likely to arise from some other cause as it is from a fractured sheet. The location of the feed pipe, if

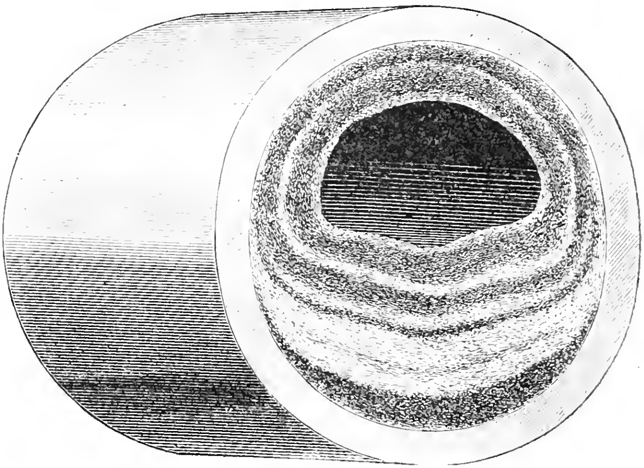


FIG. 2.

cold water is used, in the front head of the boiler near the bottom, will often cause severe leakage of the girth seams, which in many cases may give rise to a fear that the plate is fractured. It is also the most prolific cause of fractures of furnace plates, both through the seams and through the solid iron that we meet with.

Only a very short time ago a case came under our notice where a battery of four new boilers was put in; the feed pipe was put into the front head, run back about four or five feet, turned down, and discharged its water directly over the hottest part of the furnace, and only a few inches above the bottom of the boiler. About three months' running was sufficient to fracture the shells through the solid iron, in three out of the four boilers. The feed was then changed and no further trouble has occurred.

The accompanying illustration, Fig. 1, shows a fracture through the inner-lap of a girth-seam of a horizontal tubular boiler. The first cut of the figure shows the appearance of the seam from the outside, apparently perfect. The second portion is a view of the inside lap after being cut out, and the third shows the same with the plates separated. This was discovered by our inspector when making his first examination of a boiler that had been proposed for insurance.

Sometimes, when boilers and their appliances are not looked after as sharply as they should be, and due attention to repairing and keeping things in proper condition, is not given, it happens that the boiler or some of its appliances enter a decided protest against the state of affairs, and inaugurate a sort of a strike as it were. For instance, the steam-pump used to feed a certain battery of boilers not long since, seemed to get dissatisfied with the amount of work it had to do, and could only with great difficulty be prevailed upon to do it, and after a while it resolutely refused to throw water enough to feed the boilers. A thorough investigation of everything was then made, and the explanation of the behavior of the feed-pump may be found in Fig. 2, which shows a section of the feed-pipe between the pump and boiler. Comment is unnecessary; the cause of the trouble will be seen at once. This is another example of a defect that could be discovered only by observing the action of something quite removed from the source of the difficulty.

Inspectors' Reports.

May, 1886.

There were made by the inspectors of this company during the month of May last, 3,224 inspection trips, in the course of which 5,889 boilers were examined, 2,918 were inspected internally, and 452 were tested by hydrostatic pressure. 6,219 defects were discovered and reported, 698 of which were considered dangerous, and thirty boilers were condemned. The following table shows the defects in detail.

Nature of defects.	Whole number.	Dangerous.
Deposit of sediment,	510	28
Incrustation and scale,	784	27
Internal grooving,	19	5
Internal corrosion,	192	15
External corrosion,	167	31
Broken and loose braces and stays,	109	49
Defective settings,	154	12
Furnaces out of shape,	186	8
Fractured plates,	142	59
Burned plates,	96	21
Blistered plates,	244	22
Cases of defective riveting,	1343	74
Defective heads,	52	21
Leakage around tube ends,	1165	219
Leakage at seams,	548	21
Defective water-gauges,	79	15
Defective blow-offs,	34	8
Cases of deficiency of water,	6	3
Safety-valves overloaded,	18	8
Safety-valves defective in construction,	32	15
Defective pressure-gauges,	233	35
Boilers without pressure-gauges,	3	0
Defective man-hole frames,	1	1
Defective man-hole plates,	1	0
Broken hand-hole plates,	1	1
Total,	6,219	698

Defective pressure gauges form a large item in our monthly list of defects, and in addition to being quite numerous, defects of this class are apt to be of a very serious character. It is essential that the pressure under which a boiler is habitually run should be known, at least approximately, but it cannot be unless the pressure-gauge gives correct indications.

Of the various kinds of pressure-gauges manufactured at the present time, the "Bourdon Spring" gauge seems to be most in favor, and is very extensively used. The cheaper forms of this gauge are very low-priced. When well made it is a most excellent pressure-indicator, and if properly connected, may be relied upon to give practically correct indications for many years. We do not mean by this that when once set right it will always remain so; what we mean is, that a well-made Bourdon spring will not, if properly used, become "set" at the point where the pressure is generally carried sufficiently to destroy its usefulness at other points on the dial. The set will be so slight that it may be adjusted to give nearly correct indications all around the dial. We are not aware that any gauge can be made to give absolutely correct indications unless it is graduated under the exact conditions to which it is subjected in its daily use.

Some of the cheaper forms of this gauge are simply execrable, and should never be used on steam boilers. The springs become so badly set in a short time that there may be a variation of twenty or more pounds between zero and the ordinary working pressure, which it is simply impossible to correct. The only remedy in such cases is to graduate a new dial, especially for the spring, which operation would cost more than the whole affair would be worth when finished.

The ordinary diaphragm gauges, especially the cheap imported ones, are much more apt to become set than the American gauges with the Bourdon spring. It is difficult to find a gauge of this description, which has run any length of time, that can be adjusted so that the pointer will make a complete circuit of the dial and lie less than twenty-five pounds. Of course they can be set right at any particular point, although this is sometimes a matter of considerable trouble where the axis of the pointer is square, and the pointer is provided with a square hole, for then the least that the pointer can be moved is one-fourth of a turn. These gauges are sometimes constructed with a screw and turn-buckle arrangement for bringing the pointer to any particular figure on the dial, but the clumsiness of its design is such that it is better calculated to promote profanity than accuracy in steam-pressure indications.

In justice to diaphragm gauges we are compelled to state that there was made in this country at one time (we do not know whether it is manufactured at the present time or not) a gauge of this description, which could always be adjusted, to give absolutely correct reading all around the dial, no matter how much the diaphragm became set. The movement of the diaphragm gave motion to a thin brass plate, one edge of which gave, by a sliding motion, movement to the pointer mechanism. The outline or profile of the end of this plate determined the motion of the pointer, and by simply filing it, and changing its form as required, the gauge could always be adjusted to give correct indications from 0 to the limit of pressure. Such a gauge would cost somewhat more, but not necessarily *much* more, than the ordinary Bourdon spring gauge. Still, the ordinary Bourdon gauge answers every requirement of ordinary practice perfectly well.

The greatest care should always be exercised that gauge connections be properly made. Gauges should never be attached directly to an iron uptake or flue, as they frequently are; the heat takes the temper out of the spring, and a very short time suffices to so seriously impair its strength and elasticity, that its indications are utterly worthless, if accuracy is wanted. Where it is absolutely necessary to attach the gauge to any surface exposed to but a very moderate degree of heat, a thick layer of some non-conducting material should always be interposed between them to prevent overheating the gauge.

For like reasons a siphon arrangement of the pipes connecting gauges to boilers, or some equivalent arrangement, should invariably be used so that the gauge-spring may stand full of water when steam-pressure is on. This admission of steam of high temperature to the spring will, in a very short time, destroy its elasticity and render its indications worthless.

Care should always be exercised when gauges are screwed to walls by means of the flange nearly always provided for that purpose, that in making the connection with the union that the gauge is not cramped. Serious errors may be introduced if this matter is overlooked. A recent case in our own practice will illustrate this. A battery of seven boilers was run together, and all the boilers had gauges precisely alike. These gauges were screwed to a board attached to the front wall of the setting, and connected to the boilers by quarter-inch pipes and unions in the usual manner. All of the gauges were set at the same point by comparison with a standard gauge, and were then put up and connected with the boiler. No two of them now indicated the same pressure, the variation being as much as five pounds, which amount is inadmissible where accuracy is required. A very little investigation revealed the cause of the trouble. The piping was not done with extreme care, and where the connection with the union was made, the spring was cramped sufficiently to cause the error. A little straightening of the pipes, so that the unions came together perfectly fair, remedied the trouble completely.

Boiler Explosions.

MAY, 1886.

Saw-Mill (63). — A terrible accident occurred at Dana's saw-mill, in the south-east corner of Ray County, Missouri, May 6th. The boiler in the saw-mill exploded with terrific force, throwing Mr. Dana, who was running the saw at the time, a distance of sixty feet, almost instantly killing him. The engineer was fatally scalded, as was also another man who was standing near at the time of the explosion. In addition to the injuries to Mr. Dana by the water and steam his left leg was broken. Two pieces of the saw, which also burst at the time of the boiler explosion, crushed through the back of his head, another piece entering his chin, and a log, three feet in diameter, falling diagonally across his body. Various theories are advanced as to the cause of the explosion, but the most plausible one is that the engineer had allowed the water to get too low in the boiler. The explosion was heard a distance of four miles.

Locomotive (64). — Engine No. 159, of the Delaware and Hudson Canal Company, exploded its boiler at Schenevus, N. Y., May 11th. The engine was completely wrecked, and the engineer, James Gleason, was instantly kil ed. The fireman, whose name was Loucks, was fatally injured. A brakeman named Wells was also badly injured.

Portable ——— (65). — A boiler exploded May 11th, on the McCrum farm, where C. D. Robbins was drilling for gas, 30 miles from Wheeling, West Virginia, and blew John Barr 125 feet, killing him. He leaves a wife and four children. He was an old driller. The boiler was blown 75 feet.

Saw-Mill: Potable (66). — The boiler in the saw-mill of J. H. Herring, at Sarahsville, Ohio, exploded May 14th, demolishing the building and burying six men in the ruins. Edward Hill, Lafayette Tuttle, Lew Bailey, and James Herring, the proprietor, were instantly killed. Nathan Butler was so severely injured that he cannot recover.

Rolling-Mill (67). — A boiler at the Kittaning (Penn.) rolling-mills exploded at 1 a.m. May 18th, with terrific force. The boiler-house was totally wrecked and considerable other damage was done. Solomon Wallace, colored, fireman, was fatally scalded. Six tramps, who were sleeping near the boiler just previous to the explosion, are missing.

Saw-Mill (68). — The boiler in the saw-mill of Buchanan & Ferguson, near Deshler, Ohio, exploded May 25th, instantly killing the engineer, William Smith, and so badly injuring Webb Buchanan and Bruce Ferguson, sons of the proprietors, and William Fleck, that they cannot possibly recover. Three other persons were also seriously injured. The building was destroyed.

Colliery (69). — One of a battery of four boilers at the Primrose Colliery, exploded May 27th. Thomas Chapman, the fireman, was struck on the head by a flying brick and painfully but not dangerously injured. Jacob Wells, a boy of 13, who was eating his dinner at the time in the boiler-room, was knocked down and had his leg broken in three places.

Locomotive (70). — Three men were badly scalded and injured by a locomotive boiler explosion on the Illinois Central Road, at Wildwood Station, three miles south of Kensington, Ill., May 29th. The engineer, H. E. Perkins of 1516 Wabash avenue, in charge of engine 119, Fireman Charles Schechner, and Conductor William D. Lindsey, were the victims. Engine 119 is used in hauling gravel from the pit at Wildwood, and was about to pull from a switch track to the main line when a terrific explosion was heard, followed in an instant with blinding clouds of steam. Conductor Lindsey, who belonged to another train, and had just turned the switch, was blown fifteen feet into a ditch and terribly scalded, having been standing immediately alongside the engine. When the steam cleared away Fireman Schechner was picked up in a helpless condition, having been blown through the cab window, while Engineer Perkins was taken out badly cut and bleeding and terribly scalded. An examination of the wrecked engine was made, and it was found that the crown sheet had been blown out. The front of the engine was broken badly, while everything in the tender was completely wrecked. The blowing down of the crown sheet let the water in the boiler into the fire, thus generating more steam, which blew out the fire-box door, and was the cause of the injury to the men.

Locomotive (71). — A disastrous explosion occurred in the round-house of the International and Great Western shops at Palestine, Texas, May 31st, instantly killing two men, wounding nine, and doing great damage to the building. Fireman J. T. Fultz was engaged in cleaning locomotive No. 720 preparatory to her going out. Stepping from the engine, in company with Engineer Henry Rhody, they went to the side of the round-house for a drink of water. Fultz insisted on his chief drinking first. This courtesy saved the fireman's life, for Rhody thereby reached the locomotive first, just in time to be hurled into eternity by an explosion which shook every house in the city, and was plainly heard six miles from town. The tremendous shock brought the 300 workmen out of the shops in a twinkling. They rushed to the spot and began the work of rescue. The roof of the great building immediately where the locomotive stood was entirely demolished, leaving a hole 40 feet square. The walls of the building are also shattered and dangerous. Under the débris of iron and timber were found the mangled remains of Engineer Rhody and Machinist D. W. Riggs. Not far from the locomotive stood a group of four engineers, who were all dangerously injured. Engineer Milton Goodrich, was badly scalded, and had his left leg broken near the ankle. Engineer James Healy was struck by flying fragments of the boiler. His right leg was broken and he was terribly injured on the head and stomach. Engineer Robert Gibson was seriously scalded and cut on the left arm, while Engineer Thomas Molter was frightfully scalded about the neck and chest, and had his shoulder dislocated. Albert Lang, a wiper, was struck on the face and head by a fragment. Engineer Dickerson, George Radford, Frank Ward, and Machinist McCloud, were all injured, but not seriously. Half a dozen other employés about the round-house were struck by falling timbers, but their injuries are not severe.

Later.— Palestine, Tex., June 2d.— An examination of the results of the explosion in the round-house of the International and Great Northern railway shows the damage to the property to have been much greater than at first supposed. It is estimated that the loss to the company will reach $100,000. Five locomotives standing in proximity to the exploded engine are very badly damaged. One locomotive on the same track was driven half way to the side of the round-house. The shock of the explosion was so great that thirty men among the workmen in the shops were so violently thrown to the ground that they were unable to work. Nearly all of them are suffering from pains in the head and are partially deaf. Engineers Goodrich, Gibson, Molten, Holly, and Dickerson, are all resting easy, but their condition is critical. Pieces of the boiler and machinery were picked up to-day over 300 yards from the scene.

Scientific Experts as Witnesses.

The expert occupies a totally anomalous position in court. Technically he is a mere witness; practically he is something between a witness and an advocate, sharing the responsibilities of both, but without the privileges of the latter. He has to instruct counsel before the trial and to prompt him during its course. But in cross-examination he is the more open to insult because the court does not see clearly how he arrives at his conclusions, and suspects whatever it does not understand. The late Dr. R. Angus Smith complained of being "contemptuously compelled to herd with thieves and scoundrels in a witness-box." He adds: "I have seen barristers speaking to a scientific witness in such a way as to show that to them a witness was always an inferior person." Surely every person who has been present at a technical trial, or has had to appear as an expert in a poisoning, a patent, or an adulteration case, will be able to confirm this from his own observation and experience.

Now it may, perhaps, be cynically hinted that men of science should be willing to bear all this annoyance for the public good. But is it for the public good? In the first place, not a few of the most eminent men in every department of science distinctly and peremptorily refuse to be mixed up in any affair which may expose them to cross-examination. "I will investigate the matter, if you wish it, and will give you a report for your guidance, but only on the distinct understanding that I am not to enter the witness-box." Such in substance is the decision of not a few men of the highest reputation and the most sterling integrity. Certainly it is not for the interests of justice to render it impossible for such men to give the court the benefit of their knowledge.

Further, the spectacle of two men of standing contradicting or seeming to contradict each other in the interest of their respective clients is a grave scandal. Men of the world are tempted to say that "Science can lay but little claim to certainty, and is rather a mass of doubtful speculations than a body of demonstrable truth." To us, at least, there is nothing more saddening than to read the trial of a notorious prisoner, or the report of a great patent case, especially if taken along with the comments of the press and of society on these occasions.

Here, then, we see that our present mode of dealing with scientific evidence is found on all hands unsatisfactory. The outside public is scandalized; experts are indignant; the bench and the bar share this feeling, but unfortunately are disposed to blame the individual rather than condemn the system.

As it seems to us, the expert should be the adviser of the court, no longer acting in the interest of either party. Above all things he must be exempt from cross-examination. His evidence, or rather his conclusions, should be given in writing, and accepted just as are the decisions of the bench on points of law.—*Chemical News.*

The Locomotive.

HARTFORD, JULY, 1886.

J. M. ALLEN, *Editor.* H. F. SMITH, *Associate Editor.*

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 *cents per year when mailed from this office.*
Bound volumes one dollar each.

THE importance of starting right when designing and laying out a manufacturing plant cannot be overestimated. One of the most important things to be considered is the possibility of future additions to the buildings and machinery which may be demanded by an increasing business; yet how often is this overlooked. It is nearly always just as easy when locating buildings, to so place them that they may be added to at any future time without tearing down some other building or removing a large amount of machinery, as it is to huddle them all together, so that there is no chance for expansion without remodeling a whole plant, or stopping some portion, or a whole, of the works for a longer or shorter time. Such additions to a plant are generally made when business is rushing, and the concern can the least afford to stop.

Especially is this true with respect to the motive-power of a manufactory. Upon this depends primarily the running of the works, and it is of the utmost importance that boilers and engines should be so placed that their capacity may be doubled or trebled without interfering with the running of the works. The boiler-room is especially apt to be slighted in planning the works. This arises generally from the mistaken idea that any place that a boiler can be gotten into is a good-enough place in which to set it up and run it. When the works expand the mistake is generally felt, but many times the conditions are not improved. In consequence, there will be found to-day a great many concerns, comparatively small, with two or three separate boiler-rooms; some have one boiler-room, some two, and perhaps another with some other number of boilers. The running of two or three separate boiler-rooms, when all might be consolidated into one, is a very expensive and unsatisfactory way of making steam.

IN some of our large manufacturing cities, where the capacity of the mills or shops have increased many times beyond the anticipations of their founders, with the result that all the available land has been built upon to a height of five or six stories, the location of a boiler-house sufficiently large to meet the requirements of the business has often been a matter of extreme difficulty. After crowding and cramming in boilers until it can no longer be done, and forcing what boilers can be set far beyond their economical limit, the whole boiler-plant is generally removed to some distance, and a new start made. This generally necessitates carrying steam a long distance to supply some large engine. This should be avoided, if possible; steam should be used just as soon after it leaves the boilers as it conveniently can be. The advantage and economy resulting from a boiler-house centrally located are indisputable.

In such cases, instead of going half a mile or so across some river, which necessitates bridges, large steam-pipes running a long distance, and waste of heat by radiation, to say nothing of the purchase of large tracts of valuable land, we believe the erection of a *two-story* or even a *three-story* boiler-house would be much cheaper in first cost, and in maintenance, and also believe a better degree of economy would be realized. We see no more objection to having one battery of boilers above another, in a properly constructed building, than we do in having a spinning-room above a weaving room.

"The Mitis Process of producing Wrought Iron and Steel Castings," compiled by W. F. Durfee, M. E., is the title of a neat pamphlet received, which gives interesting facts relating to the working of the process, and the properties of castings made. To those interested it is most valuable. Casting made by this or some other analogous process, must, from the nature of things, soon play an important part in the industrial arts.

Domes and Drums.

The use of steam-domes, steam-drums, and mud-drums on all kinds of boilers is the rule in some parts of this country under all conditions. Some engineers insist upon having them on boilers designed by them, and most boiler-makers would rather put them on than not. They are expensive appliances, hence there should be some good reason for their presence, else they would better be omitted. Are they, in the majority of cases where they are used, worth the money paid for them? Do they exert a beneficial influence upon the working of the boilers, their durability, or upon the quality of the steam? In nine cases out of ten we believe they do not.

The purpose for which mud-drums are used is to form a lodging-place for sediment to deposit itself in. In most cases where it is used, the feed-water is also introduced to the boiler through it. Where two and frequently more boilers are set together over one grate, it is a common practice to connect them all together by means of a long mud-drum, running the entire width of the battery; very often in such cases all the boilers are supplied with water by one pipe, which delivers the water into this drum. Does this arrangement fulfill its intended purpose without other disadvantages, greater than those it is intended to obviate?

As to providing a lodging-place for sediment, we can only say, sediment should never be allowed to lodge anywhere. There is no excuse and not the slightest necessity for it. It is as easily blown out of a boiler as from a mud-drum. A two-inch blow-off pipe, connected to the botton of a boiler, not over twelve inches from the back end, and opened a few seconds every day, at the proper time, will suffice to keep a boiler entirely free from sediment.

Mud-drums, from their location in the cooler portion of the furnace, and more especially where the feed water is introduced through them, are exposed to a temperature which seems peculiarly apt to cause corrosion. This, taken in connection with the fact that they are usually so constructed that a proper inspection of them is difficult, and often impossible, furnishes a very strong argument in favor of their abolition. A very great number of most destructive accidents have arisen from this cause alone.

Where a mud-drum is insisted upon, a boiler should not, under any circumstances, be fed through it. It is almost the worst place for the introduction of the feed that could be devised. The feed-water, often cold, and always at a much lower temperature than the shell-plates of the boiler, enters the boiler at the bottom and flows along the shell toward the front end in direct contact with the plates. The evil effects of this can hardly be overestimated. It is almost certain to fracture the shell-plates in a very short time. More fractures of girth seams on boiler bottoms, with the consequent large bill for repairs, have probably arisen from this cause, in boilers fed in this manner, than from all other causes combined.

Where several boilers are set together, and connected by a common mud-drum, and dependence is placed upon the drum and its connections for equalizing the height of the water in the several boilers, trouble is sure to arise, unless the connections are very large. In such cases the connection between the boilers and drum should not be less than eight inches in diameter. If they are less, there is danger of the water being driven partially out of any boiler which may be fired somewhat harder than the others. This is a very frequent occurrence, and overheating of tubes is the inevitable result.

For the prevention of incrustation in a boiler, the mud-drum is wholly useless under all conditions.

In all cases where a mud-drum is used it should be connected and set so that access may be had to it at all times, even when the boiler is running. Such an arrangement may save much trouble. The importance of accessibility to a mud-drum cannot be overestimated.

Steam-domes are, in the majority of cases, much more useless appendages to steam boilers, if such a thing be possible, than mud-drums are. The object for which a steam-dome is used is, in itself, a very good one, but it is rarely accomplished by using the dome. The object is, of course, to obtain dryer steam than could be had by connecting the steam-pipe directly to the boiler shell, but if a boiler is properly designed, and there is no good reason why it should not be, the steam delivered will be dryer without a dome than it will be with it. Even where a boiler is not properly constructed, there is no evidence that the quality of the steam is ever improved by the addition of a dome. The object sought is dryer steam: that actually gained is the additional moisture due to the condensation within the dome, and in the case of a large dome, exposed to currents of air, this condensation will be quite a large amount, unless the dome is well protected by some good non-conducting material.

A dome is an expensive luxury, and as usually constructed, very considerably weakens the boiler shell. When the opening from the boiler into the dome is the full size of the dome, the shell is greatly weakened, unless an elaborate system of bracing is resorted to. It is a very difficult part of the boiler to brace properly, and hence it is rarely done. When not done, there is almost always leaking, and other evidences of distress are manifest around the flange at junction of dome and shell.

When a dome is used on a boiler the best way to make everything secure is to cut the opening through the shell out the same size and form as that made for the man-hole, and rivet an exactly similar ring around the opening. This renders the interior of the dome accessible for inspection and repairs, and gives it a good margin of strength. As that portion of the boiler shell inclosed within the dome is subjected to pressure on both sides, the stress on other parts of the shell, and on the shell of the dome, arising from the steam pressure, tends to flatten it, and when high pressures are used, it is always well, and sometimes absolutely necessary to so brace it as to resist this flattening out tendency. This may be accomplished by tying the shell to top of dome by strong braces, or by riveting strong stiffening bars to the top of the shell inside of the dome. With large boilers and domes, the braces properly distributed and fastened form much the better arrangement, and can never be safely omitted.

The storage capacity for steam which a dome adds to a steam boiler, which is sometimes adduced as an argument in favor of their use, is insignificant, and can be obtained many times cheaper by making the boiler shell slightly larger. For example, take a 48-inch boiler with tubes 15 feet long, and provided with a dome 27 inches in diameter and 27 inches high. The dome would have a storage capacity of about 9 cubic feet, while the shell would have, with the water at its usual height, a steam-room of 52 cubic feet. $52-9=61$, and retaining the same number and arrangement of tubes we can get the extra 9 cubic feet of steam-room by simply making the boiler shell 2 inches larger in diameter. The cost of this extra 2 inches added to the shell of the boiler would be much less than that of adding a dome to the smaller boiler, while the extra surface presented to the air for the radiation of heat and consequent condensation of steam would be very much less. We will add here that either a 48-inch or 50-inch boiler is shown by experience to possess ample *height* of steam-room, without any dome, to insure the delivery of dry steam.

Steam-drums are a nuisance, pure and simple, in ninety-nine cases in a hundred where they are used. Why steam should be generated, conducted outside of the boilers, and stored up in a drum whose only possible function is to furnish cooling surface for the condensation of the steam, passes our comprehension. Steam, the instant it passes out of the boiler, away from the influence of the furnace heat, begins to part with its heat; no matter how well the surfaces of the containing pipes or drums may be protected, there will always be some loss, which is continuous and irrevocable from the time it leaves the boiler. This radiation of heat means condensation of steam, therefore it is evident that the steam should be retained in the boiler so far as it can be done until it is ready to be used. Do away as far as possible with storage domes and drums, and make the body of water in the boiler the reservoir of heat. The steam supply will be much steadier and its quality will be better in this case than it will be if the conversion into steam has taken place and an attempt has been made to bottle it up outside of the boiler.

Tornado Study — Its Past, Present, and Future.

By Lieut. John P. Finley, U. S. Signal Corps.

[*Extracts from a Lecture delivered before the Franklin Institute, November* 27, 1885.]

(Continued from p. 95.)

I cannot lead you through the details of this work within the scope of this paper. Sufficient to say that the work affords gratifying results, as will be shown.

Tornado prediction is no longer a possibility, but in many respects may be considered an accomplished fact. By this I do not mean absolute perfection, but reasonable success. The system of preparation and study which leads to the result is subject to improvement, both as to manipulation of charted data and the verification of forecasts. It is believed that the work now in hand, with the above end in view, will greatly advance the present measure of success.

Beginning with the year 1884, the daily weather maps were closely studied to determine the conditions favorable for the development of tornadoes. On the tenth of March, 1884, regular tornado predictions were commenced experimentally, and during the remainder of the month were made twice daily, at intervals of eight hours. The first prediction was made from the morning (seven A. M. Washington time) weather map, and embraced the eight hours up to three P. M. The second prediction was made from the afternoon (three P. M. Washington time) weather map, and embraced the eight hours up to eleven P. M.

For the month of April, the same plan was followed.

For the months of May, June, and July only one prediction was made. This prediction resulted from a study of the seven A. M. (Washington time) weather map, and embraced the sixteen hours up to eleven P. M. Tornado predictions were made for certain districts. That portion of the United States lying between the seventy-seventh and 102d meridians was divided into eighteen sections or districts. Tornado predictions for the year 1885 began June 1st, and terminated September 20th. These predictions were made from a study of the seven A. M. (Washington time) weather map, and embraced the sixteen hours up to eleven P. M.

In preparing for the work of making tornado predictions, it was necessary to ascertain, as nearly as possible, the limits of that portion of the United States within which tornadoes were most likely to occur. These limits were determined from the geographical distribution of tornadoes, as taken from the records of the past ninety years. Each district was subdivided by imaginary lines into four equal parts, and predictions were made either for the entire district, or for any one, or more, of these parts. As a whole, this study proved fairly successful for the period during which the work progressed. In no instance where it was predicted that conditions were favorable for the development of tornadoes did violent storms fail to occur, either hail, hurricanes, or tornadoes. But no prediction was considered entirely successful unless the characteristic funnel-shaped cloud was actually reported as a feature of the storm, and that the tornado's path was clearly within the region or district for which the prediction was made, and that the tornado occurred within the eight or sixteen hours specified in the prediction. All of the most remarkable and destructive tornadoes of the two seasons were predicted for the districts within which they occurred from five to eight hours in advance of their appearance. It was not considered advisable to furnish these predictions to the public at the time they were made, because the work was undertaken experimentally, as a matter of study and official record, with a view of ascertaining what might be accomplished in this direction for the benefit of the agricultural sections of the country.

In what follows there is presented in concise form some of the most important results that have been attained by the methods of investigation already pursued:

(1.) That there is a definite portion of an area of low pressure within which the conditions for the development of tornadoes is most favorable, and this has been called the dangerous octant.

(2.) That there is a definite relation between the position of tornado regions and the region of high contrasts in temperature, the former lying to the south and east.

(3.) That there is a similar definite relation of position of tornado regions and the region of high contrasts in dew-point, the former being, as before, to the south and east.

(4.) That the position of tornado regions is to the south and east of the region of high contrasts of cool northerly and warm southerly winds — a rule that seems to follow from the preceding, and is of use when observations of temperature and dew-point are not accessible.

(5.) The relation of tornado regions to the movement of upper and lower clouds has been studied, and good results are still hoped for.

(6.) The study of the relation of tornado regions to the form of barometric depressions seems to show that tornadoes are more frequent when the major axis of the barometric troughs trends north and south, or northeast and southwest, than when it trends east and west.

(7.) The general direction of movement of the tornado is invariably from a point in the southwest quadrant to a point in the northeast quadrant.

(8.) The tornado cloud assumes the form of a funnel, the small end drawing near, or resting upon the earth.

(9.) The cloud and the air beneath it revolve about a central vertical axis with inconceivable rapidity, and always in a direction contrary to the movement of the hands of a clock.

(10.) The destructive violence of a tornado is sometimes confined to a path a few yards in width, or it may widen to the extreme limit of eighty rods.

(11.) The tornado, with hardly an exception, occurs in the afternoon, just after the hottest part of the day.

(12.) The hour of greatest frequency is between three and four P. M.

(13.) The destructive power of the wind increases steadily from the circumference of the storm to its center.

(14.) Observations with a single isolated barometer will not indicate the approach of a tornado, however near the position of the instrument to the path of the storm; but such observations are of value in this connection only when a number of them are displayed upon the daily weather map.

(15.) The tornado season is embraced between the first of April and the first of

October. There are, however, instances in a long series of years where tornadoes have been reported in every month of the year.

(16.) The months of greatest frequency are June and July.

(17.) Taking the whole United States together, it is found that the region of greatest frequency per year per square mile embraces the following States: Georgia, South Carolina, Illinois, Indiana, Iowa, Kansas, Missouri, Ohio, and Wisconsin.

(18.) The movements of a tornado cloud are comprised within limits of four peculiar and distinct motions. Knowing these, and obeying the rules given in Signal Service Notes, No. XII, as to his movements on the approach of a tornado cloud, no person need suffer injury or death from the fury of the storm.

(19.) No buildings, however strong, have yet been able to withstand the violence of a tornado.

(20.) People must resort to dug outs and cellar caves, the preparation and use of which is indicated in Signal Service Notes, No. XII, in order to place themselves and their valuables beyond the possibility of danger.

(21.) Under no circumstances, whether in a building or a cellar, take position in a northeast corner, in an east room, or against an east wall, remembering that the tornado cloud invariably moves in a northeasterly direction.

(22). The comcomitants of the tornado are: An oppressive condition of the air, the gradual setting in and prolonged opposition of northerly and southerly currents over a considerable area, a gradual but continual fall of the thermometer, with a prevalence of the northerly currents, and a rise with the predominance of the southerly. Decided contrasts of temperature north and south of the line of progressive movement. Huge masses of dark and portentous clouds in the northwest and southwest, possessing a remarkable intensity of color, usually a deep green. A remarkable rolling and tumbling of the clouds, scuds darting from all points of the compass toward a common center. Hail and rain accompanying the tornado, the former either in unusual size, form, or quantity, and the latter either remarkable in quantity or size of drops. The presence of ozone in the wake of the tornado. A remarkable roaring noise, like the passage of many railroad trains through a tunnel. The clouds generated by the vortex assume the form of a funnel, with the smallest end toward the earth. The remarkable contraction of the storm's path. The remarkable definiteness of the limits of the storm's path. Upon reaching the earth's surface, the vortex assumes the form of an hour-glass. The vortex has four motions: (1.) The whirling or gyratory motion, always from right to left. (2.) The progressive motion, generally from some point in the southwest quadrant to some point in the northeast quadrant. (3.) The ricochet motion. (4.) The oscillatory motion.

(23.) The characteristic effects of a tornado are: Objects are drawn towards the vortex from every point of the compass. Objects passing into the vortex are thrown upward and outward by the vortical action of the engaged air. Structures are literally torn to pieces by the vortical action of the air, evidence of which is afforded both by the fineness of the débris, and also its disposition in the storm's path. The débris is thrown inward from each side of the storm's path. Light objects are carried to great heights, and also to great distances. Objects are carried inward and upward by the centripetal, and outward by the centrifugal force of the vortex. Weight or size are conditions which generally present immaterial values to the power of the tornado. Persons are stripped of clothing. Fowls and birds are denuded of feathers and killed. Trees are whipped to bare poles. Long and heavy timbers are driven to considerable depths in the solid earth. The vortex is completely filled with flying débris. Timbers are driven through the sides of buildings. Sand and gravel are driven into wood. Human beings and animals are run through with splinters and timbers. Straws, bits of glass, and pieces of metal are driven into wood. The strongest trees are uprooted or twisted off near the roots. Men and animals are terribly mangled by contact with flying débris, and by being rolled over the ground for considerable distances. In the path of the storm all vegetation is destroyed. Railroad trains are thrown from the track. Iron bridges are completely dismantled and carried from their foundations. Heavy bowlders, weighing tons, are rolled along the earth. The largest railroad engines are lifted from the tracks on which they rest. All objects, whether metal or non metallic, magnetic or non-magnetic, simple or compound, animate or inanimate, are acted upon in a similar manner.

(24.) Cheap buildings, dug-outs, and cellar caves, with general insurance, is recommended as the wisest policy to be pursued by people living in the tornado districts. During the past four years tornado insurance companies have been formed, and tornado risks have been written by several large companies engaged in other branches of insurance. Within the period above indicated tornado risks have been taken to the amount of about $50,000,000 in the tornado districts of the country, principally in the West. The terrible loss of life and property which follows in the wake of a tornado, and the intense suffering and misery endured by those who survive its perils only to find that all their worldly goods have been swept away, makes this storm one of the direst calamities that can befall a community. Hundreds of thousands of dollars' worth of property are destroyed in a few hours and scores of persons killed or maimed for life along the track of a single tornado.

The study of the origin, nature, and the laws governing the development and movements of this class of local storms is of the utmost interest to the agricultural sections of the tornado districts. The work already accomplished has been received with great satisfaction by the people living in the regions traversed by these storms. During the year numerous letters have been received from nearly every State in the Union, testifying to the progress and success of the work.

Firemen.

There are probably few callings deserving of so much attention, but yet so neglected as that of a fireman for a steam-boiler. The impression is that any able-bodied man, young or old, can fire a steam-boiler, and it is often more a question of wages than of age or experience. So far as the opinions of the writer go, firing needs as much study, practice, and investigation, as some trades. In fact, there are several trades where not half as much knowledge and education are required, with reference to natural laws, as in firing. In older countries the subject has received considerable attention, and it is as difficult to get a position as fireman as it is that of an engineer. The applicant must answer a number of questions, and furnish satisfactory references as to his experience, ability, and knowledge of firing generally, including a knowledge of steam-boilers, different kinds of coal, treatment of a steam-boiler, careful firing, so as to make as little smoke as possible; this last is considered equally as important there as here.

The question of wages is not the first in consideration of the value of a good fireman, so long as he has had experience, and can be trusted. Of course, all engineers are aware that a good fireman can save more coal in a day than his wages would pay for, and also that an intelligent fireman is generally acknowledged to be the best smoke-burner on the market. Outside of the fact of wasting fuel, there are a number of things that are dependent on the fireman's ability. Prominent among them is the care that he gives to his boiler; he should give close attention to the gauges, know when they are working correctly, and keep them clean and in good order; he should maintain a steady pressure of steam throughout the day, and feed just as fast as the water is evaporated from the boiler, and no faster. The temperature of the furnace should be maintained as regular as the steam pressure and the water level. He should also be more or less familiar with the gaseous nature of the coals he is using, so that he can fire accordingly; he should also be conversant with the scale-forming properties in the water, and know also how to remove it with the least injury to the boiler, and he should know how to prevent scale-forming by means of blowing down periodically, either from the blow-off pipe or from the surface blow. The fireman should also have enough interest in his situation and his employer to clean the boiler frequently and keep the gaskets in good order, so that man-hole plates can be tightened up with a 12-inch instead of a 12-foot wrench. Banking fires properly, regulating draft, cleaning fires, and the manipulation of them to insure good combustion and a long life to the fire-walls and grate-bars, keeping the masonry around the boiler clean, inside and out, grinding valves in connection with the boiler, are the duties of a fireman, and to perform them well he must be a capable and intelligent man.

It is to be regretted that manufacturers do not regard the position of a fireman more than they do. A good, skillful fireman is worth as much as a good mechanic. His hours are longer, and his work is never completed, practically. When others go home at the sound of the whistle, the duties of a fireman (as well as an engineer) practically begin. There is always something to be done in the shape of banking fires, grinding valves, cleaning grate-bars, repairing brick-work, cleaning flues, and washing out boiler, and probably a dozen other little things, apparently trifling, too numerous to mention.

No matter how smart an engineer may be, a good fireman is his right-hand man, and without him his labors are considerably reduced in value. An ignorant, careless fireman is dear at any price, and should not be given charge of a boiler with steam off, to say nothing of a boiler with steam on.

A steam boiler, when properly made of good material, in a substantial setting, ought to last twenty-five years with very little repair; but there are few that last half of that time, and I attribute their speedy destruction entirely to the manner in which they are treated. We may have a plant consisting of a good automatic engine, good boilers, an improved system of setting, a first-class engineer, an economical system; in fact, all the way through, but with an ignorant, careless fireman, the economy that might otherwise exist is reduced to a minimum. The writer does not blame the fireman for everything, yet the poorest plant is capable of doing well in the hands of a first-class fireman, while in the hands of a poor one the coal bills hasten the ruin of the proprietor.

Our most improved devices, whether an engine or a sawing machine, are at the mercy of the attendant, and if he is ignorant and careless, the possibilities of success are very slight.

It would have been well, while the smoke ordinance of Chicago was being enforced, if some steps had been taken to investigate the reputation and mechanical ability of the fireman, from the fact that the best smoke-preventers to-day are useless if not handled properly. Manufacturers ought to encourage the movement by willingness to pay a good fireman enough to supply the necessities of life. The average pay of firemen to-day, when based upon the number of hours he has to work (or rather ought to work) to do his duty properly, is simply starvation, few firemen receiving more than $1.50 a day, and working from twelve to thirteen hours for it, to say nothing of Sunday work. This is entirely insufficient, and instead of firing being a calling that men ought to take some interest in, to learn thoroughly, it is reduced far below that of a laborer in a foundry. A fireman, in getting a position under a good engineer, should be able to subscribe for mechanical papers and books, read up, and know as much about firing as the engineer himself; such a man would be invaluable, not only to the employer, but to a probably over-worked engineer. His business should have attraction instead of repulsion. We all know that very few firemen stay in one place any great length of time. Firemen should be willing and anxious to increase their knowledge, and to be as conversant with the principles of a steam-boiler as the engineer; but when we consider the enormous amount of labor and the trifling pay therefor, we cannot expect them to take interest in it.

Much can be done to improve the position and standing of a fireman, and I hope that the attention of both manufacturers and engineers will be directed to this fact.

—John Erwood *in The Mechanical Engineer.*

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

New Series—Vol. VII. HARTFORD, CONN., AUGUST, 1886. No. 8.

Dangerous Boiler Connections.

Probably the most dangerous style of connecting boilers that could be devised is that shown in Fig. 1, where each of two or more boilers is provided with its own stop-valve, so placed that steam can be shut into the boiler, while only one safety-valve is provided for the whole battery, this valve being placed upon the steam-drum beyond the stop-valves. Such an arrangement is bad enough when each boiler has its own steam-gauge connected directly with the boiler, but it is doubly dangerous when but one steam

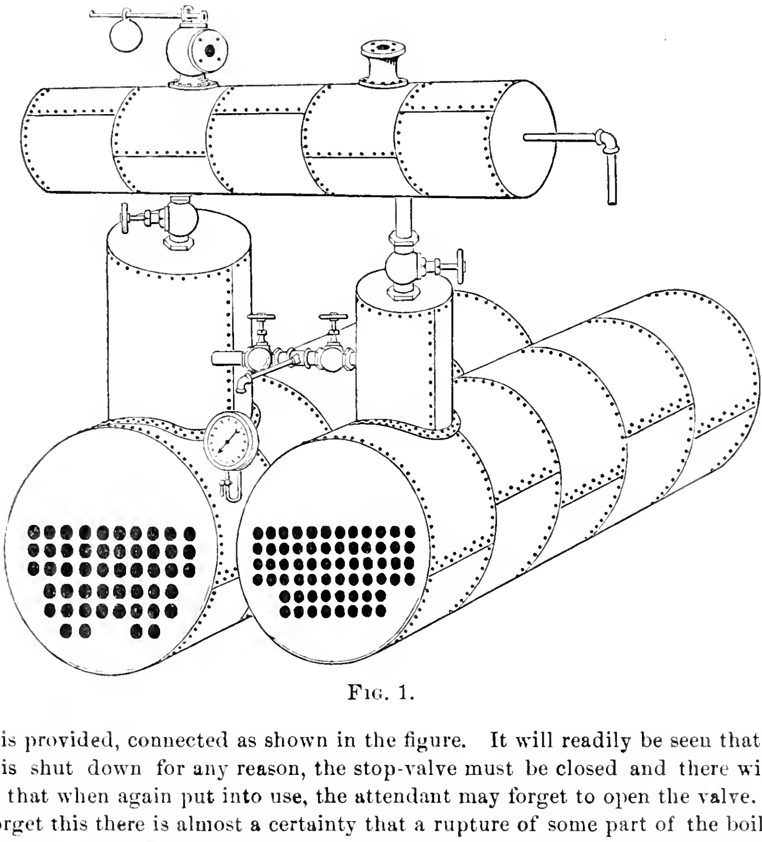


Fig. 1.

gauge is provided, connected as shown in the figure. It will readily be seen that if one boiler is shut down for any reason, the stop-valve must be closed and there will be a chance that when again put into use, the attendant may forget to open the valve. If he does forget this there is almost a certainty that a rupture of some part of the boiler will result. We have known of several explosions which have occurred from this cause. The one from which the wreck shown in our illustrations resulted, occurred but a short time since. The owners of the boilers were careful and responsible men who wanted things all right, and supposed when the boilers were set and connected that everything was as it should be. The steam-fitter, however, put the work up as shown in figure 1, and the owners not being practically familiar with this kind of work, thought it was all right.

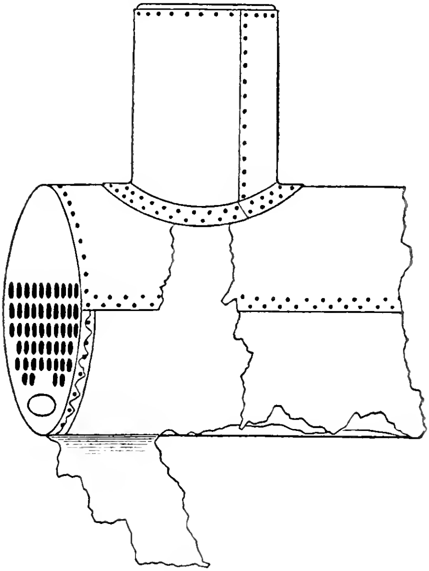


FIG. 2.

For some reason or other one boiler was shut down, and the steam gauge removed for repairs. When the boiler was again fired up, the engineer neglected to open the stop-

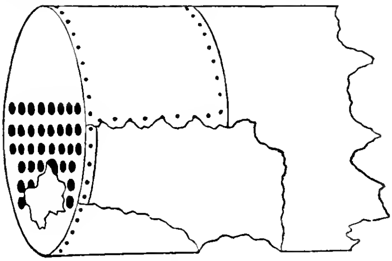


FIG. 3.

valve, and, there being no outlet for the steam or connection with the safety-valve, a terrific explosion followed, portions of the boiler being thrown over 700 feet. Fig. 2

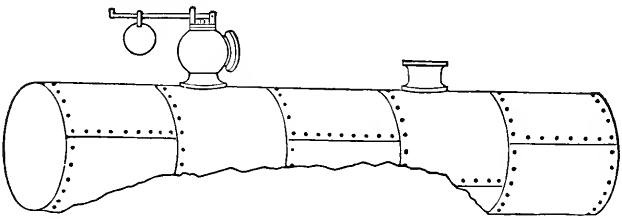


FIG. 4.

shows the front end of the left-hand boiler. Fig. 3 the rear end of same boiler, which was thrown nearly 300 feet, while Fig. 4 shows the upper portion of the steam-drum.

We have had Fig. 5 engraved to show how these boilers should have been connected. A safety-valve for each boiler is placed directly upon the shell, there being no possible chance to cut off the communication with the boiler. Each boiler is also pro-

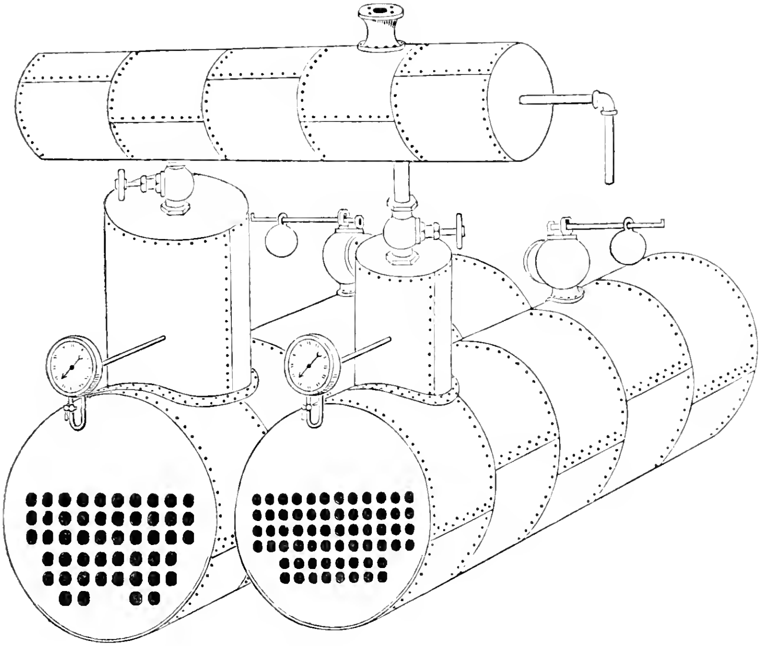


Fig. 5.

vided with its own steam pressure-gauge, directly connected. Had the boilers been connected in this manner, the explosion, with its accompanying loss of several thousands of dollars, would never have occurred.

The first rule to be observed in connecting-up steam boilers is: *Never put a stop-valve between the boiler and safety-valve.*

Inspectors' Reports.

June, 1886.

June is usually quite a busy month for the inspectors, as will be seen from the report below, for the month of June last, during which 3,076 visits of inspection were made, 6,238 boilers were examined, 2,772 were inspected internally, and 451 by hydrostatic pressure. The total number of defects reported, was 6,484 of which 819 were considered dangerous; 50 boilers were condemned.

Our usual statement of defects is appended.

Nature of defects.	Whole number.	Dangerous.
Deposit of sediment,	509	36
Incrustation and scale,	802	45
Internal grooving,	22	8
Internal corrosion,	219	25
External corrosion,	326	44
Broken and loose braces and stays,	151	23

Nature of defects.	Whole number.	Dangerous.
Defective settings,	134	15
Furnaces out of shape,	118	13
Fractured plates,	159	84
Burned plates,	106	59
Blistered plates,	229	18
Cases of defective riveting,	1527	153
Defective heads,	35	14
Leakage around tube ends,	1076	184
Leakage at seams,	591	22
Defective water-gauges,	74	11
Defective blow-offs,	33	6
Cases of deficiency of water,	6	6
Safety-valves overloaded,	16	11
Safety-valves defective in construction,	35	7
Defective pressure-gauges,	314	34
Defective man-hole frames,	1	1
Defective fusible plug,	1	0
Total,	6,484	819

One of the essentials of a steam plant, no matter for what purpose it may be used, is a *good chimney*. Without this, the most elaborate appliances for the promotion of economy, and the most painstaking efforts of those in charge are of no avail; for the prime requisite, without which economy is simply impossible, is the perfect combustion of the fuel under the boiler. The most perfectly constructed boiler, and the most elaborate setting, kept in the best possible condition, with the most approved appliances for the utilization of steam after it is generated, cannot, in themselves, create economy. The fuel must be perfectly burned to begin with, or waste is the result.

In most manufacturing plants of considerable magnitude, chimneys will be found large enough to perfectly serve the purpose for which they were originally built. As the plants increase in size, and more boilers are added, it often happens that the chimney becomes overworked, so much so that proper combustion of the fuel is impossible. In such cases as this the remedy is obvious, and is generally very easily applied.

There are cases, however, where an increase in the power of a chimney, although it may be imperatively demanded, is surrounded with grave difficulties. Take for instance a fine building, say a church, which is so located that it may be seen from all points, and we will suppose the architect has made the most of the situation with the result that the edifice as a whole, when viewed externally, is architecturally perfect, all parts are well proportioned, in perfect balance, and the effect is fine. But the steam-fitter finds, when he puts in the boiler for heating this fine building, that the chimney-flue, carried up inside the wall is only one-fourth large enough to furnish the necessary draught for the boiler. What is to be done?

It is, of course, perfectly easy to build a chimney outside if there is sufficient land for the purpose, but this spoils the beauty of the edifice as viewed from the side on which the chimney is located. A man with an eye for the beautiful does not like to do this, for it makes the whole building look like a "botched" job. On the other hand, he hesitates about connecting the boiler to the small chimney, for he knows by experience that the draught will be sluggish, the coal will be imperfectly burned, as a consequence much of it will be wasted, and it *may* be impossible to properly warm the building in the coldest weather. If he goes ahead, puts in his work, and it does fail to warm the building, he is blamed by those in charge of the property, perhaps they refuse payment on the ground of unsatisfactory work. On the other hand if he plainly states his opinion that the chimney is too small, he is quite apt to be roundly abused by the architect, for architects are about like other men and don't like to have their mistakes brought home to them in such a matter as this.

It will thus be seen that the building of a chimney too small may give rise to serious consequences. Each individual case must be met and treated according to its circumstances. Such cases will continue to arise so long as any architect is ignorant of one of the first things he *ought* to learn about his profession.

Boiler Explosions.

JUNE, 1886.

Carriage Shop (72). — The boiler in Kimbark's carriage wood-work factory, Quincy, Mich., exploded June 1st, about two hours after steam was gotten up. The south wing of the building was blown out. William Cole, the engineer, and Joseph Benton were killed. Superintendent F. G. Sheldon was badly hurt by being struck with débris. E. C. Chase, an employé, was internally injured. A worker named William Reed was cut about the face and body, and four others were considerably injured, but not seriously. The explosion is attributed to low water in the boiler.

Locomotive (73). — Engine No. 412 on the Baltimore & Ohio Railroad exploded its boiler while standing in the yard at Bellaire, Ohio, June 3d. In the cab stood George Johnson, the engineer: John Vandevort, a fireman, and Matthew Hammond, another engineer, talking of their runs. Just as Hammond was leaving the cab the boiler exploded, and the three men were blown high in the air. Part of Johnson's body dropped near the engine, his lower limbs having been blown into fragments. Hammond was blown three hundred yards over the tops of houses, dropping to the ground, a mangled mass of flesh and bones. Vandevort was blown about two hundred yards to the left and fell in an open field, lifeless, the back of his head being burst open and his body a lifeless mass. Walter Haslop, brakeman, had just stepped off the engine, and before he reached the rear of the tender was knocked senseless, but not seriously injured. A piece of iron was blown against a house some distance away and struck Peter Manly in the small of the back, inflicting perhaps fatal injury.

Dry Dock (74). — A boiler explosion occurred June —, at the yards of the Cincinnati Dry Dock Company on Eastern avenue, Cincinnati, Ohio. A boiler was being tested when the explosion occurred. A man named Jacob Schatzman was struck by a fragment of the boiler and sustained probably fatal injuries. He was also badly scalded. Two men in the employ of the company, William Boyd and Thomas Barlow, were badly scalded.

Iron Works (75). — By the collapse of a flue in a boiler at the Rensselaer Mills, one of the establishments of the Troy Iron and Steel Works, June 7th, one man was killed and nine injured, two fatally. Michael Dunroth was instantly killed, Patrick Gaynor, Peter Appleton, Thomas Welch, Daniel Conway, Thomas Galligan, W. L. Riley, Edward Powers, John Murray, and Edward Palmer severely injured. The mill had been idle two years and had just resumed operations, beginning on Thursday last. The collapse was due to low water.

Saw-Mill (76). — The boiler in J. H. Brecken's shingle mill, south of Mecosta Mich., exploded June —, killing Charles Bartlett and seriously injuring a man named Palmer.

Brick-yard (77). — The boiler at the Mountain View, N. J., brick-yard exploded June —. No one was injured, and beyond the destruction of the boiler, and the shanty in which it was located, no damage was done.

FLOURING MILL (78). — A boiler in the steam flouring mill at Florence, N. Y., four miles north of Burgettstown, exploded with terrible force June 10th, scalding a man by the name of W. T. Dennis about the face and hands but not seriously. Not much damage was done to the mill.

FURNITURE SHOP (79). — An explosion occurred in the furniture establishment of H. H. Amsden & Sons at Penacook, N. H., June 12th. The night watchman, Ira C. Phillips, was going his rounds, had just entered the brick boiler-house when the explosion took place, and the shavings at once ignited, and an alarm was rung, the department quickly responding. The force of the explosion was so great that it blew out the sides of the boiler-house, and knocked the watchman, Mr. Phillips, down, injuring him severely.

STONE-YARD (80). — John Roessler, aged 50, engineer at Goodall's stone yard, Cincinnati, Ohio, June 14th, invited a friend to examine a leak in the boiler. Just as the two were about to enter the boiler-room a flue burst, and the rushing steam threw the fire and bricks of the furnace into a pile of shavings. Roessler got the hose and rushed in, and his friend followed with a bucket of water, but as he entered saw Roessler fall backward with a groan. When the fire was extinguished the body of Roessler was disclosed lying on the floor, dead. Not a mark or bruise could be found on him, and the coroner said that death resulted from inhaling the steam. Roessler leaves a widow and several children.

SAW-MILL (81). — The boiler in Rice's saw-mill, Bloomington, Ind., blew up June 15th, instantly killing Charles Goss, one of the mill hands. The accident occurred just after dinner, before the rest had gone to work.

LAUNDRY (82). — The ten-horse power (non-explosive) boiler at the carpet beating and laundry establishment of S. B. Dane on Eastern avenue, Lynn, Mass., exploded June, 17th, with terrible force, completely wrecking the building, a one-story wooden structure, and demolishing the machinery. The boiler, when the explosion took place, shot up into the air about 50 feet, and landed in a field at the foot of Moose Hill, some 400 feet away. Some of the debris blew off about the same distance in an opposite direction. Fortunately nobody was injured, although Mr. Dane had just left the place, and a number of children had passed on their way to school a few minutes before. The cause of the explosion was over-pressure, the steam gauge indicating 100 pounds when the limit is 80 pounds. The damage is estimated at between $700 and $1000.

SAW-MILL (83). — A terrible disaster occurred in the saw-mill of T. R. Adams, three miles from Atkins, Ark., June 24th, on the Little Rock & Fort Smith Railroad. The boiler exploded, instantly killing T. R. Adams, the proprietor, L. N. Clark, and John Wilson, and seriously injuring two others. The cause of the explosion is supposed to have been from allowing the water to get too low in the boiler. The building was completely wrecked. Loss about $1,500.

IRON-WORKS (84). — There was a terrific explosion June 30th, at the Richmond Iron Works mine, at the Leet ore bed, Richmond, Mass. Seven men were eating supper about 20 feet from the front of the boilers, three in number, when the one on the south side exploded, demolishing the building completely, not leaving one timber or brick upon another. The men miraculously escaped with slight bruises. Part of the boiler took out three bents of the new trestle works, snapping timber 12 inches square like pipe stems. The dome and a large piece of the boiler, estimated to weigh over two tons, was thrown over two hundred feet from where it stood and rests fifty feet higher. Some small parts were thrown a great deal farther. The report of the explosion was heard over a mile. The boiler was a forty horse-power that had been thoroughly repaired about four weeks ago.

The Locomotive.

HARTFORD, AUGUST, 1886.

J. M. ALLEN, *Editor.* H. F. SMITH, *Associate Editor.*

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 *cents per year when mailed from this office.*
Bound volumes one dollar each.

THE discussion of the question, "Is steel a suitable material for steam boilers?" is still carried on by parties who ought to have settled it to their satisfaction long before this. The great stumbling-block seems to be the idea that anything bearing the name of steel must necessarily have all the characteristics of ordinary tool steel. For the kind of metal used for boiler-plates, and all kindred purposes, at the present day, the name of steel is apt to be misleading, but it has been applied and used for such a length of time that it will probably stick. This is, however, a question of no consequence whatever, as long as the material furnished, is perfectly adapted to its purpose.

The steel to which we refer is really a very pure and homogeneous iron,—this purity and homogeneity resulting from the scientific method of its manufacture. In view of the extraordinary results following the discovery of the modern method of making homogeneous iron, called steel; the comparative simplicity of the processes, and the saving of labor as compared with the ordinary method of making wrought iron, it seems strange to us that the processes were not discovered hundreds of years ago, instead of but a quarter of a century. It seems a reproach to metallurgists that this is so.

IT is a mistake often made to assume that any old, worn out boiler is "good enough to use for heating." While it is true enough that a boiler which may not be strong enough to run at eighty pounds pressure, will answer very well to run at a somewhat lower pressure, we do not think it quite safe to use for heating, or any other purpose, a superannuated or worn out boiler. In many cases it is not the steam pressure in itself which is alone to be considered, but the strains resulting from the conditions of every day use, to which every boiler is subject, without regard to the actual pressure carried.

If a boiler has been used for a long period, and there is the slightest ground for thinking the plates unsound and brittle, it should be rejected for any and all kinds of work. It is a mistake to suppose that no serious explosion can occur if the pressure does not exceed twenty to twenty-five pounds per square inch. Many very destructive explosions have occurred at these pressures, and will continue to occur so long as unsound boilers are used.

AMATEUR photographers are becoming as plenty as "peas in a pod," and strange and wonderful are some of their productions, and marvelous is the quality of the exaggeration displayed in some of the many stories told about their performances by the non-photographic reporters of some of the daily papers. But it is much the same in photography as in everything else; *because* a man is an amateur, it does not reasonably follow that there is no merit in his productions; and on the other hand, the mere fact that any person practices a thing professionally, is no guarantee that he knews his business, or that his productions are, necessarily, uniformly meritorious. We are moved to say this by the fact that we have at various times had photographs of exploded boilers and kindred subjects made by professional photographers, and some of the resulting prints resemble the original objects about as much as a turnip resembles an orange.

Considerations in the Generation and Use of Steam.

At the present time when constant efforts are being made to secure increased economy in the use of steam-power, it may not be amiss to consider briefly some of the fundamental principles governing its use, to the end that we may better know in what direction to look for improved performance.

The first step is the generation of steam. The quality of the fuel, the perfection of its combustion, and the design of the boiler and its setting are the most important factors to be considered in connection with this problem.

The quality of fuel should always be judged from the standpoint of its cost. The best fuel is that from which the most steam can be obtained for a given sum of money, and by this we mean not merely the market price of the fuel, but include all the expenses of storage, transportion, handling, etc., in fact everything going to make up the total cost of the fuel, from the time it is selected to the time the ash and refuse are finally disposed of. In the case of a very inferior grade of fuel, the extra cost and expense of maintenance of the greater number of boilers required to furnish a certain amount of steam, than would be necessary were a better grade of fuel used, should be carefully taken into consideration.

A carefully kept record of this character, which would show the exact commercial value of each kind of fuel, would prove of the greatest value.

The primary considerations governing the selection of a boiler are safety, economy, and durability. With a well-constructed boiler of almost any of the ordinary types, the first condition will be fulfilled, if the boiler is properly cared for, unless it is, safety cannot be expected under any circumstances. With any type of boiler, intelligent and painstaking care is imperative if we would reduce the risk to a minimum.

Economy is the object in boiler design and construction that has oftener been "shot at and missed," probably, than any other thing under the sun. Most of those who have sought this have *aimed* very high, but for some reason or other their shots have usually fallen far short of the target. Very few bull's eyes have been made in this sort of practice. The explanation of this may be found in the fact that about ninety-nine in every hundred who have tried their hand at *improving* the steam-boiler have not understood the first principles underlying economy. Hence the immense number of monstrosities which may be seen on every hand. Expensive and complicated designs have multiplied to such an extent, and the failures have been so many, that one wonders that anybody can be found with sufficient hardihood to make another attempt. But still each day brings forth some device which its sanguine inventor fondly imagines is to revolutionize everything.

The generation of steam is accomplished by transmitting to the water in the boiler, the heat liberated by the combustion of the fuel. This in itself is a very simple process, and to our mind it appears that the plainest and simplest arrangement of the heating surface of the boiler will yield absolutely the best results. The principal things to be borne in mind in designing a steam-boiler are: to give a proper amount of heating-surface, to place this heating-surface so that it may be the most effective, and to so shape the boiler that the circulation shall be as free as possible. Due regard must also be paid to what may most appropriately be called the "get-at-ability" of the whole structure for facility of cleaning and making repairs. With all due respect for some of the magnificent specimens of boiler architecture which have from time to time been erected at great expenditure of money and brain-power, we feel impelled to say that in our opinion, based upon observation of the practical working of all kinds of boilers, the best types of boiler for use on land, and the one which, entirely aside from the fact that it is the cheapest, most easily constructed, kept clean and repaired, most perfectly fulfills the above conditions, is the ordinary form of horizontal tubular boiler, when properly designed, and well built and set. It should, of course, be somewhat modified in its proportions to most perfectly adapt it to the different fuels which may be used, or quality of water which may be available. But the general form should remain the same; it should still remain a horizontal tubular boiler. We fail to see any advantage arising from setting it up and running it at the various angles of altitude which have been tried by different engineers at divers times.

The proportion of grate to heating-surface should be such that a sharp fire may be kept, and yet have the resulting heat absorbed by the water. Slow combustion gives the best results only when the heating surface of the boiler is insufficient to transmit the heat to the water, when there is a sharp fire, and it passes up the chimney. This will be evident when we consider that the heat available is that due to the *difference* between the temperature in the furnace and that of the steam, which depends upon the pressure carried. The sharper the fire the higher its temperature, and the greater is this difference which is thus directly available. But the heating-surface must be sufficient to *absorb* this heat and not allow it to pass up the chimney.

This ratio of grate to heating-surface should never be greater than 1 to 40, and 1 to 60 is better.

After steam has been generated it should be used as quickly as possible. Storing it up in domes or drums to give it a chance to get dry, has the opposite effect. It gets wetter, by reason of condensation resulting from loss of heat by radiation, which we are unable to *entirely* prevent. It therefore naturally follows that we should locate boilers just as near as possible to the place where the steam is to be used, and do away with all domes and drums. This point is too obvious to require demonstration, but is often disregarded.

The same principles govern the selection of an engine that apply to the selection of a boiler; that is, get the one that will yield the best return on the money invested in it. The selection of a type of engine best adapted to a given purpose is a question that has given rise to a vast amount of discussion among engineers, and the determination of the size of an engine to yield a given power with the greatest absolute economy has been a fruitful theme of discussion among theorists. Many and complex are the formulae that have been devised to determine the best ratio of expansion, which in its turn would fix the size of the cylinder to give the very best results. In our opinion the discussion of this question from a theoretical standpoint, is a very pretty exercise of mathematical ability which don't amount to so much as a row of pins, practically. All such formulae must necessarily start from the basis of a constant load, and to the best of our knowledge (and it covers a period of quite a number of years) this is a condition that is *never* fulfilled. The most that can be done is to fix the size of the engine so that with ordinary pressures, say from 75 to 100 pounds per square inch, the point of cut-off shall not, with the ordinary variations of load, be much shorter than one-fifth of the stroke, nor more than one-third of the stroke. Between these points an ordinary unjacketed simple engine, whether condensing or non-condensing, gives its best, and at the same time, practically the same economical results. Due allowance must also be made in putting in an engine, if an increase of business, and, consequently, of the load to be driven, is likely to follow. These are things that no mathematical formula *can* deal with, and must be left entirely to the judgment of the persons most interested. People who are thoroughly conversant with the details of their business, are better judges of this question than are the most expert mathematicians, and it can safely be left to their judgment.

The question of whether a high-grade automatic cut-off, or plain slide valve engine should be used for any given purpose has also caused much more discussion, and a greater waste of printer's ink than is at all necessary. In our opinion, no man who has to buy fuel of any kind can *afford* to run a slide-valve engine of more than ten horse-power, for stationary purposes. The performance of the better class of engine is so far ahead of the other that there is no chance for discussion on this point. H. F. S.

Decline of the Paper Collar.

It is hardly twenty-five years since the advent of the paper collar. Prior to that time the average man wore neck-gear made from linen fabric, or was content to go without collars, except on Sundays and legal holidays. Then the collar was frequently built in with the shirt and worn with a loose, limp, and decidedly comfortable manner. The mechanic going to his daily work despised collars altogether, and in order to see an aggregation of white linen, stiffly starched and held about the neck with satin stocks, it was necessary to attend church or go abroad at a Fourth of July celebration. Then it was that some genius discovered that "there was nothing like paper," and produced that useful, convenient, and always "done up" article, the paper collar. It struck the popular fancy, the paper collar did, as a cyclone strikes a western hamlet, carrying everything before it, and so complete a revolution of gentlemen's toilet was never before effected in so short a time. Everybody, or pretty much everybody, appeared out in clean paper collars. Their advantage over any other collar was apparent. They never needed the careful attention of the washer-woman, and after one had been worn until it was in a state of dilapidation, another, bright, clean, folded without a wrinkle, was ready in the box to take its place. The banker, if he was not too old fogyish, wore paper collars; the business man, the society man, the working-man, even the "dudes" of those days wore paper collars.

The manufacturers grew rich, and covered the labels of their collar boxes with "patents and re-issues" until there was scarcely room for the size of the collar to be inserted. The shelves of the gents' furnishing stores were filled with masses of paper boxes of paper collars, and the man who didn't use up a box a week was considered far behind the age. But there came a time when there was a satiety of the paper collar. It never had that inexpressible cleanly look that its linen competitor enjoyed, and although attempts were made to bring it to the standard by covering it with thin cloth, in order that linen fabric might be more closely imitated, it was a failure. In fact, such an attempt was a confession on the part of the paper-collar makers that the article they had been selling was not, all things considered, quite the equal of the linen collar. Society set its face, or rather its neck, against it, and the edict went forth that "paper collars were no longer considered proper" at receptions and parties. Then the battle of the collars began. It was paper *vs.* linen, and the struggle was a hot one. The Troy laundries determined that the paper collar must go, and the paper collar manufacturers determined that the linen collar should not come. Troy gathered the dirty linen collars of the country weekly, laundried them and returned them to the wearers with all the gloss and finish of a new collar fresh from the collar foundry. The paper-collar men put their wares into unique boxes, pasteboard cottages, pasteboard palaces, little wooden pails, little tin pails, until the purchaser of paper collars cared more for the decorated box than he did for the collars inside.

But as soon as the paper-collar men began to curry favors with the public in this way, the day of their doom was sealed, and the approach of linen collar supremacy was nigh. The paper collar could no longer stand alone, although it was equal to its linen brother in pasteboard stiffness. It went. Practically, the day of the paper collar has declined. It no longer crowds the furnishing goods stores, no longer is it seen at society receptions and church picnics, but at best is only upon the necks of those who, having formed an affection for it, formed such affection lastingly. And yet the paper collar had a mission and fulfilled it well. It taught the average American citizen that a clean collar was a necessary accompaniment to a correct toilet.—*Hartford Post.*

English Trade and Labor.

A telegraphic despatch from London states that the final report of the royal commission appointed by the conservative government of 1885 to inquire into the depression of trade, is completed and will shortly be issued. The report announces that the commission does not find any evidence of depression as regards restriction of trading operations, the volume of British trade having increased more than commensurately with the growth of the population of the country. Low prices and consequent diminished profit, the commission finds, constitute the only evidence of depression. There has been an excessively prolonged period of over-production, which the commission believes has been wholly due to the vast increase of wealth in the country, and it is not the belief of the commission that commercial legislation regarding labor has worked any injury to trade.

The report deprecates any increase of the hours of labor, or any diminution of wages. It distinctly favors trades-unions, and considers the recent failures of agricultural industries the main, if not the sole, cause of the diminution of home trade, which otherwise, the commission believes, would be in a satisfactory condition.

The condition of the working classes, the commission finds has been very much improved during the last twenty years. Competition with British trade, both at home and abroad, has greatly increased, especially as regards Germany, the trade of which country is improving rapidly and pressing England closely at home and abroad.

The report suggests no fiscal alterations and makes no reference whatever to protection or reciprocity. The commission recommends that British consuls be instructed to report more frequently upon the condition of trade with Great Britain at their respective posts, and urges British manufacturers to adapt their manufactures to the necessities of foreign markets, in which respect Germany excels all other countries. — *Boston Journal of Commerce.*

Curious Facts About the Newspapers.

Two editions of the American Newspaper Directory are published this year by George P. Rowell & Co. One is dated 1776, and you can almost hide it under an old-fashioned copper cent. It contains in sixteen microscopic pages a list of the thirty-seven newspapers that were printed in the United States of America 110 years ago. Seven of them are still alive. It is the other and the larger volume which is more immediately adapted to the needs of 1886. The contrast is impressive. Almost as big as an Unabridged Dictionary, with nearly 2,000 pages crammed with matter interesting to every newspaper man and to every newspaper advertiser, it is in the fullest sense a directory to the American press of to-day.

There are now published in the United States 14,160 newspapers and periodicals of all classes. The net gain of the year has been 666. The daily newspapers number 1,216, a gain of 33. Canada has 679 periodicals. There are about 1,200 periodicals of all sorts, which, according to the ratings and estimates of the editor of the Directory, enjoy a circulation of more than 5,000 copies each. The increase of the weekly rural press, which comprises about two-thirds of the whole list, has been most marked in States like Kansas and Nebraska, where the gain has been respectively 24 and 18 per cent. Kansas also shows the greatest gain in daily newspapers. The weekly press is gaining in Massachusetts, while the magazines and other monthly publications are losing ground there. The tendency of such publications toward New York city, as the literary center of the country, is shown by the establishment there of not less than twenty-three monthly periodicals during the year.

There are 700 religious and denominational newspapers published in the United States, and nearly one-third of them are printed in New York, Philadelphia, Boston, and Chicago. New York is far ahead in this respect, but Chicago leads Boston. Three newspapers are devoted to the silkworm, six to the honey bee, and not less than thirty-two to poultry. The dentists have eighteen journals, the phonographers nine, and the deaf and dumb and blind nineteen. There are three publications exclusively devoted to philately, and one to the terpsichorean art. The prohibitionists have 129 organs to the liquor dealers' eight. The woman suffragists have seven, the candy-makers three. Gastronomy is represented by three papers; gas by two. There are about 600 newspapers printed in German, and forty-two in French. The towns which have most French periodicals are New York, New Orleans, and Worcester, Mass., — four apiece. There are more Swedish prints than French. Two daily newspapers are printed in the Bohemian tongue. The toughest names are found among the Polish, Finnish, and Welsh press; for instance, the *Dziensuriety* and the *Przjaciel Ludi* of Chicago, the *Yhdyswalta in Sanomat* of Ohio, and the *Y Wawr* of Utica, New York. There is one Gaelic publication, one Hebrew, one Chinese, and one in the Cherokee language.—*The Paper World.*

A Wonder in Medicine.—The Details of a Series of Most Marvelous Experiments.

Some remarkable discoveries have been recently made by French physicians in regard to what they call the action of medicines at a distance. The patients experimented on have been those either hypnotized or capable of being hypnotized; that is, they could be thrown into a sort of magnetic slumber, in which effects could be produced on others independent of their will. There is nothing specially new in magnetism nor in hypnotism, but the new facts now elicited are of a nature so striking as to render credible the most seemingly absurd and impossible cases of so-called mind reading.

The experiments took place at the School of Rochefort, and in the first place on a man subject to hysteria. They were tried after a series of attacks which left him in a state of extreme nervous sensitiveness. It was first endeavored to study the effects of metals. Silver and lead produced no result whatever; zinc, copper, platinum, iron, and steel, being applied, showed different influences, one causing pains, another trembling, and another vascular congestion. But the contact of gold with the skin had a most extraordinary effect, causing an intense sensation of heat. A sleeve button touching the face or finger of the patient caused him to utter a cry of agony. Even when applied outside of his clothing, or with the hand of the physician between the object and his skin, there was the sense of acute pain. Sometimes a piece of silver or gold was slipped into his bed without his knowledge. He did not seem to be aware of the presence of the first, but the other caused him to twist and turn till he had found and ejected it.

To show that the pain was not the result of imagination or deception, articles of aluminum, bronze, or other metals having the appearance of gold, were placed near him without producing the slightest result. Mercury had the effect of gold, though more violent. When a thermometer was applied to the patient's person, though the metal was hermetically sealed in glass, it caused a violent sensation of heat. One day a thermometer was wrapped in a cloth, that he might not know the nature of the object, and placed under his forearm. The effect was not only a sensation of burning, but a blister of the flesh and a permanent wound. Then the compounds of the metals were tried. Chloride of gold, enclosed in a corked flask, had the effect of the pure metal. So, also, the nitrate of mercury, similarly guarded against direct contact, while nitrate of silver and carbonate and sulphate of lead, like their originals, had no effect whatever. Iodide of potassium, wrapped in a paper and placed under the forearm, caused yawning and sneezing, though the untaught patient, even if he had been aware what the objects were, could not possibly have known what physical action they were likely to cause. Hydrogen had an effect analogous to that produced when it is used medically.

But all these phenomena, though curious and entirely incomprehensible, were thrown into the shade by experiments made with medicines under similar conditions. A bit of crude opium enveloped in a paper was placed under the head of the patient. In less than a minute his eyelids closed, his muscles relaxed, and he was in a sound and tranquil sleep. In ten minutes he awoke of his own accord, rubbed his eyes, yawned, and had all the symptoms of a person awakened from profound repose. The opium was then applied to the forehead, the back of the neck, the right and left sides of the head, the soles of the feet, and always with the same result. A small bottle of narceine caused sleep with the turning of the head to the left. One of codeine, sleep with snoring. One of nicotine, applied to the right wrist, convulsions of the face on the right side, and such an intense burning at the point of contact, that it was necessary to remove the bottle. Chloro-hydrate of narcotine produced sleep with great pain on awaking. A vial of atropine placed under the sole of the foot caused the patient in three seconds to rest immovable with his eyes open. Soon the eyelids dropped, the eyes were convulsed, and the pupils became dilated. Chloral in a paper applied to the arm caused sleep in less than a minute. A vial of digitalis placed on the sole of the foot brought on immediate vomiting and spitting, with a feeble pulse and interrupted breathing. The phenomena alarmed the physicians in attendance they were so intense. Sulphate of quinine in a vial produced no effect, but placed on the forehead caused an intense headache. So also with cafeine, which only when placed on the arm caused a violent excitement, with pulse and respiration accelerated.

The most curious and most convincing of these experiments was the following: When the sick person had retired for the night, there was slipped under his pillow a little packet of jaborandi. In less than a minute his eyelids closed and sleep ensued. Three minutes afterward sleep ceased, saliva exuded from the mouth, the skin became moist, and the patient complained of excessive heat. In recovering consciousness he spoke of a sweet taste when he drank milk or when he put a cigarette to his lips. This saccharine action of the saliva was unknown to the attendant physicians, though it had been previously described as an attendant phenomenon. In this case it is scarcely necessary to call attention to the marvelous features of the experiment. The medicine was not even placed in contact with the skin, but at a distance from the patient, who did not know that anything was under his pillow, or if he had been aware of it could not have known its nature or its possible results. Yet the effect on his system was similar though more radical than would have been the same remedy applied in a regular way. Some skeptical physicians applied mercury or opium in packets whose contents were unknown to the others present, and could not be even surmised by the patient, and always with the intolerable burning or sleep as described in the previous cases.

These experiments and others with other medicines were renewed on these and other patients in numberless ways, and always with the same consequences. Cherry laurel produced a religious ecstacy; a bottle of champagne, unopened, intoxication, with singing and dancing. How were all of these mysterious effects produced, often without even external contact? How could mercury blister the flesh through its tubes of glass and cloth envelopes? How could a medicine, placed unknown under a person's pillow, cause salivation, with the accompanying symptoms? The substances were usually inclosed in paper, or in bottles, and many of them are odorless and could send forth no effluvium to affect the patient's nerves. The whole matter is profoundly mysterious.—*San Francisco Chronicle.*

A "Horizontal Flarer."

"Never saw a natural gas well?" inquired a talkative passenger, as the train sped along in the darkness and through the oil country; "you never saw a gas well? You ought to see one, especially one on fire. Beats all the fireworks ever got up. Something funny about these gas wells, too. All of a sudden they'll start up in a flame, flare two or three times way up to the sky, and then stop as quick as they started. That is the effect of spontaneous combustion. Guess I know more about the natural gas well business than any other man in the country. I've studied 'em, sir, for many months and have 'em down fine. Let me see, it's now 9.38 o'clock. At 9.40 a spouter is due over in the valley there, and if you'll keep your eye peeled in that direction, mebbe you'll see it on fire."

At once all the passengers seated themselves on the side of the car next to the valley and looked intently for the promised display. The gas well expert sat down across the aisle, took out his pipe and filled it, as he remarked:

"I study these gas wells as astronomers study the heavenly bodies, and I can tell to a minute when they're going to burst. Look out now—she's a coming!"

And sure enough, way down in the valley seemingly two or three miles away, there was a burst of flame, quickly followed by two or three more, and then all was darkness again.

"Wonderful! wonderful!" exclaimed one of the astonished passengers; "the grandest sight I ever saw," echoed another; "marvelous, simply marvelous," chimed in a third.

"Oh, that's nothing," said the expert. "wait till you see one of these wells that take fire and flare out in two or three directions, as if the flames wanted to lick a clean spot off the face of the earth. They're worth looking at, I tell you. Lemme see, where's my note book? Oh, here it is. Only ten o'clock—say, friends, if you'll wait eleven minutes you'll see a horizontal flarer a little further up the road. She's due at 10.16 o'clock. I figured her all out to-day."

Of course the passengers were willing to wait, and they began to look down into the dark valley, anxious to see the great flarer. Soon a word of warning from across the aisle caused every eye to open wide with expectation, and expressions of amazement, came from a dozen lips as two dozen eyes beheld a shot of flame which sprang up out of the darkness, darted this way and that three or four times, and then disappeared with a blink.

"Didn't I tell you I had it down fine?" exclaimed the man with the pipe. "They can't any of 'em get away with me on the gas well business,—I've studied 'em through and through. But say, friends, I get off at the next station. I'm a poor man, and my family at home is hungry. Can't you do something for me?"

The hat was passed round and filled full of quarters, half dollars, cigars, and whisky bottles more or less empty, and the whole poured into the lap of the grateful expert.

"Thanks, gentlemen, thanks," said he; "just tell your folks at home that you've seen the great horizontal flarer up in the oil regions, and that Bill Cooper, the great astronomer and geologist of the gas well country, showed it to you. Good-night."

After his departure the passengers began telling of the great mystery they had seen, and to wonder how Bill Cooper could so correctly calculate the appearance of the flames of fire.

"I'll show how it's done," said a drummer who had been seated in the rear part of the car, and who had not as yet taken any interest in the proceedings. "I'll show you how this trick is done. Has anybody got a match?"

A match was produced. The drummer seated himself on the opposite side of the car, took out a pocket mirror, held it up against the window, and told the passengers to look out into the valley if they wanted to see another flarer. The match was struck and held before the mirror, and lo and behold, there was another flaming gas well in view of the beholders.

"To make a horizontal flarer," said the drummer, striking another match, "all I have to do is to blow gently on the flame of the match, and there you have it. I travel over this road every week, and have seen Bill Cooper before. No, there's no use asking the conductor to back the train up to the last station. He won't do it, and if he did you wouldn't catch Bill. He's down in the valley by this time, fishing for more suckers." — *Forgotton Ex.*

The Highest Observatory in Europe.

A recent number of our English contemporary, *Iron*, contains a description of the erection of an observatory on the Sonnblick, one of the summits of the massif of the Tyrolese Alps. The Sonnblick (Sun Glance) is a mountain nearly 10,000 feet high, the summit of which is less difficult of access, and where a house is now being erected which is to serve for meteorological observation. It will consequently be an observatory at the highest elevation in Europe — higher than that on Mount Ætna, the Pic du Midi, in the Pyrenees and on the Sentis, canton of Appenzell. The first to draw the attention of meteorologists to this mountain as a suitable spot for an observatory was the owner the Rauriser Goldberg, Mr. Rojacher. His private residence and mines are situated on the slopes of the Sonnblick, at an elevation of over 5,000 feet and from these a wire rope way, used for the purpose of the mines, but also practicable for passengers, leads up to a height of nearly 8,000 feet. Here a house has been erected for about twenty miners, who reside there also during winter. Thence the summit of the mountain is reached by an easy ascent over a glacier, in three hours. In descending this portion may be traversed in low sledges in fifteen minutes. The observatory now being erected on the summit, and which looks like a black spot when viewed from the Rauris valley, and from which the Sonnblick rises like a precipitous wall 3,000 feet high, consists of a blockhouse, flanked by a massive stone tower forty feet high. To guard against the frightful storms raging round the summit, the walls of the tower are made of enormous thickness, whilst the blockhouse itself is anchored to the rock by stout wire ropes. Wood has been selected for the construction of the house, because it keeps out the cold better, which is most intense in that exposed spot in mid winter. The house contains two living rooms — one for the resident observer and another for those scientific men who may ascend in favorable weather with a view of carrying on experiments. The walls of the house are paneled inside, and neatly covered outside by wood shingles. The tower will be fitted with all the instruments used in meteorological observations. As there is no great danger to the building from the terrific thunderstorms which burst round the summit, the observatory is protected not only by three lightning conductors, but also by a lightning proof fencing. The solitary resident observer who has chosen to exile himself from the outer world is one of the twenty miners permanently residing in the miners' house, 8,000 feet above the sea-level, who is now undergoing a course of instruction in meteorology. But he will not be cut off entirely from intercourse with his kindred, for he will be able to keep up communication by telephone with the miners' house 2,000 feet below him, whence another telephone wire, 15 miles long, leads to Rauris. From there his daily record of observations will be wired to Vienna, thence to be flashed to the scientific world generally.

The Locomotive.

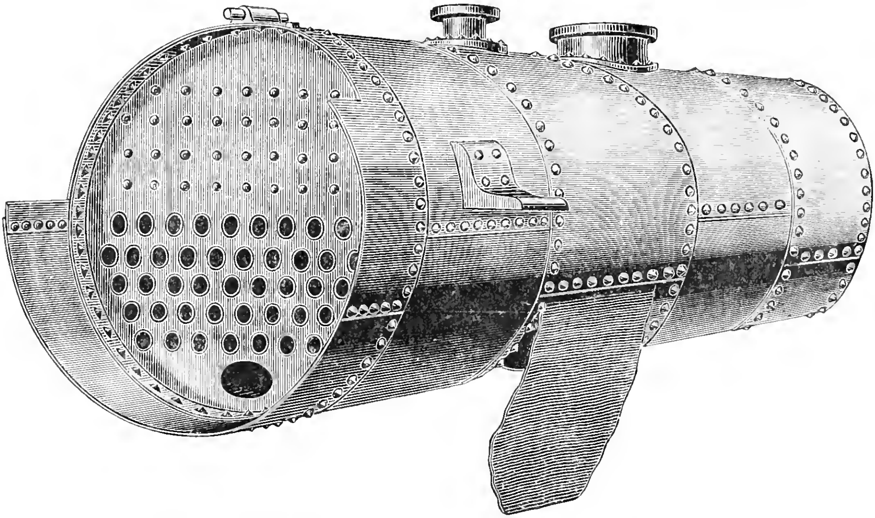
PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

NEW SERIES—VOL. VII. HARTFORD, CONN., SEPTEMBER, 1886 No. 9

Explosion resulting from Low Water.

The explosion illustrated in this issue of the LOCOMOTIVE occurred in a neighboring town a few months ago, and while it was not of a particularly destructive character, it presents sufficient points of interest to justify an account being given in our columns.

The boiler which exploded was the one on the extreme right of a battery of five, all of which had been running several years without accident. It was 48 inches in diameter and sixteen feet long; the shell was of iron five-sixteenths of an inch in thickness.



It was set in brick-work in the usual manner, and was provided with the usual complement of fittings.

Before giving an account of the explosion, it will be well to state a few facts in relation to the boilers, which will help to render clear the exact manner in which the explosion was brought about.

As before stated, there were five boilers in the battery; these were numbered from left to right in the usual manner. There was a passage-way to the rear of the battery on both sides of it. At the rear end of the setting of number one boiler there was a stand-pipe connected to feeding apparatus. From this stand pipe an independent feed-pipe, with stop-valve, was led to each boiler; the feed-pipes entered each boiler through the back head, through a hole originally made for a fusible plug, and extended forward to a point just over the bridge wall, where they terminated.

As before stated the boilers were quite old; they were to be soon replaced by new ones. Numbers three and four had been removed a few days previously, a new one to take their place was completed, and a man was engaged in removing the bricks which formed the old settings at the time of the explosion. The man thus engaged was an old fireman. The man who had charge of the boilers was an inexperienced hand at the business. Boilers numbers one and two were kept under steam continually to supply the establishment. The fire under number five, the boiler which exploded, was allowed to die out each night. It was kindled each morning, and steam raised about 9 o'clock, as soon after that time the factory began to use more steam than could be well furnished by two boilers.

The day before the explosion the fireman had allowed number five boiler to get full of water, being deceived by the glass gauge, on which he evidently relied. His attention was called to it by the man who was removing the old bricks, just before the time for shutting down, and he went around back of the boiler to open the blow-off to let the surplus water run out. Subsequent occurrences prove conclusively that he must have forgotten to shut this valve again.

On the morning of the explosion the boiler was fired up as usual; soon afterward, the man who was cleaning bricks noticed something wrong, and upon trying the gauge cocks found no water present. He called the fireman's attention to it, who answered, "There was two gauges a little while ago." Nevertheless he immediately tried the gauge cocks, and finding no water he went around number one boiler to start the feed. By this time there was considerable hissing around the back end of the boiler, and the brick cleaner went to the back end of the setting and climbing upon some blocks or boxes there, tried to look through some cracks, which had been made in the side wall of the setting by the removal of the adjacent setting, into the back connection to see what was going on. The fireman, it is supposed, turned on the feed, and then went along the passage-way in the rear of the boilers to see if the blow-off valve was closed. The inference is, that he found it open, and after closing it started for the front of the boiler through the narrow passage between the right-hand side of the setting and the end wall of the boiler-room. At this instant the boiler let go and ruptured as shown in the cut, which was made from a photograph. The right hand wall of the setting was set bodily against the end wall of the boiler-room, and the fireman was found some hours afterward, pinned between the two walls in an upright position, just opposite the point in the boiler where the break occurred. He must have been killed instantly. Had he been two seconds earlier or later in his journey to the front of the boiler, he would have been uninjured, as the force of the explosion was altogether to the right. The boiler was hardly displaced. The man who was looking through the crack in the left-hand wall of the setting was not hurt by the explosion, but was considerably frightened, and in his confusion, while endeavoring to escape, run his head against the setting of number two boiler, and cut his face, but sustained no further injuries.

Subsequent investigation showed that these were probably exact circumstances under which the explosion occurred, but whether they were or not, it cannot be questioned that the sole cause was a deficiency of water. The shell plates were very much overheated all the way up to where they were closed in by the setting walls. Another strong proof that this was the case was furnished by the fact that a well-defined water line existed near the bottom of the boiler, just in a line with the lower side of the blow-off pipe, which entered the boiler through the back head, a few inches above the bottom of the boiler. This is strong proof that the only water present in the boiler when the fire was built was what would naturally remain in it if the blow-off valve had been left open the night before. The explosion was not a destructive one; when they result from low water in this kind of a boiler they seldom are. A good quantity of water is a necessary condition to a violent boiler explosion.

The only peculiar thing about this explosion was the nature of the fracture which occurred through the solid plate, instead of through a seam, the seams being usually considered the weakest parts of a boiler shell. This peculiarity is easily explained.

It will be noticed that the initial rupture occurred just over the bridge wall. This would naturally be the hottest part of the furnace. This was also the exact place where the feed-pipe terminated. The shell was probably red hot at this point, and when the feed was put on the water run in and was discharged from the pipe directly on this hottest portion of the shell. The iron, probably rendered brittle by long years of service, and badly overheated, was unable to withstand the severe contraction thus caused and gave way soon after the pressure began to rise. A very few pounds pressure would be sufficient to do the damage. It probably did not exceed five pounds per square inch at the time of the explosion, in all probability it was only what was generated from the time the unfortunate fireman closed the blow-off valve.

The occurrence was a pure accident, such as is liable to occur to any steam boiler. The only person in any way to blame paid for his carelessness with his life.

Inspectors' Reports.

JULY, 1886.

There were made during the month of July 3,527 visits of inspection. 6,952 boilers were inspected, 3,450 of which were inspected both externally and internally. 478 others were tested by hydrostatic pressure, and 34 were condemned as unfit for further use. The whole number of defects reported foots up 6,019, of which number 552 were considered dangerous, as per the following detailed statement:

Nature of defects.	Whole number.	Dangerous.
Deposit of sediment,	518	24
Incrustation and scale,	751	37
Internal grooving,	32	6
Internal corrosion,	223	12
External corrosion,	365	23
Broken, loose, and defective braces and stays,	142	19
Defective settings,	117	14
Furnaces out of shape,	159	12
Fractured plates,	176	44
Burned plates,	74	12
Blistered plates.	303	21
Cases of defective riveting,	1,396	80
Defective heads,	38	11
Leakage around tube ends,	824	150
Leakage at seams,	528	23
Defective water gauges,	66	24
Defective blow-offs,	18	4
Cases of deficiency of water,	5	2
Safety-valves overloaded.	32	7
Safety-valves defective in construction,	26	11
Defective pressure-gauges,	220	11
Boilers without pressure gauges,	1	1
Defective man-hole rings,	3	2
Defective man-hole plates,	1	1
Defective hand-hole plates,	1	1
Total,	6,019	552

The greater portion of the defective rivets reported above were found in new boilers, while they were under hydrostatic pressure in the yards of their makers. A large proportion, also, of the leaky tubes and seams were discovered under the same circumstances, but the proportion of the latter two defects thus discovered was much smaller than the proportion of defective rivets. This may be accounted for by the fact that a rivet once properly driven is bound to always remain all right, under ordinary circumstances, while seams, and the joints around tube ends, rapidly deteriorate under many conditions to which they may be subjected in every-day use.

Ordinary machine riveting probably results in a greater proportion of defective rivets than any other one cause. Machine riveting to make good work must be very carefully done. The rivet hole must be truly in line with the machine dies. The holes in the two plates must also be in line with each other. If there is an offset of an eighth of an inch between them, the rivet is bound under any circumstances to be a very bad one.

The most satisfactory riveting of boiler plates is done at the present time by a properly constructed and used button set. By this means better seams can be made than can be made by hand riveting. The work is also done more expeditiously than it can be done by the old method. A well-constructed machine will enable the work to be done considerably quicker than it can be done with the set, but we have rarely seen a complete job of machine riveting which left *nothing* to be desired. It was not the fault of the machine, however.

In hand riveting the excellence of the joint depends entirely upon the skill of the riveters; in button-set riveting, much depends upon the form of the set. With an improper set it is impossible to do good work, no matter how skillful the workmen may be.

Button-set riveting has been tried in many shops and abandoned as impracticable. Experience in other shops, where it is perfectly successful, would seem to indicate that the failures have not arisen from any defect in the principles underlying the process, but rather from a failure on the part of those trying the process to fully grasp the problem.

Boiler Explosions.

JULY, 1886.

SAW-MILL (85).—The boiler of T. R. Adams' saw-mill, three miles west of Atkins, Ark., exploded July 1st, killing T. R. Adams, John Wilson, Nelson Clark, and mortally wounding James Anderson and John Wells.

SAW-MILL (86).—While George Hutchinson, Delos Newton, and Elias Tripp were sawing lumber July 2d, five miles north of Unadilla, N. Y., the boiler burst, killing Hutchinson and Newton, and seriously injuring Tripp. The boiler had been condemned and it was the intention to not heat it up again. Only a few minutes before the explosion Hutchinson, who had arranged for a new boiler, said he was "afraid the thing would blow up." He was thrown against the timbers and killed instantly. Newton lived two hours. Tripp was blown through the side of the mill and badly hurt.

HARVESTER (87)—The boiler of a combined harvester exploded near Tulare, Cal., on June 19th, setting fire to and destroying about three acres of wheat.

THRESHER, PORTABLE (88).—James Hinkle of Delaware, Ohio, has for years been running a threshing machine, and was engaged July 3d in overhauling his machinery for the opening of the season, and for the purpose of discovering any leaks in the boiler he fired up. A few moments afterward the boiler exploded with great violence, throwing Mr. Hinkle against a barn, a distance of eighty-five feet; he was frighfully scalded, cut about the head, his right arm fractured, and his right leg so badly mangled that amputation at the knee was necessary. His recovery is an impossibility. The engine had been in constant use for nearly sixteen years, and was recently repaired at Columbus. The boiler was thrown a distance of 130 feet, and was completely turned around from its former position.

COAL MINE (89).—A boiler forming one of a nest of six at shaft 3 of the Delaware & Hudson Canal Company, at Plymouth Junction, Penn., exploded July —, with great violence. The report was heard for a long distance around and the destruction and damage caused was great. The boiler-house, a substantial structure of brick and timber, was literally blown to pieces, and the wreck scattered around over an area several hundred yards in diameter. The other five boilers were torn from their settings and thrown around. George Scott, the fireman, was in the boiler-house at the time. He was half-buried in debris, badly brused and cut, and terribly scalded by the hot water and steam. He was taken to his home in a dying condition. The engineer was scalded by escaping steam, though not dangerously. The boilers had been in use for several years, but were regarded as good and serviceable. The only person who knew anything of the condition of the boilers at the moment they exploded was Scott, and he was not able to say anything about the matter.

TILE WORKS (90).—The boiler in the Bruner tile works at Streator, Ill., exploded July 8th, killing Henry Bruner, one of the proprietors, outright, and seriously injuring Jabez and Robert Morrison, who were employed about the engine.

THRESHER, PORTABLE (91).—While threshing wheat July 9th, on the farm of John Jefferey, about three miles north of Grand View, Ind., the boiler of the portable engine exploded with terrific force and the following result: Gormon Jones, engineer, instantly killed and blown fifty yards away; James McClellan, leg broken and cut about the breast so that he can hardly recover; Marion Chancellor, leg broken and bruised about the head and body; John B. Jefferey, struck in the back by the smoke-stack and injured internally; George McCullough, caught in the belt and slightly injured; Tom Jefferey, slightly bruised; Charles Morton, badly bruised. Several others were more or less injured. Cause of explosion not known.

STEAM DRILL (92).—The immense boiler used by the Diamond Drill Company at Topeka, Kan., in sinking the drill at the coal hole, blew up July 10th, and with a loud noise and terrific whizzing of steam went tearing its way through the trees fully fifty feet above the ground, and landed on one end about 150 yards north of where it formerly rested. The cause of the explosion is not known. The boiler-house was completely demolished and the fragments scattered in all directions. In making its circuit the boiler cut its way through the trees, taking off the tops of several large ones. The heavy timbers on which it rested were carried along. Mr. Chamberlain, the engineer, who was sitting by the tower, fifteen or twenty feet from the boiler-house, was fearfully scalded, and his skull fractured. He was taken to the hospital, where he died.

FLOUR MILL (93).—The boiler of the National Flouring Mills, in Parsons, Kan., exploded July 12th. David Rumrine, white, and Anderson Story, colored, were killed.

THRESHER, PORTABLE (94).—A portable engine on the farm of Z. B. Job, at Alton Junction, Ill., blew up July 12th. Five men were badly wounded—three of them fatally. The engine was torn to atoms, the thrashing machine and all the wheat adjacent burned, and three or four horses killed.

SAW-MILL, PORTABLE (95).—Thomas Snyder's portable saw-mill, situated about five miles up the Newport pike, on the Little Muskingum, in Ohio, was blown to pieces July 12th, by an old boiler exploding. Judson Snyder, the engineer, was fatally injured. He was thrown about thirty feet; his left hand was taken off and his head badly cut.

COLLIERY (96).—Two of a nest of 75 boilers at the Mineral Railroad and Mining

Company Colliery near Shamokin, Penn., exploded July 12th, with terrible effect. The damage done to property is very considerable. Fortunately no lives were lost.

SHOP (97).—An upright boiler in the shop of Joseph Fassett, at Wellsville, Ohio, exploded July 17th, and was thrown three hundred feet through the air. Two children of Mrs Maggie Driscoll, who were playing in an adjoining door-yard, were killed.

SAW-MILL (98).—The small boiler of the Port Austin, Mich., Manufacturing Company's saw-mill and salt block exploded with terrible force July 16th, seriously injuring the engineer, Daniel Dygert, and instantly killing Willie Jewett, a boy of 12 years, who was dug out from under the stones of one of the fallen walls of the boiler-house with his face battered beyond recognition. It was the custom of this boy to sit with his hands in his pockets and they were so when the body was found. There were several almost miraculous escapes. The damage to the building, boilers, and machinery is estimated at $800.

MINE (99).—The mud-drum of the boiler at the Lane mine, in Angels Camp, near San Andreas, California, exploded July 21st, badly scalding Lane, the engineer. It is thought his injuries will prove fatal.

LOCOMOTIVE (100).—Engine No. 519, of Louisville & Nashville R. R., which was coming north, exploded, July 20th, throwing the tender 150 feet in an opposite direction. Mr. Robertson was instantly killed, being disemboweled by a piece of iron.

BREWERY (101).—A brewing tank in the Willimansett, Mass., brewery exploded July 23d, doing about $4,000 worth of damage. The tank was blown to fragments, the whole north end of the building was demolished, and considerable damage was also done to other parts of the building.

HOT-WATER BOILER (102).—By the explosion of the hot-water boiler, July 23d, sad havoc resulted in the kitchen, pantry, and rear of the Winchester boarding house at No. 44 Third street, San Francisco. The remnants of the boiler were found at a distance of nearly 200 feet from the scene of the explosion. The head of it was jammed and twisted like so much crushed paper, and the cylinder was almost pressed flat. The head cook was scalded in a shocking manner, from the waist up, and the head girl in the dining-room, who was just going into the kitchen when the explosion took place, was cut and bruised about the head by splintered glass. The damage was about $1,000.

WATER WORKS (103).—The boiler of the Columbia, S. C., water works exploded, July 23d, wrecking the building, killing one man and wounding seriously or painfully six others. The huge boiler was thrown bodily into the air and fell seventy yards away. The brick-work about it was widely scattered and the building was torn to pieces.

RENDERING TANK (104).—A terrific explosion occurred in Armour's oleomargarine factory, Chicago, July 25th. A large tank, one of six in the factory adjoining the packing-house on Forty-third street and Packers avenue, became overcharged with steam and exploded with frightful force, sending its boiling contents over four men, while two others at 30 yards distance were injured by flying débris. Thomas Dolan died from the effect of his injuries, and James Baily is not expected to live. The damage to the building is about $5,000.

SHODDY MILL (105).—One of the boilers at Regan's shoddy mill in Rockville, Conn., exploded July 27th. There were two men near at the time. One of them escaped, his only injury being a broken thumb. The other, Paul Nyman, boiler tender, aged about 40, was buried in the débris. The break in the boiler was about one foot by three feet. The explosion resulted from low water.

——— MILL (106).—The boiler in Col. Thomas Graves' mill, at Tchula, Holmes county, Miss., exploded July 28th, killing three negroes and two white men. Col. Graves was injured.

Plating Works (107).— The boiler of the Galesburg, Ill., Plating Works, exploded July 28th, with terrible force, wrecking the back part of the building, and sending the boiler a distance of over 100 feet in height. Mr. Fred Tyler, brother of the proprietor, was struck by the descending boiler, and almost instantly killed. Mr. Ed. Tyler, the proprietor of the works, narrowly escaped a similar fate. The loss will exceed $1,000.

——— Factory (108).— William Heitmann, aged 30, employed by the Oaks Manufacturing Company at Steinway, Long Island, received fatal injuries, July 28, at the factory, where a small boiler exploded. Heitman was terribly scalded and bruised. The explosion caused several hundred dollars' worth of damage to the factory by breaking windows and destroying walls.

Mine (109).— Two boilers at John Henning's ore mines, at Topton, Penn., exploded July 28th. Josiah Bloch, the superintendent, was blown 400 feet and instantly killed. Jerome Trexler was fatally scalded and Moses Houpt was seriously injured by falling timbers. The building was burned down and the machinery was entirely wrecked.

——— (110).— A boiler exploded July 28th, on Honey Island, Miss., killing Henry Dupuret, a carpenter, another white man and three negroes, and injuring four others.

Speed of European War Vessels. — An official paper published at Rome has the following regarding the fastest iron-clads in the world: The Italian iron-clad *Italia* has a speed of 18 knots an hour; the *Lepanto*, *Umberto*, *Sicilia*, and *Sardegna*, all of them Italian, 17.50 knots; the *Warspite*, belonging to England, 17.20 knots; the *Impérieuse*, of the English navy, 17 knots; the *Ruggiero di Luariae*, the *Morosina*, and the *Andrea Doria*, all of them Italian, 16.50 knots; the *Nile*, the *Trafalgar*, the *Sanspareil*, the *Anson*, the *Camperdown*, the *Ben Bow*, the *Rodney*, the *Howe*, the *Collingwood*, the *Colossus*, and the *Edinburgh*, of the English navy, 16 knots; the Italian iron clad *Duilio*, 15.50 knots; the *Dandolo*, also Italian, 15.20 knots; the *Devastation*, of the French Navy, 15.17 knots; the *Alexandra*, belonging to England, 15 knots; the *Foudroyant*, the *Admiral Baudin*, the *Formidable*, the *Neptune*, the *Hoche*, the *Marceaux*, and the *Magenta*, all French, 15 knots; the *Hercules*, of the English navy, 14.69 knots; the *Redoubtable*, of the French navy, 14.66 knots: the *Temeraire*, an English ship, 14.65; the *Dreadnought*, an English vessel, 14.52; the *Affondatore*, of the Italian navy, 14.50; the *Terrible*, the *Indomptable*, the *Caiman*, and the *Requin*, all French vessels, 14.50; the *Admiral Duperré*, also French, 14.47; the *Sultan*, an English vessel, 14.30; the *Neptune*, also English, 14.20; the *Inflexible*, likewise an English ship, 14, and the *Vauban*, French, 14.

Luminous Pork Chops.— The suggestion that meat in course of decomposition may be used for illuminating purposes has at least the merit of novelty, says the *New York Herald*. We read in the Berliner Tageblatt:

Herr Nusch of Basel lectured recently on decomposing foods. He displayed some pork chops, the light emitted by which was strong enough to enable persons standing near the platform to recognize each other and to tell the time by a watch.

The chops thus luminous seem to have owed their remarkable capacity for shedding light to the presence of numerous bacteria, infesting flesh otherwise sound and without disagreeable odor. How the infection was traced to its source is thus narrated:

The infection was found to occur in the butcher's shop, a thorough cleaning and purification of which failed to prevent the appearance of the bacteria. A current of pure air kept moving through the shop only served to hasten the decomposition. Finally the infection was traced to a rotten plank in the counter on which the meat had been placed. On new wood being inserted the bacteria disappeared.

The Locomotive.

HARTFORD, SEPTEMBER, 1886.

J. M. ALLEN, *Editor.* H. F. SMITH, *Associate Editor.*

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Bound volumes one dollar each.

A WRITER on "Boiler Management" in the *American Engineer* well says: "Second only to the proper application, use, and introduction of heat to the boiler, circulation should be well provided for and assisted so that the best results may be attained."

This is true: but in how many instances it has been overlooked, or disregarded. Heating surface, all that it was possible to crowd into a boiler, was a few years ago the universal fashion, and consequently boilers were filled with tubes. They were set as close together in many instances as five-eighths of an inch in horizontal tubular boilers, the rows were staggered, and they were carried as close to the sides and bottom of the boiler as the flange on the tube sheet would admit. We have seen them within less than an inch of the shell, with the result that active circulation was impossible, the spaces soon became choked up with scale, and the boiler, originally a "poor steamer," rendered almost worthless.

We are glad to see that a change is going on in the direction of more rational construction. It is beginning to be realized that heating surface is *not* heating surface *unless* the water circulates freely over it. When this fact is *generally* appreciated we may confidently expect to see greatly improved boiler construction.

WE would call especial notice to the article in this issue from the pen of Mr. John Erwood of Chicago, Ill., on *Sanitary Engineering.* It shows up the way that our plumbing is usually done, in a very graphic manner. Mr. Erwood is a vigorous writer, and handles his subject without gloves.

In another article, reproduced from *Nature*, an English publication, will be found a resumé of some points in Sanitary Science, viewed from an English standpoint.

THERE has been a "sudden, total, and widespread" cessation of the discussion in *Engineering* concerning English *vs.* American locomotives, since it was shown by official figures that the cost of motive power used to haul a ton of freight one mile actually *is* about fifty per cent. greater in England than it is in the United States. Facts are stubborn things and — American Locomotives are hard to beat!

A NEAT brick chimney to furnish draught for the boiler which generates steam to drive the electric lighting plant to light the Bartholdi Statue would seem to better accord with the general spirit of the design, than does the cheap stove-pipe affair used, held up by guy rods, *à la* portable saw-mill.

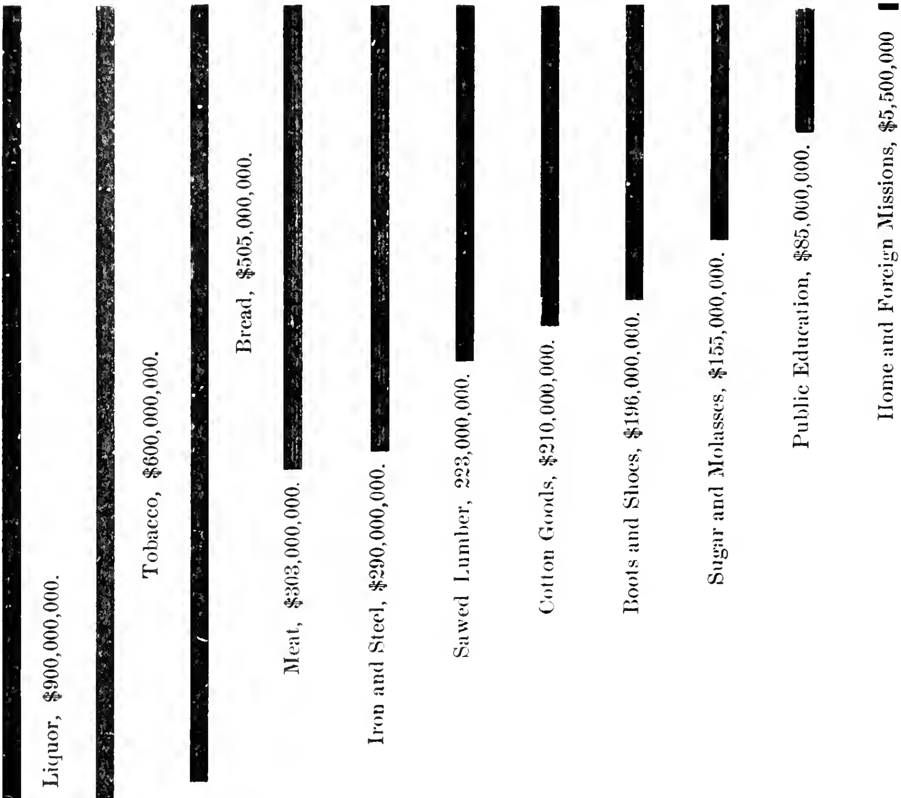
WE must beg our readers to pardon us for the delay in this number of the LOCOMOTIVE. The delay was unavoidable, and we hope it will not occur again.

Sanitary Engineering.

It would be an interesting thing to know, in detail, what kind of a knowledge is necessary to constitute a full fledged sanitary engineer. The name would imply an individual well up, professionally, in sanitary science, but it is an unfortunate thing that the science, in a developed form, does not benefit humanity to a greater extent. It is to be hoped that the sanitary engineer is not responsible for connecting the trapless drains of wash-basins in bed-chambers directly into soil-pipes or the connection from bath-tubs and sinks. It is probably not the sanitary engineer who is responsible for the hanging of lead pipes on nails driven into the wall, and soil-pipes of the same material running vertically through the building, hanging from their upper ends, and otherwise connecting the drain pipes leading from bed-chambers directly into the sewers; in other words, making a direct connection, and imperfectly trapped at that, from the rooms we live in, down into the pipes containing the most poisonous vapor imaginable. It is to be hoped that the sanitary engineer is a little better informed upon common decency than to be liable to make such inexcusable blunders. Mechanical engineers have successfully grappled with the most powerful and valuable agent known to men — steam. It can be used in dwellings, and successfully handled by domesties, knowing nothing of its scientific principles. It is surely the place for the sanitary engineer to so manipulate the agents with which he would naturally be brought into contact in his profession. There is no question but what, as large cities and towns increase in population, that a large majority of the disorders that men and women are not heir to are brought about by a violation of sanitary laws. A recent case has come under the notice of the writer, where the head of a wealthy family died recently. They were the possessors of probably one of the handsomest residences in Cook County, but notwithstanding this, it has been recently discovered that a sewer-pipe, leading from underneath the wash-basin in the bed-room, to carry off drips from underneath, was simply a direct connection to the soil pipes of the establishment, and it is generally believed, at this late day, to be the cause of the individual's death, as the symptoms of the disease itself were suggestive of something of this kind being the cause. As far as the writer goes, he cannot see where the science of engineering comes in. So long as closets are in the house they should be entirely distinct from the establishment. The independent pipes should be kept entirely apart from any drain-pipes or overflows from wash-basins. These places of convenience are an everlasting pest, and are poisonous in any respectable house; so much so as to make the country privy preferable to a modern and scientifically arranged substitute. One is practically little better than the other, for while the former may poison our well-water with the germ of Asiatic cholera and typhoid fever the latter can as successfully and completely poison the atmosphere that we breathe to the same deadly extent. It is possible, and to be hoped, that sanitary engineering cannot be blamed for these outrageous blunders and mistakes. Part of the blame they lay to the plumber, who, like the rest of his brethren in other professions, figures to get a job as cheap as he can, and when he gets it, figures to get out of it as cheaply as possible; while the balance of the blame may be due to the penurious propensities of the individual putting up the establishment. Such a mode of action, however, is little short of murder. It is not the wish of the writer to bear too hard upon the sanitary engineer. His profession may be a great benefit to humanity, but it is a difficult thing to locate in the ordinary dwelling-house, by any of the sanitary appliances, wherein such a science as sanitary engineering comes in. The writer is glad to note that the subject is receiving more consideration of late than it has heretofore enjoyed, but at this advanced age of the high-speed locomotive, the triple compound condensing marine engine, and the electric light and telegraph, it is rather late in the day to expound the principles of a science of such immense importance to the whole civilized world. People shudder at cremation as being unnatural when they may have in their own establishments, in fact in their very sleeping rooms, direct connections to one of the most disgusting sources of ill-health. — John Erwood, *Chicago, Ill.*

How Our Money is Spent.

AS SHOWN BY THE UNITED STATES OFFICIAL STATISTICS FOR 1885.



In round numbers three billion four hundred and eighty-two million five hundred thousand dollars ($3,482,500,000), divided as above.

The above figures show that our liquors cost nine hundred million dollars ($900,000,000), or

One-eighth more than all our meat and bread.

Three times as much as our iron or steel.

Ten times as much as our public education.

Our tobacco costs six hundred million dollars ($600,000,000), or

One-fifth more than our bread.

Twice as much as our meat and iron.

Three times as much as our boots and shoes.

Seven times as much as our public education.

Our liquors and tobacco cost one billion five hundred million dollars ($1,500,000,000) or

Three times as much as our bread.

Five times as much as our meat and iron.

Seven times as much as our lumber.

Seventeen times as much as our public education, and these two items alone cost more than four-fifths than all the rest.

Hygiene.

"Hygiene," in the words of the late Professor Parkes, "is the art of preserving health; that is, of obtaining the most perfect action of body and mind during as long a period as is consistent with the laws of life. In other words, it aims at rendering growth more perfect, decay less rapid, life more vigorous, death more remote." The art of preserving health is correlative with the science of prevention of disease, since perfect health means the absence of disease and of tendencies to disease. Hygiene is thus the art of preserving health and the science of preventing disease: and in taking into account recent advances in sanitary science we must consider recent acquisitions in our knowledge of the origin, causes, and spread of disease, more especially of those diseases known as "preventable," as well as the methods of improving the natural conditions or social relations surrounding us, which are instrumental in preserving health and counteracting disease.

The etiological relations of all diseases are a subject of interest to the sanitarian, but those which have received the most attention of recent years, and in which the most striking advances of knowledge have either already been made, or are imminent in the near future, are perhaps Asiatic cholera, typhoid or enteric fever, diphtheria, and phthisis, or tubercular disease of the lungs. The mode of origin and spread of Asiatic cholera has attracted great popular attention, both on account of its possible introduction into this country from infected districts of the Continent, and from the alleged discovery by Koch of a *spirillum* or *comma-bacillus*, asserted to be the specific cause of this terrible disease. The Report of the Government Commission, consisting of Drs. Klein and Heneage Gibbes, who visited India in 1884, with the object of undertaking researches into the etiology of Asiatic cholera, has lately appeared, and in this report the conclusions arrived at by Koch from his own researches are very directly traversed. This report, too, has received a very cordial support from a committee consisting of many eminent physicians and physiologists, which was convened by the Secretary of State for India for the purpose of taking it into consideration. It must be apparent, however, to any one who makes an impartial study of the literature of the subject, that, if Koch's organism has not yet been proved to be the actual cause of the disease, it has been proved to differ from all other organisms asserted to be identical with it, from the fact that its growth in various nutrient media is characteristic, and serves to distinguish it from all other organisms. As far as our knowledge at present extends, difference in manner of growth in nutrient media affords as just a basis for distinction between micro-organisms as difference in microscopical appearance or other morphological characteristics. Koch's comma-bacillus is therefore diagnostic of the disease, and this fact has now placed in the hands of medical men the power of at once recognizing a true case of Asiatic cholera, the isolation of the organism from others in the choleraic discharges and its cultivation in suitable media being alone needed. The results of Koch's researches, whether fully accepted or not, have not affected, nor are they likely to affect, the measures on which reliance alone can be placed for the prevention of outbreaks and spread of the disease. In the words of the committee before alluded to, "Sanitary measures in their true sense, and sanitary measures alone, are the only trustworthy means to prevent outbreaks of the disease, and to restrain its spread and mitigate its severity when it is prevalent. Experience in Europe and in the East has shown that sanitary cordons and quarantine restrictions (under whatsoever form) are not only useless as means for arresting the progress of cholera, but positively injurious."

The view that typhoid fever cannot arise *de novo*, but is always propagated by a specific contagion from a previous case of the disease, is steadily gaining ground, as the number of epidemics where the disease has been definitely traced to specifically polluted air or water increases. In many other cases although the specific pollution has not been definitely proved, the probabilities in favor of such a view have been very great. No micro-organism has yet been found which can lay claim to be regarded as the specific contagion of the disease, but we are in possession of so many facts concerning the mode of origin and spread of this disease, that any discovery of that nature would probably not greatly affect the measures now taken for its prevention.

The etiology of diphtheria has lately received very careful study, but so far without the attainment of any results capable of exact formulation. It is not a disease invariably dependent on insanitary conditions, such as typhoid fever is, but that such conditions favor its spread and severity is more than probable. The far greater comparative frequency of diphtheria in rural districts than in large towns in this country is well known, and has been attributed to the presence in the air of the latter of the products of coal combustion. This view appears the more probable seeing that Continental cities, where wood and not coal is chiefly used as fuel, enjoy no such comparative immunity from the disease. Excessive moisture in the air of a house, whether arising from defective construction of the walls or roof, or from a water-logged soil, are conditions very often associated with diphtheria. The fact also that the disease is most prevalent in the damper seasons of the year, when vegetable matter is undergoing decay and fungus life is most active, favors the theory that the specific contagium of this disease is a mould or fungus, which flourishes most strongly in a damp and smokeless air. It is a remarkable fact that diphtheria is sometimes associated with scarlet fever in one epidemic, the two diseases appearing to be interchangeable: but this is a subject that requires further elucidation. The contagion of diphtheria is extremely persistent and long-lived, clinging with great pertinacity to infected articles, so that every article which is likely to have become contaminated requires very thorough disinfection, preferably by heat. There can be no doubt that school attendance is often a chief factor in the propagation of the disease amongst children.

Koch's discovery of the *Bacillus tuberculosis*, a micro-organism now proved to be the specific contagium of tubercular disease in men and animals, has placed tubercular phthisis in the category of contagious diseases. A peculiar disposition or tendency, whether hereditary or acquired, is no doubt wanted to enable the germ to take up its habitat in the human lung, but the fact that this idiosyncrasy can seldom be definitely recognized renders great caution necessary both on the part of members of a family in their association with a consumptive relation, and of hospital authorities in admitting into a general ward cases of tubercular disease, or of massing together into one institution patients in every stage of the disease. The bacillus is constantly present in the sputum and probably in the breath of phthisical patients, and this points to the necessity of a free ventilation of living and sleeping apartments, and disinfection of soiled articles of clothing and furniture. The external conditions which, of all others, cause a predisposition to consumption are, a damp sub-soil, causing excess of moisture in the air, and the constant breathing of an atmosphere vitiated by human respiration. It has been asserted that tubercle can be propagated from animals to man by the consumption of diseased meat, or, in the case of the cow, from the milk of a tuberculous animal. Further proof is required before we can accept such an hypothesis, but there is nothing improbable in such a mode of conveyance of the disease, especially in the case of children with a tubercular predisposition.

Besides the diseases which we now know to have been propagated through the agency of milk — enteric fever, scarlet fever, diphtheria, etc., in which the introduction of the morbid matter is accidental, the milk serving only as a means for its conveyance and perhaps for its growth — there is a complaint fairly definite in character, which has been attributed to the consumption of the milk of cows suffering from foot and mouth disease. Here the morbid quality is inherent to the milk as taken from the cow, and is not due to an accidental introduction. The symptoms described in the epidemics recorded are fever, vesicular eruptions on the lips and in the throat and mouth, and enlargement of the glands of the neck. During the prevalence of foot and mouth disease, all milk taken by a household should be boiled before consumption. In view of the many dangers which threaten us through the agency of milk, it would perhaps be advisable, especially where children are the chief consumers, that this precaution should be always adopted; at least until the sanitary authorities in towns have the power of inspecting and controlling the farms and dairies in the country, from which the chief part of the milk-supply is derived.

The possibility of the transmission of the contagion of small-pox for considerable distances, not exceeding one mile, through the air, has been warmly supported. There are many facts in favor of such a view, and its great probability will be seen from the following considerations. The contagion is almost undoubtedly a micro organism of the class bacteria, but as it has not yet been isolated and identified, we are unaware if it is capable of spore-formation or not. The spores of bacteria can resist external agencies — heat, cold, drying, and antiseptics — to a much greater extent than the fully formed organisms, and it is probable that those diseases in which the contagion remains dormant for long periods are transmitted through spores capable of existing for long periods outside the body. But in small-pox it is not necessary to rely upon spore-formation to support theories of aerial transmission. The contagion as given off from the body of the patient is inclosed in minute epithelial scales and dry puss accumulations. Here, protected from the air and from external destructive agencies, it may be wafted as a minute dust through the air, to descend at considerable distances. That the radius of infection from a small-pox hospital as a center does not exceed a mile, may be due to the great dilution of the contagion as it is diffused through greater distance than a mile from its center of origin, the hospital. The observations of Dr. Miquel, at the observatory of Montsouris, near Paris, have shown the number and variety of solid particles which are carried in the air, and the immense distances which some of them, as pollen and spores, may be presumed to have traveled. An educated public opinion will soon, if it does not already, regard small-pox hospitals as possible centers of infection, and will insist on their removal outside inhabited areas.

The compulsory notification of infectious diseases to sanitary authorities, either by the householder in whose house the case occurs, or by the medical attendant, or by both, has been adopted in numerous provincial towns during the last five years. This measure has done much to furnish the authorities with early information of the occurrence of infectious disease which would not otherwise have been obtained, and such information has doubtless enabled the sanitary officials to stamp out many an epidemic in the bud, which might otherwise have reached large dimensions. The more universal adoption of a measure of compulsory notification in our large towns is urgently needed.

In the domain of domestic sanitation the advances of recent years have been mostly limited to the practical applications of sound principles already acquired to the carrying out of works of construction, drainage, or water-supply of the dwelling. Houses built for the use of the well-to-do classes (not those of the speculative builder) in recent years will most generally be found to be planned and fitted on modern sanitary principles. Thorough ventilation of the drain and soil-pipe, disconnection of the waste pipes of baths, sinks, and lavatories, and of the overflow-pipes of cisterns from the drainage system, are now understood to be necessaries of modern life. A break in the connection between the house drain and the public sewer by means of a man-hole chamber and water-seal or trap, though not considered necessary or desirable by all, is now very usually practiced. We cannot doubt that the air of a public sewer is sometimes the means of disseminating disease, and any method which practically excludes such a source of danger from our houses is one to be encouraged. As knowledge extends, the simplest form of apparatus is found to be the best; many of the more complicated kinds of traps and contrivances for excluding sewer air are now discarded by builders and architects for those simpler forms which are equally effective.

In the matter of water-supply, the belief is steadily gaining ground that a water once polluted by sewage cannot be regarded as safe for drinking purposes. Safe it may be so long as filtration on the large scale is efficiently performed, but any failure to thoroughly filtrate and aerate the water in times of epidemic visitation might be attended with disastrous consequences, even supposing that filtration through sand and gravel is destructive of disease organisms or their spores. The introduction of a constant supply of water into towns, in the sense that cisterns and receptacles for storing water are no longer necessary, has been of great benefit — especially in the poorer parts of towns, where water stored on the premises is usually highly contaminated.

Of the scientific witnesses who were examined before the Royal Commission on Metropolitan Sewage Discharge, nearly all were in favor of the principle of separation of the rainfall from the sewage. "The rain to the river, the sewage to the soil." In view of the ultimate disposal of the sewage, the advantages of the "separate method" are very great, and would now probably lead to its adoption in any new scheme of sewerage for a town where the circumstances are favorable. From the public health point of view, it is also desirable to have impermeable pipe or brick sewers of small size, so that contamination of the soil by leakage into it of the contents of sewers may be avoided. In any such scheme of sewerage it must not be forgotten that not only are channels on the surfaces of the streets and roads required to convey away surface water, but previous drains laid in the sub-soil are absolutely necessary in the health interests of the town to keep the sub-soil water at a permanently low level. For the disposal of the sewage, the value of a regular daily flow, and the elimination of the necessity in times of heavy rain, of dealing with an enormous and uncontrollable volume of dilute sewage, must be obvious. The surface waters of towns are certainly not clean, but where the streets are efficiently scavenged they are free from taint of human excretal refuse, and fit for admission into the rivers which nature intended as drainage channels of the surrounding high lands.

The extreme importance of thoroughly ventilating sewers is now very generally understood. Pipe sewers require as much ventilation as brick sewers, although the absence of deposit on the smooth internal surfaces of the pipes, and their consequent freedom from smell due to decomposition of deposited organic detritus, originally led to the belief that ventilating openings were not required in pipe systems of sewerage. It was not until Dr. Buchanan showed in the case of Croydon that the absence of proper ventilation in the pipe sewers of that town was in all probability instrumental in aiding the spread of enteric fever, that the opinion of engineers on this matter underwent a change. Displacement of air in pipe sewers of small diameter is greatly more sudden than in brick sewers of larger diameter, and it is plain, says Dr. Buchanan, "that means of such ventilation are wanted more numerously in proportion as the displacements of air may be local and sudden." Openings into sewers from the street level are still regarded as the best practicable means for the admission of fresh air, and the exit of sewer air. Charcoal trays, Archimedean screws, and other contrivances for purifying the issuing air, or hastening its exit, are now generally abandoned as useless and inconvenient.

The purification and utilization of the sewage of towns is a subject of much importance both in its public health and commercial aspects. The idea, so long entertained, that town sewage could by various methods be made to yield a manure which would give rise by its sale to an enormous profit, is now exploded. The highest degree of purification, we now know, can only be attained on land naturally suitable from its porosity and other properties, and artificially prepared by extensive under-drainage. The agents which purify sewage in its passage through soil, by converting the nitrogenized organic matters into inorganic salts — nitrates and nitrites of the alkaline and earthy bases, and ammonia — have been discovered to be bacterial micro-organisms resident chiefly in the superficial 18 inches of soil, and far more abundant in some soils than in others. Sewage farming has been ascertained to be profitable, under suitable conditions. The sewage must flow from the town to the farm by gravitation — the cost of pumping will neutralize profits from the sale of farm produce; a part of the farm must be laid out as a filter bed, so that the sewage, when not required on the cultivated land, or when so dilute from the presence of storm waters as to be inapplicable, may be purified on a small, very porous area, by the process of intermittent downward filtration. Very few growing crops are benefited by the application of sewage, except the various kinds of grasses, and of these such enormous quantities can be produced that, unless converted into "silage," or utilized on the farm in the production of stock and dairy produce, they may be expected to result in a loss, from the absence of any demand for such large quantities at all periods of the year.

In this country, the sewage farm at Birmingham is probably the best example of what has been done to solve a most difficult problem by the application of sewage to land. Here, the sewage is first freed from its suspended matters by a process of precipitation, a proceeding necessary not only to prevent warping of the land with offensive solid matters, but also to withdraw the metallic salts and acids incidental to the sewage of a manufacturing town, which would be injurious to vegetation. Even this magnificent example of dealing satisfactorily with the most difficult municipal problem of modern times is eclipsed by the city of Berlin on the Continent. The sewage farms at Berlin have successfully dealt with the sewage of 887,500 people — nearly twice the population of Birmingham — while London is still allowing to run waste an enormous amount of valuable material, at the same time polluting a river — the highway of its commerce — to an extent never previously dreamt of.

Processes of precipitating sewage by chemicals are now known to exert only a partially purifying influence. The best process yet discovered can do little more than free the sewage from its suspended matters, allowing all the dissolved constituents of sewage — by far the most valuable portion, agriculturally and chemically — to pass away in the effluent. Lime dissolved as lime water, sulphate of alumina, and perhaps proto-sulphate of iron, taken together and added to the sewage in the proportion of not more than 10 to 15 grains to the gallon, are the best, most economical, and most effective precipitants. Other more valuable substances, added to the sewage with the view of increasing the value of the precipitated sludge or manure, are in large proportion lost in the effluent water, and as they do not assist precipitation, might just as well be added to the sludge afterwards, if fortification is required. Half-a-crown and no more is the value per ton of the precipitated solids of sewage. This value will generally pay for the cost of their carriage a mile or so in agricultural districts, but no farther.

A great improvement in dealing with the semi-liquid sewage sludge has been lately effected. The sludge containing over 90 per cent. of water was formerly allowed to dry in the air or in a drying chamber, and a most intolerable nuisance resulted. It is now possible by means of hydraulic filter-presses to convert the semi-liquid sludge into solid cakes containing 40 to 50 per cent. of water, and in this form it is innocuous to the senses, and can be readily conveyed away by cartage.

The knowledge already acquired demands that now, and in the future, the sewage of towns should, whenever possible, be utilized on land in the production of crops or dairy produce; failing this, the sewage should be freed from its solids by precipitation, and subsequently purified on land laid out as filter-beds, efficient purification, and not the production of crops being alone aimed at. If application to land is impossible, then precipitating processes alone must be relied on, and where the sewage can be turned into the sea, and effectually got rid of without nuisance, there it may be allowable to waste valuable matter which cannot be utilized except at a cost destructive of all profits from its utilization. — *From Nature.*

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

NEW SERIES—VOL. VII. HARTFORD, CONN., OCTOBER, 1886. No. 10.

Explosion of a Rotary Bleaching Boiler.

A rotary bleaching apparatus exploded some time ago in a neighboring State, with astonishing force, killing one man and demolishing a substantial brick mill. The conditions and dimensions are mainly as follows: The rotating cylinder A was 7 feet diameter by 20 feet long, constructed of five courses or rings, of $\frac{1}{2}''$ boiler plates, three plates in each course. The longitudinal seams were double riveted. The ends were formed irregularly convex of flat cast-iron flanges and a zone of wrought iron plates. The flanges were 48 inches diameter by about 4″ thick, with trunnions 14 inches diameter. These flanges were each joined to the cylinder by a zone of 6 gore sheets of $\frac{9}{16}$ boiler plates, single riveted together, but double riveted to the cast-iron flanges. Steam was brought through an inch and a half wrought iron pipe a distance of about 140 feet and admitted through one of the trunnions to the interior of the cylinder, at a pressure of about 50 pounds to the square inch above the atmosphere. It passed through a regulating appar-

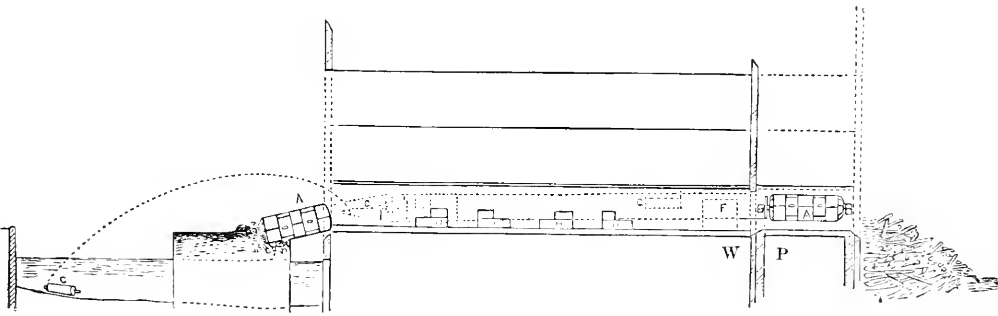


FIG. 1.

atus situated near the cylinder, upon which was a steam pressure gauge. The cylinder was fitted with two large doors, similar to ordinary man-holes, through which the material to be treated was introduced from above, the cylinder being stopped with the doors looking upward for this purpose, and for the discharge of the boiled stock they were made to look downward. Diametrically opposite to the doors were weights to counterbalance the weights of the doors, their frames and attachments. Inside the cylinder were four rows of radial pins about one foot long attached to the shell, intended to agitate and mix up the stuff by lifting portions of it on the upgoing pins, as the cylinder slowly revolved during the operation. The weight of the cylinder and attachments is roughly estimated to be about 13,000 pounds, and it was charged with about 5,000 pounds of rough paper stock, and probably 14,000 pounds of bleaching liquor, which was pumped in cold from the mixing tanks through a pipe between the doors, making a total load of something like 16 net tons — 32,000 pounds, including the weight of the apparatus. It is probable that a little calculation will show that this load, even in addition to the internal steam pressure, was not excessive, provided the cylinder had the strength due to a well made structure of good materials and in a state of rest.

The accompanying sketches are intended to show the relative location of objects involved in this astonishing accident, Fig. 1 being a sectional elevation, and Fig. 2 a plan of the part of the mill in which they were situated. Reference letters designate same objects in all sketches. On the day of the explosion the apparatus was charged in the usual way about 5 P. M., and at about 11 P. M. the same night it exploded, giving way at the outer end. The cast-iron flange and its attached zone of gore sheets separated from the remainder of the cylinder and from each other, and were scattered in the vicinity, all the wrought iron gores, E E E E E E, except one remaining within the boundaries of the building: the one that went out fell near by, among the ruins, while the flange D took nearly an axial direction, and fell a short distance beyond the pile of debris in the Connecticut River. The break in the flange D, Fig. 5, followed regularly the line of the inner circle of rivet holes by which it was secured to the wrought-iron gore pieces. The gore pieces were separated from each other on diverse lines of rupture, Fig. 2,—some through the sound plates, others partly on the meridian seams and partly through the sound plates. One alone followed a meridian seam throughout, which gave way by shearing nearly all the rivets in that line. The separation of the zone from the cylinder

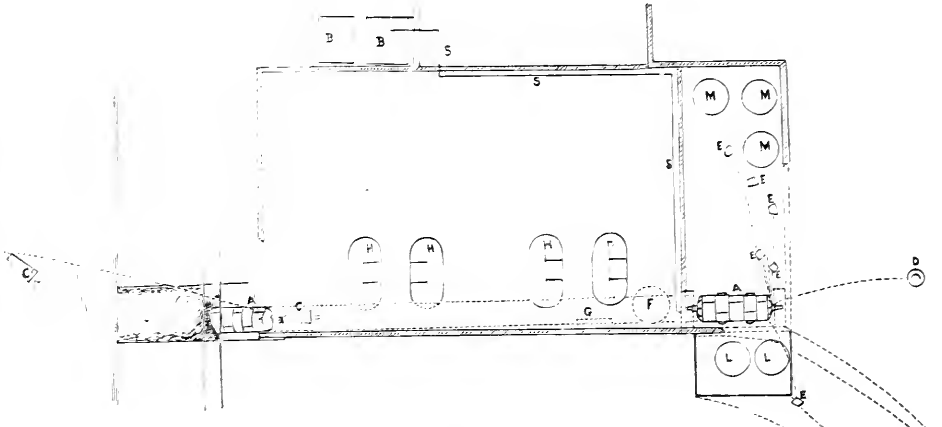


FIG. 2.

was not entirely along the girth seam, but the line of rupture extended in four places into the sheets of the shell, Fig. 3, separating as many triangular pieces, which remained attached to the adjoining gores, and in one instance into the zone, leaving a triangular piece composed of parts of two gores attached to the cylinder. It is difficult to point definitely to the initial break, since it appears to have been almost simultaneous along the various lines. The almost perfect coincidence of the line of flight of the principal part with its projected axial line indicates that no advance lateral discharge of water could have occurred, because the reaction of such a discharge would have thrown the cylinder out of its true line of flight. The astonishing fact that the main portion of, probably, 5 tons weight, exclusive of the contents, did not deviate more than one foot from a horizontal direction in going a distance of over 100 feet, see dotted line, Fig. 1, indicates a velocity almost inconceivable, particularly when the several obstacles it encountered are taken into consideration. Its inner supporting pier P, and a 16-inch brick wall W, a ten foot tank F, full of water, and a suspended lime tank G, are met with at the outset. It may have been deflected upward slightly in grazing over the prostrated pier, but it could not have been much, or it would have damaged the ceiling under which it passed, starting within about one foot or less of the ceiling line.

If the above simple history is not treated as a sensational fiction, and if the case receives that calm consideration to which its importance entitles it, then it seems to suggest a thoughtful review of all the fancy *explosion theories*, for none of them seem to be applicable to it.

These theories are mostly based on the supposition that by some means, explained in half a dozen different ways by as many theoretical experts, there is a sudden evolution of force within the boiler, too powerful to be resisted by any practicable structure. Some (perhaps *more practical*) experts teach us that this force, though sudden and powerful, may be successfully resisted by a boiler constructed and set according to their elaborate and expensive plans.

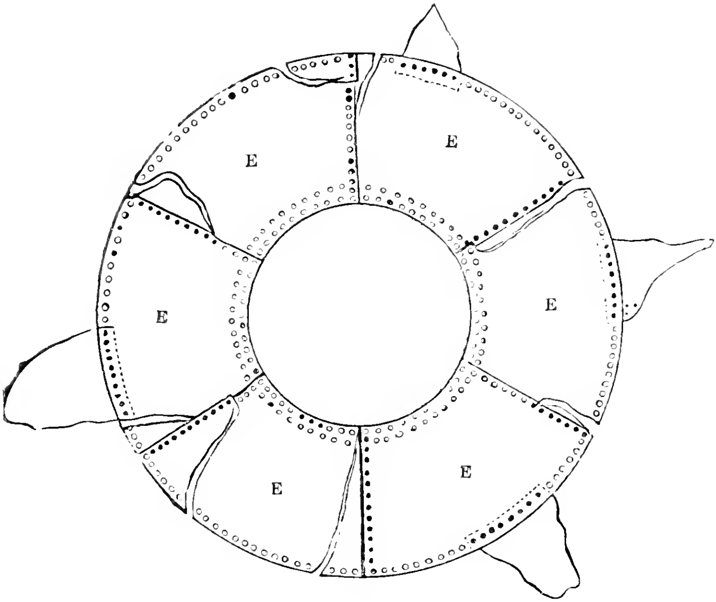


Fig. 3.

This sudden evolution of force is said, by these experts, to arise from overheating the water by contact with highly heated plates, or from superheated steam through which the water is diffused on being relieved of superincumbent pressure by a sudden escape of steam; and numerous cases are cited in proof where boilers have exploded from this cause on starting up the engine, or on an increase of load suddenly put upon the engine, which is followed by an automatic opening of the throttle valve. An increase of pressure may occur from these causes, and to very many weak boilers they have probably proved the final "straw which broke the camel's back," but to magnify these shocks into a irresistible power such as would blow up a sound boiler, by causing initial ruptures in the stronger parts of them, is not consistent with facts as they appear to those who make a business of practically studying the subject for no other purpose than the prevention (for their own benefit) of these accidents. Whatever may be said of steam-pipes as incendiaries, it would be absurd to allow them to take a place among the possible causes of this accident, by conveying superheated steam into this large cylinder. It was probably half full of a mixture of fibrous and liquid matter in about the proportion of 55 ounces of the former to a pint of the latter, agitated by mechanical means so as to be thoroughly mixed, receiving steam at a supposed temperature of about 300° F., through 140 feet of pipe which was only partially protected from the refrigeration of the atmosphere.

It would be an insult to the good sense of the most stupid tyro in practical science to ask him to believe that the steam within this chamber was much hotter than what is due to the pressure, as indicated by the numerous gauges.

The other cause mentioned above of the sudden evolution of force is the one most often assigned. It is said to be the "lifting of the water," or, in other words, the repulsion of the water by the overheated plates. On a disturbance occurring by some change in the conditions — either the introduction of feed water, the opening of the blow valve or the steam valve — the water returns to the hot plates, and concussive ebullition follows, which is said by some to resemble in effect the explosion of a charge of detonating compound on the surface of a submerged rock, and by reaction breaking through the plate, and by others it is said to resemble the blasting of rocks under water, whereby the boiler is ruptured by the impact of the projected water. Another way of producing this effect, it is said, is by feeding cold water suddenly upon overheated plates; but since overheating of plates is out of the question, no theory depending on their presence will do for this case.

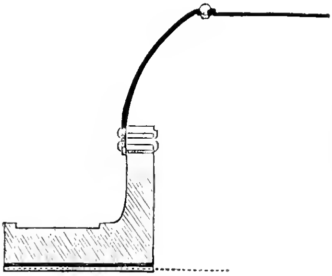


FIG. 4.

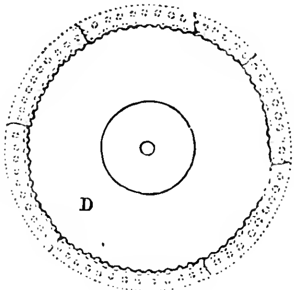


FIG. 5.

The gas theory, meaning a decomposition of the steam, and the explosion of the hydrogen with great violence, or the violent reunion of the gases, whichever it may be, will not for like reasons be admissible.

We may not speak so positively of the electrical theory, since the iron steam pipe is an excellent conductor, but thunderbolts were not, at the moment of the accident, flying about the mill.

The more plausible theory of a gradual accumulation of a very high pressure is also almost certainly precluded, since the pressure could be no higher than it was in the generating boilers (unless another source of heat is found). These boilers were fitted with safety valves about the efficiency of which there can be no doubt, as they remained at their post for examination after the accident. Besides this, the unusual precaution of having a half hourly record made by the watchman, of the state of the pressure gauges on all the bleachers, was resorted to by the intelligent proprietor of these extensive mills.

We are then apparently face to face with a first-class explosion at a moderate pressure, which has evidently arisen from the gradual deterioration of the containing vessel. And in character and effect it resembles an ordinary boiler explosion, and is in all respects similar.

The records of this company cover notices of 26 explosions of vessels detached from the generating boiler used at moderate pressure for various purposes in the arts, and there have been many others of less importance that were not considered worthy of public mention, and it is safe to say that the percentage of explosions among bleaching, digesting, rendering, and other similar apparatus is ten times greater than among steam boilers proper at like average pressures, and the character of the destructive work done by those that use like quantities of liquid is quite as astonishing as that of ordinary steam generators.

The uneasiness caused by the idea that there is or may be in any steam generator an unstable compound like nitro-glycerine, or a slumbering power capable of springing upon and breaking, or even seriously testing the strength of its confining walls would be distressing, and if generally believed would lead to the abandonment of the use of steam by all who care for their lives or the lives of the employees.

The readers of the LOCOMOTIVE doubtless remember the oft-repeated opinions held by this company on the subject of mysterious boiler accidents; while there are some explosions of steam generators occurring that it is difficult for some persons to fully explain or classify definitely, we believe that they would readily take their places in one of these well-defined classes, if all the conditions attending and antecedent to the accident were positively known.

There may be and it is *known* that there are defects of both workmanship and materials sometimes so hidden that they cannot be detected by any inspection short of cutting the boiler to pieces, testing the material, and searching for the "scamping" done by the workmen, still it is believed that these cases are very rare compared with the detectable defects which are being reported by the thousand for which timely and adequate remedies are suggested and adopted. There is now a large plate of iron in the collection of defective material in this office which came from the establishment of a manufacturer noted for the excellence of his boiler plates, and it was put into a boiler by a firm of undoubted ability and honesty, where it kept its place but a short time under the ordinary circumstances of boiler practice when a very slight but peculiar defect was discovered by the inspector, and on careful search more singular but all slight defects were detected in the same sheet. Its removal having been recommended, it was found to be so brittle in places as to fall to pieces under the blows that were necessary to detach it from its place. This is mentioned being the most recent and best authenticated of the many cases that are on record), as tending to show that no firm is exempt from the liability of sending out occasionally a defective piece of work, and that perfect immunity from accidents in the use of steam can only be realized by careful and frequent inspections by the most competent and reliable professional inspectors.

From the nature of the business of manufacturing and working boiler plates, such defects are more liable to occur than in almost any other mechanical industry. The puddling and other operations in the manufacture of the plates call for not only a good degree of skill and patience, but they must be associated with almost superhuman endurance in the workman; while the working of the plates into some of the complicated forms of steam boilers requires a very high grade of skill and patience, coupled with a good degree of endurance. And more especially is the skill, patience, and endurance called for in repairs to boilers, for they are generally accomplished under the most discouraging difficulties. The material is stubborn, the room in which the work is to be performed is often so contracted as to scarcely admit the workman's hands and *perhaps* his lamp and head; ashes, dust, and smoke conspire with perhaps hot water, steam, and hot bricks to make his situation uncomfortable, and try his patience — often too in the night, and night and day continuously, with little or no rest till the job is done, for the proprietor cannot let his works stand. It is not strange, therefore, that this kind of work is not always as perfect as it should be, and it is generally only those that are not familiar by experience with those difficulties who confidently and arrogantly assert that it is impossible for any defects in workmanship to escape their vigilance, or that they know that the work was perfect when it left their hands.

Inspectors' Reports.

AUGUST, 1886.

There were made during the month of August last a total of 3,373 inspection trips, 6,261 boilers were inspected, 2,671 were thoroughly examined both externally and internally, 483 were tested by hydrostatic pressure, 6,453 defects were reported, of which 927 were considered dangerous, and led to the condemnation of 29 boilers. Our usual summary of defects is appended:

Nature of defects.	Whole number.	Dangerous.
Deposit of sediment,	458	32
Incrustation and scale,	630	55
Internal grooving,	20	7
Internal corrosion,	155	16
External corrosion,	346	23
Broken, loose, and defective braces and stays,	205	39
Defective settings,	178	17
Furnaces out of shape,	248	12
Fractured plates,	123	65
Burned plates,	89	22
Blistered plates,	254	11
Cases of defective riveting,	1,649	187
Defective heads,	30	15
Leakage around tube ends,	974	331
Leakage at seams,	574	22
Defective water-gauges,	163	27
Defective blow-offs,	30	8
Cases of deficiency of water,	5	2
Safety-valves overloaded,	29	7
Safety-valves defective in construction,	42	7
Defective pressure-gauges,	238	19
Boilers without pressure-gauges,	4	0
Defective hand-hole plates,	3	3
Defective hangers,	13	0
Defective fusible plugs,	1	0
Total,	6,453	927

Boiler Explosions.

AUGUST, 1886.

THRESHER (111).— The boiler of a threshing-machine engine exploded August 1st while in operation on a farm a few miles southwest of Parsons, Kansas. Frank Fruster, the engineer, was instantly killed. Several others were badly injured, and the machine and adjacent grain stacks consumed by fire, having been ignited by the fire in the fire-box to the engine being blown into the straw.

MACHINE SHOP (112).— A terrible boiler explosion wrecked the machine shop of the Lehigh Coal and Navigation Company at Lansford, Penn., August 3d, killed five men, seriously wounded eight, and injured in a less degree several others. About four hundred men are employed in the works, of whom some forty were engaged in the machine shops. The boiler was that of an old camel-back locomotive put into the building fifteen years ago, when that portion of the shops was built. The explosion raised the boiler clear out of its stone foundations, and scattered the fragments of iron and broken stone in every direction. Portions of iron were hurled through the roof and the building was thoroughly wrecked. The force of the explosion was felt for miles, and the head of the boiler was thrown fully 200 feet high in the air. The released steam and water instantly enveloped the torn and mangled men buried in the ruins of the shop, adding to the intensity of their sufferings. William Lewis was instantly killed. He was eighteen years of age, and was badly mangled by iron and scalded. Jacob Alderson, the boss blacksmith, had his head badly cut open and was internally injured. Kistler was found wedged in the wreck, wounded in the head and scalded. Daniel Scott had his limbs lacerated. Edward Murray had his lower limbs broken, and the others were maimed and scalded, some in the most frightful manner. Four men died soon after they had reached home. As to the cause of the disaster nothing definite can be learned.

Locomotive (113).— The boiler of engine No. 392 of the Lyons coal train burst August 2d, near Clyde, on the New York Central Railroad. John Freeze, the engineer, of East Syracuse, who has been in the employ of the company in this capacity for forty years, lost the sight of his left eye. His lower jaw was broken in two places, and his body was burned and scalded. He died a few hours afterward. Henry Rider, head brakeman, of East Syracuse, was badly scalded about the face, neck, and hands. The fireman, John Downey, of East Syracuse, was slightly burned, and somewhat injured in jumping from the engine, which was running at full speed.

Wagon Works (114).— A boiler at the Allegheny, Pa., wagon works exploded, August 7th, with terrific force, badly wrecking the building, and almost completely demolishing two small brick dwellings in the rear. A number of persons were struck by flying bricks, but none were fatally injured. Those most seriously injured were Albert Cook, Mrs. Chapman, and a small child named Light. The loss was about $5,000.

(115).— August 5th the boiler of a six-horse power stationary engine, located in the rear of the cellar at 1,942 North Broadway, St. Louis, exploded, and was blown through the intervening floors and roof high into the air. In descending it alighted upon the roof of the front of the same building and crashed through again, finally resting on the floor of the front room of the second story. The building was occupied by three families, but no one was injured except Henry Stege, a twelve-year old boy, who was struck in the back and neck by a piece of the boiler. He will recover. The building was almost completely demolished.

Thresher (116).—The boiler of a threshing engine exploded, August 10th, on the Foster farm, near Jefferson, Wis., killing five persons instantly — Anthony Klein, the engineer, and his son, Joseph Lester, and his ten-year-old boy, and Joseph Hass. Another of Lester's sons, aged eight years, and a man named Fisher were fatally scalded. Several others received scalds.

Switch Engine (117).— A switch engine exploded in the Union Pacific yards, West Kansas City, August 10th. Charles Haige, fireman, and Edward Colestock, foreman of the yards, were dangerously hurt. Robert Wilson, engineer, and Abe Laughlin, switchman, were also badly wounded.

Oil Well (118).— A boiler exploded at the Coast Brothers' oil well, on the W. W. Smith farm, near Washington, Pa., August 12th, doing terrible damage. John O'Brien, a tank builder, was blown sixty feet and instantly killed, his body being horribly mangled. J. White and "Cooney" Shoup, tank builders, were also injured. White was badly scalded about the head and shoulders. Shoup was cut about the face, but his injuries are not of a serious nature. The explosion was terrific, the concussion being felt in Washington. The cause of the explosion cannot be traced. Part of the boiler was blown over three hundred feet, while the ground around the boiler site was covered with fragments of iron and wood.

LOCOMOTIVE (119).— An engine of the Louisville & Nashville Railroad exploded her boiler at Lexington, Ky., August 11th, making a total wreck of the engine. The engineer, William Suckles, had a leg blown off, and died a few moments after. Peter Dair, the fireman, was injured, probably fatally.

CARPENTER SHOP (120).— A boiler in the carpenter shop of Perinier & Webster at Ashland, Ky., exploded, August 16th. The boiler-house was utterly demolished, and five men and boys were instantly killed and two wounded. The killed were Willie P. Perinier, Alex. Perinier, Joseph McLaughlin, O. V. Johnson, and August Olson. The cause of the explosion was a lack of water in the boiler. The boiler was blown off on Saturday and pumped up after cleaning. As usual, fire was built Monday morning, when it was found that the injector would not work. While trying to fix it the explosion occurred.

THRESHER (121).— The boiler of a threshing machine exploded near Vermontville, Mich., August 17th, killing E. Darrow and Leonard Garinger. The body of the latter was blown to fragments and hurled thirty rods. A piece of the boiler weighing 1,500 pounds was thrown nearly forty rods. Darrow leaves a large family, very poor. Garinger was unmarried. The cause of the explosion is wholly unknown.

BREWERY (122).— A boiler at Ebert & Co.'s brewery, Ironton, O., exploded, August 17th, producing a shock like an earthquake for half a mile around. Sparks shot out of the building a hundred feet in all directions and set fire to an ice-house. The watchman had just left the boiler-room, and thus escaped almost certain death. The boiler fell near the starting point, after tearing through the roof timbers.

LOCOMOTIVE (123).— The boiler of engine No. 3 of the Ulster & Delaware Railroad Company exploded at Rondout, N. Y., August 23d, while standing near the water tank in the railroad yard. John Bowes, who was in charge of the engine, and Thomas Dugan, his helper, were blown up, badly mutilated, and scalded. The cab of the engine was scarcely injured, the boiler exploding from the center, which is unusual. Pieces of the boiler were blown across Rondout creek; some fell on a hill one-eighth of a mile distant. The engine had been in the service of the company about twelve years, and was overhauled in 1884.

MACHINE SHOP (124).— The boiler in the machine shop and foundry of J. H. Small, San Francisco, Cal., exploded August 21st, during the progress of a large fire, in which nearly all of three blocks of buildings were destroyed. No one was injured by the explosion. The boiler went up in the air about one hundred feet. Cause supposed to be that the rafters and roof of the building fell on the safety valve lever and held it down so it could not raise. The works were in operation when the fire broke out at five P. M., and there was a fire in the furnace of the boilers.

STEEL WORKS (125).— A flue in one of the boilers of the rail mill of the Pennsylvania Steel Works, Steelton, Pa., collapsed, August 26th, causing the death of the fireman, Wilhelm Newbaum. At the time of the accident Mr. Newbaum was cleaning his fires, and the force of the escaping steam and water threw him to the ground and burned and scalded him so badly that he died shortly afterward. A fellow workman attempted to pull him away from the boiler by grasping him by the arm, but the flesh was so thoroughly scalded that it pulled off from the bone.

SAW-MILL (126).—The boiler in Buchanan & Ferguson's saw-mill at Deshler, Henry County, O., exploded, August —, instantly killing William Smith, the engineer, and fatally injuring Webb Buchanan, Bruce Ferguson, and William Fleck.

GAS WELL (127).— A boiler exploded, June 1st, at the gas well on the corner of Woodland avenue and Jackson street. No person was injured.

The Locomotive.

HARTFORD, OCTOBER, 1886.

J M. ALLEN, *Editor.* H. F. SMITH, *Associate Editor.*

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Subscription price 50 *cents per year when mailed from this office.*
Bound volumes one dollar each.

The Use of High Steam Pressures.

The constant tendency on the part of steam users is toward higher steam pressures, and very naturally too, since, theoretically at least, the higher the pressure used the greater is the economy attainable in the important matter of fuel. This tendency is altogether in the right direction, and has our fullest sympathy, yet it may be well before going too far in this direction to briefly review the question, to determine if possible whether it is really worth while to depend upon extremely high steam pressure alone for economy in the use of fuel.

Naturally the first difficulty encountered in the use of steam of extremely high pressure lies in the construction of the boiler. If steam users would be content with a small boiler the difficulty would be easily overcome; but they are not: on the contrary, they want the very largest sizes built to carry the highest pressures. As the strength of boiler shells of any given thickness is inversely proportional to their diameters, and the thickness of plates exposed to the action of furnace heat is limited, it will at once be seen that the difficulty is a serious one; a limit is soon reached either in size or amount of pressure that can be safely carried. A large boiler is more economical than a small one for several reasons: for a unit of power developed, it is cheaper in first cost; it requires less space, less brickwork for setting it properly; there are fewer joints, parts, and pieces, consequently it costs less to keep it in repair, and as it exposes less radiating surface to the air, a slightly greater degree of economy in the use of fuel may be realized by its use. For example, suppose 100 horse-power is wanted, we can get it by using four 36-inch boilers, or one 72-inch boiler. The four small boilers would require a boiler room 39 feet long and 23½ feet wide, the large boiler, furnishing the same power, would require a room of the same length, but its width would need to be but 10½ feet, less than one-half of that required in the first case, and in many places this would be a most important matter, enough in itself to compel the use of the larger size. The fittings required in the first case, such as piping, gauge cocks, steam gauges, safety-valves, etc., would cost at least three times as much as they would for the large boiler, while about twice as many bricks would be required for the settings. The matter of firing one furnace instead of four possesses such manifest advantages, that it is quite unnecessary to draw any comparison between the two cases. The 72-inch boiler has decided advantages in every respect save one: the 36-inch boiler can be built to safely carry a pressure just twice as high as the 72-inch. The 72-inch boiler can very easily be built to carry safely a pressure of 100 pounds per square inch, and the 36-inch 200 pounds. How much can be gained by the employment of this higher pressure?

Theoretically a saving of about 12½ per cent. in fuel *could* be effected by the use of the higher pressure; *practically* not more than one-half of this, or say 6 per cent., *would* be gained. This gain would be more than offset by the greater first cost and cost of maintenance of the high pressure plant.

The following table shows the pounds of steam per I. H. P. per hour, calculated for various pressures, and also the pounds of coal per I. H. P. per hour required by a perfect steam engine, working with dry saturated steam, the latter quantity being calculated on the assumption that 1,100 thermal units per pound of coal are utilized by the boiler, which corresponds to an evaporation of about $11\frac{4}{10}$ pounds of water from and at 212 degrees per pound of coal, a result readily attained under ordinary conditions with good coal.

TABLE SHOWING THE STEAM AND FUEL CONSUMPTION IN A PERFECT STEAM ENGINE.

BOILER PRESSURE. Per Gauge.	TEMPERATURE, Fahrenheit.	POUNDS OF STEAM, Per I. H. P. per hour.		POUNDS OF COAL, Per I. H. P. per hour.	
		Non-Condensing	Condensing.	Non-Condensing.	Condensing.
300	421.7	10.48	6.16	.98	.64
250	405.9	11.19	6.39	1.04	.66
200	387.6	12.16	6.68	1.13	.69
175	377.1	12.81	6.87	1.18	.71
150	365.6	13.63	7.09	1.25	.73
125	352.6	14.71	7.37	1.35	.75
100	337.6	16.24	7.71	1.48	.78
90	330.9	17.05	7.89	1.55	.80
80	323.6	18.03	8.09	1 64	.82
75	319.8	18.60	8.19	1.69	.83
70	315.7	19.25	8.32	1.75	.84
60	307.1	20.83	8.59	1.88	.87
50	297.5	22.95	8.92	2.07	.90
45	292.2	24 53	9.11	2 19	.91

An inspection of the table reveals two interesting facts: first, that at high pressures a great increase of pressure can give but slight additional economy; second, that the performance of the very best modern engines is much below what it would be if no defects existed in the treatment of the steam passing through the cylinder. For instance, at 125 pounds pressure, if there were no losses in the engine, *three-fourths* of a pound of coal per hour would be sufficient to furnish one indicated horse power; very few engine builders can be found who are willing to put down a steam plant and guarantee an indicated horse power with less than *one and three-fourths* of a pound of coal per hour.

Briefly, the situation may be stated thus: A pound of coal, if perfectly burned and all the heat were utilized, would evaporate 15 pounds of water from and at 212 degrees. The boiler actually does evaporate $11\frac{1}{4}$ pounds of water under these conditions, hence its efficiency must be 75 per cent., or 75 per cent. of the heating power of the coal is utilized by the boiler.

An engine working perfectly would develop one indicated horse power with $7\frac{3}{8}$ pounds of steam (of 125 pounds initial pressure) per hour, the best actual engines consume $17\frac{1}{4}$ pounds per indicated horse power per hour, hence its efficiency is but 42 per cent., or it utilizes but 42 per cent., or less than one-half of the heat passing through the cylinder.

This shows that the boiler as it is, is a much more perfect machine than the engine, and that time and money spent in devising boilers to carry very high pressures might possibly be spent to better advantage in improving the performance of the engine, or in other words, to make better use of what the boiler has already given us.

But it must not be inferred from the foregoing that we are advocates of the use of low pressures for driving engines. On the contrary, we advise in all cases where any considerable amount of power is wanted, the use of boilers of large size, built to carry the highest pressures consistent with safety. With the best materials at our command at the present time, it is possible to build a boiler of the ordinary form 6 feet in diameter which will safely sustain a working pressure of from 100 to 125 pounds per square inch, and be good for many years' service. We believe this is the limit, beyond which it will not be safe to pass without some radical change in the materials of which boilers are made.

If the purchaser of a boiler wants one that shall give him the greatest strength, durability, and economy combined, it is almost unnecessary to call attention to the fact that he must be willing to pay a fair price for a boiler, embodying *only* first-class materials and workmanship. No amount of haggling among boiler-makers will enable him to secure a first-class article for the price of a poor one. And boiler-making establishments are much like other industrial works, some possess the requisite skill and appliances for turning out strictly first-class work, and others do not, so that judgment should be used in awarding a contract.

In purchasing a boiler of the very best type, too much care cannot be exercised in the selection of the materials. To obtain the very best article it is not sufficient to go to a dealer's stock and make a selection of his highest priced brands; it will be necessary to rigorously specify the tensile strength, elasticity, and ductility, and also limit the amount of impurities, especially phosphorus and sulphur, in the steel. In this way, and only in this way, can the very best materials be obtained. If such steel costs the purchaser more money, he has the satisfaction of knowing that he has his money's worth, which is not always the case as boilers are usually purchased.

The ordinary details of construction can also be improved upon with advantage, the most important being a change in the style of riveting the longitudinal seams. The double riveted lap-joint is not the best and strongest form of joint that can be made, especially for thick plates. H. F. S.

The Sea-Serpent.

It has been my belief for some years that there is some fitful gigantic wanderer inhabiting the ocean; but, as I had never investigated the subject or even read upon it, my impressions were vague and undefined. On the afternoon of August 12th about 1.15, I was engaged in the study of Professor Farlow's work upon algæ, when I heard the voice of Calvin W. Pool, town clerk of Rockport, at the door of my cottage at Pigeon Cove, saying: "There is some strange thing in the water; I think it is the sea-serpent." I quickly took my station upon the rail of my piazza, so that my marine glass was about fifty feet above the water and but thirty-six feet from the shore. The creature was advancing in a northerly direction, and but little more than an eighth of a mile from me. I saw it approaching, passing, and departing, and watched it most attentively for about ten minutes. Judging by the apparent length of yachts, whose dimensions I know, as they appear at that distance, I estimated the length to have been not less than eighty feet. The head seemed short, and about the size of a nail cask, while the middle of the body was larger than that of a large man. The color was dark brown, and it appeared to be somewhat mottled with a lighter shade. As the head was at no time raised above the water, I could not determine the color of the throat. The surface of the head and back was very smooth, and no one of the forty or more persons who saw it detected anything that looked like a fin or flipper.

Its movement was not that of a land serpent, but a vertical one, resembling that of the leech or the bloodsuckers of my boyhood. I could distinctly see perhaps fifteen feet of the forward portion of the body, while back of that, the convolutions being greater, the depressions were below the surface, so as to present a series of ridges, some ten or fifteen in number at a time. The extremity of the tail was not visible. During nearly the whole passage of a mile and a quarter either the muzzle or cranium cut the water so as to lead several to explain: "His head is white!" This fact would remove the possibility of its being anything floating with the tide. The cutting of the water was by something at least a foot wide, and caused wakes on either side. From my elevated position I could plainly see the movements of the body between them, while the rear portion caused another wake behind. Its course was a direct one and its speed uniform and not more than five miles an hour. When it reached a point about a half-mile north of us the undulatory movement seemed to cease, and the body was for a moment extended along the surface. There was then an apparent gathering of the caudal extremity into ridges nearer together than those previously seen, after which he disappeared. I judged that this latter movement was to aid in diving, but of course this is only conjecture.

On the 19th, a week later, the same creature, or one like it, appeared north of us, going in an easterly direction, and, although perhaps a half-mile away, it was distinctly seen by the Rev. David Brewer, assistant pastor of Park street church, Boston, by his wife and servant, and by several others. My attention was not called in season to permit me to observe anything of additional interest.

From a careful study, I am satisfied that the two localities most visited are the coasts of Norway and Cape Ann and vicinity, both rocky shores. [And both swarm with fish, this creature's food.] The limits of this article preclude any reference to the former, and but a bare mention can be made of the latter. I find the following well-authenticated visits to these shores since the opening of the present century:

Gloucester,	June 20, 1815
Gloucester,	August 10–28, 1817
Gloucester,	August —, 1818
Nahant,	August 19, 1819
Swampscott,	August 10, 1820
Nahant,	July 12, 1823
Nahant,	—— —, 1826
Lynn,	July —, 1833
Swampscott,	July —, 1849
Nahant,	July 30, 1875
Gloucester,	July 15, 1877

The reports concerning these have not come from ignorant and unreliable men, but from such gentlemen as Colonel Thomas H. Perkins of Boston; Chaplain Finch, of the United States Navy; Samuel Cabot of Brookline; James Prince, United States Marshal; the Rev. Arthur Lawrence of Stockbridge; the Hon. Lonson Nash of Gloucester, and B. F. Newhall of Saugus, as well as from intelligent captains, sailors, and fishermen. I would gladly give the details of these reports, but can only say in this article that I am surprised to find such a substantial agreement between these statements and my own, as given in the *Boston Journal* and *The Cape Ann Breeze*. In length, in color, in movement, in size, in speed, as usually seen, and in the manner of cutting the water, our accounts so agree that I could give a complete account in the words of others written years since, and which I affirm I had never seen.

I am frequently asked: "If there be such a thing as a sea-serpent, why is he not oftener seen?" I must frankly say: "I do not know," and yet I can present some suggestions which satisfy my own mind. In the first place large animals are not numerous. Eagles are less abundant than mosquitoes, elephants than mice, whales than mackerel. Again, Bishop Pontoppidan wrote, one hundred and thirty years ago: "This creature keeps himself at the bottom of the sea, excepting in the months of July and August, which is their spawning season." If this is true, as the dates just given would prove it to be, the time is short when it may be expected to appear. Again the Bishop says: "They come to the surface in calm weather, but plunge into the water again as soon as the wind raises the least wave."

I reported the sea as a dead calm, and such has been the case almost always, I think. It has been so in every case but one which I have noticed, so that the conditions in this respect are not often favorable. Again, it may be that, like the great sea turtles, it is most active in the night, when it would be least observed; and again, we must remember that the ocean is vast, and that but an infinitesimal portion of its surface is at any time being scanned by the human eye.

I have now described the object which came under my observation. I shall not attempt to classify it. Whether it belongs to the mammalia, reptilia, or pisces, whether it be ophidian, cetacean, or saurian, I must leave it to the naturalist to determine. I am no stranger by the sea. A love for its beauty and grandeur, in calm and storm, as well as a fondness for the study of its teeming life, both animal and vegetable, minute as well as gigantic, has led me to spend eighteen summers upon its very verge. This experience makes me sure that no one who saw what I did would ever entertain the suggestion that it was a school of porpoises, a grampus, or a horse-mackerel. Because some have been deceived by these, or a floating spar, or a mass of seaweed, it does not follow that others have not seen a genuine monster. Professor Silliman in his *Journal of Science*, says: "We are ourselves not skeptical. We do not see how such evidence as was presented by Dr. Jacob Bigelow, in our second volume, can be set aside." Professor Agassiz informs us that "it would be in precise conformity with analogy that such an animal should exist in American seas. I see no chance to doubt that some huge animal with outward form much like a serpent did sometimes visits these shores."

Professor Richard A. Proctor writes: "Naturalists have been far less incredulous than the general public. We confess we do not well see how such a chain of probabilities can be readily set aside." Professor Gosse says: "Are not the facts sufficiently weighty to restrain us from rejecting so great an amount of testimony? I express my own confident persuasion that there exists some oceanic animal of immense size which has not yet been received into the category of scientific zoölogy." Professor J. G. Wood remarks that "it does require some courage to face the alternative of being either ridiculed as an ignorant fool, or denounced as a contemptible imposter, but such is the ordeal through which all have to pass who venture to say that they have seen the sea-serpent."

There are many grains of truth in this assertion, yet I have never regretted that I offered my report to the public; for I am confident that the time will come when its candid judgment will be assured of the existence of this denizen of the deep.

— Granville B. Putnam, *in the Congregationalist.*

A Singular Accident.

The following communication from an engineer of experience will prove interesting to those engaged in the construction and management of boilers:

Editor Locomotive:

I take the liberty to send you an account of an accident which occurred on the 13th inst. at this place, and which would, no doubt, have resulted disastrously had not prompt action been taken. It is the first case of the kind I have met with or heard of in an experience of twenty-three years, and I believe it will interest you and be a warning to engineers and firemen:

"On the 13th inst., while getting our engines in operation, the fireman, in great excitement, came to me and said that the steam gauge on one boiler indicated 90 lbs., and the boiler was blowing off heavy. On reaching the fire-room found 100 lbs. by the gauge on this boiler, and only 80 lbs. on the others. We closed all drafts at once, and on examination found stop-valve open, and the correct weight on safety-valve lever. Here was a puzzle. From a previous examination of the stop-valve I knew that if the plug came off the stem it could not jam in its seat. The weights were now nearly all removed from the safety valve, and the pressure (which had once reached 110 lbs.) was rapidly reduced, and an examination of the stop-valve showed the plug had *worn* so as to drop off of the stem and had *turned up on its edge*, choking up the horizontal pipe leading to the drum."

The valve is a 6″ angle; flanged on to the riser, safety-valve 4″; boiler 6′ x 18′ 74 4″; tubes, one of a battery of six.

The above teaches, 1st, that the common form of stop-valve is dangerous; 2d, a 4″ safety-valve is not a safety-valve when applied to a boiler of the above dimensions; 3d, the great advantage of having a reliable pressure-gauge on each boiler of a battery.—

F. B. C., Atlanta, Ga.

A Narrow Escape.—While the boiler inspector of the Hartford Boiler Insurance Company was examining the boiler, which had been lying unused all summer in the cellar under Post's drug store, on Main street, this morning, an explosion occurred, which came near costing the inspector his life. He was about to enter the boiler through the man-hole, which had been left closed since last spring, and a quantity of foul gas had collected in the boiler. As the inspector raised the cover and put a lighted candle into the opening, there was an explosion, throwing him from the top of the boiler to the floor, and filling the cellar with smoke. Had the inspector entered the boiler before the explosion, in his own words, "there wouldn't have been much left of him." As it was he was terribly burned about the face and hands, and shaken up by his fall.—*Exchange.*

This should be a warning to all inspectors, not to enter a boiler, especially if it has been out of use for some time, until they have satisfied themselves that there is no foul gas within. This can be ascertained by cautiously introducing a lighted candle.

"An Annihilating Explosion."

We clip the following account of an explosion which recently occurred in Alabama from the Mobile *Daily Register* of October 26th. The explosion was of such violence that we are unable to fully agree with the opinion expressed, that there was but a barrel or so of water in the boiler. Such a quantity would have been quite inadequate to produce the results described.—Ed. Locomotive.

On Sunday a member of the *Register* staff visited the site of the Davis mill explosion, which took place on the 19th inst., near Lambert's Station, on the Mobile and Ohio Railroad, five miles below Citronelle, and two miles above Beaver Meadow. He considers it the most remarkable explosion of the age. The boiler, a large and old-fashioned one of the double flue style, was literally demolished and blown away, a small section of one flue five or six feet long being all that was left on the ground. Every brick composing the furnace was blown entirely away, leaving the ground over which the boiler had sat as naked as an unoccupied barn floor. Small fragments of the boiler were found one-fourth of a mile away, and where they had fallen in grassy places they had set the grass on fire, showing that the boiler must have been intensely hot at the time of the explosion. The engine and a portion of the smoke-stack was about all the iron left at the site of the mill. The large fly-wheel was entirely demolished and blown away, with the exception of one arm and two or three feet of rim. Men cutting logs about one-fourth of a mile away saw a piece of the boiler high above them, whirling round and round in the air like a bit of paper carried up by the wind. When it had fallen they went to it and extinguished the burning grass around it.

The reporter got his information from Mr. John Fitzgerald, an employee of the mill, who was himself seriously hurt by the explosion, but is recovering. He says the mill had been stopped for an hour or more, and had just been started when the explosion took place. He thinks the fly-wheel had made only two revolutions, and is of the opinion that the boiler must have been red-hot, with but a barrel or so of water in it. The first cold water thrown in by the pump set it off.

As to the condition of the boiler before the explosion the reporter knows nothing. The few fragments of it found show the iron to be considerably granulated, and he is of the opinion that this granulated and brittle condition of the iron may explain why the boiler was so completely blown into small fragments. Of the past history of the boiler he knows a good deal. He is told that it was in use in Mobile before the war, and he knows it has been in use about Citronelle and down about Grand Bay (where its owner once moved it) for about 18 years. Until recently purchased by Mr. Dan Davis, it belonged to Mr. L. D. Ramey, who, five years ago, freely expressed himself as feeling that it was not entirely safe.

A Large Barometer. — The largest barometer in this country is that contrived by Zophar Mills at his office, 146 Front Street, New York. So far as Mr. Mills knows, his is one of three glycerine barometers in the world. There is one in London and one in Scotland. Mr. Mills has had a glass tube drawn thirty-one feet long and with an outside diameter of one and one-fourth inches. The inside measurement or bore is just an inch. It was hoisted to the roof of the Front Street building, and a hole large enough to admit the tube was bored through the roof and down through the several floors to the cellar. The tube was carefully lowered through this hole and suspended by a brass collar against the wall in Mr. Mills's office, which is on the second floor. The lower end of the tube hangs in a cistern filled with glycerine in the floor of the cellar. The advantages of Mr. Mills's big barometer are these. It is so big that slight variations can be read at sight and can be seen from a distance and at a glance; the variation in movement is not only great but it is quick, and Mr. Mills thinks his big barometer will give a hint of coming storms two or three hours before a mercurial barometer will show a depression. — *Springfield Republican.*

We clip the following from *The Master Mechanic:*

Legal Responsibility of Employers for Accidents to Employees from Dangerous Machinery. — The master's obligation is not to supply the servant with absolutely safe machinery, or with any particular kind of machinery; but his obligation is to use ordinary and reasonable care not to subject the servant to extraordinary and unreasonable danger. When a master employs a servant to do a particular kind of work, with a particular kind of implements and machinery, the master does not agree that the implements and machinery are free from danger in their use, but he agrees that such implements and machinery, to be used by such servant, are sound, and fit for the purpose intended, so far as ordinary care and prudence can discover, . . . and the servant agrees that he will use such implements with care and prudence. If under such circumstances, harm or injury come to the servant, it must be ranked among the accidents, the risk of which the servant must be deemed to have assumed when he entered into such service. . . . Neither companies nor individuals are bound, as between themselves and their servants, to discard and throw away their implements or machinery, upon the discovery of every new invention which may be thought or claimed to be better than those they have in use; but if they take ordinary care and exercise ordinrry prudence to keep their implements or machinery in sound repair, so that harm does not result to the servant for want of such sound condition of the implements or machinery used, then such individuals or companies will not be responsible to servants for any injury which may occur to them in the use of such implements and machinery. — *Lake Shore & M. S. R. Co. vs. McCormick*, 74 *Ind.*, 445.

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The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

NEW SERIES—VOL. VII. HARTFORD, CONN., NOVEMBER, 1886. No. 11.

Boiler Explosion at a Nail Works.

The following article appeared in the *Iron Age* of July 18, 1878. Thinking it would interest our readers, we reproduce it here, with additional illustrations.

OFFICE OF THE HARTFORD STEAM BOILER INSPECTION & INS. CO.

Diagram No. 2 will give an idea of the relative position of the boilers which exploded. They were plain cylinder boilers, 36 inches in diameter, and 30 feet long, made of $\frac{1}{4}$-inch iron. They were supported upon iron columns and suspended over puddling

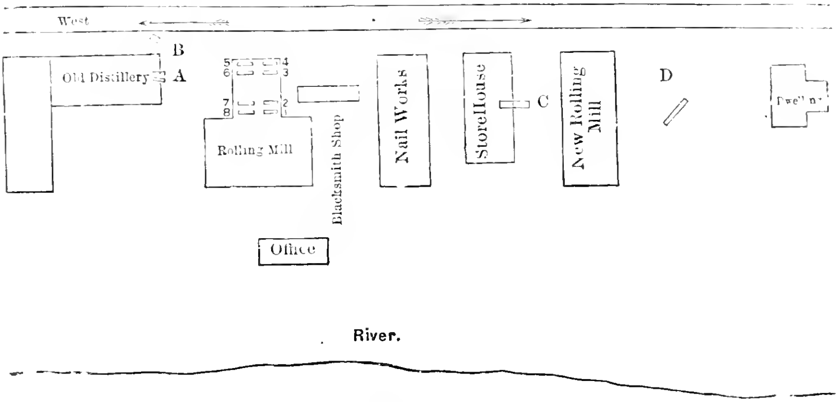

FIG. 1.

furnaces in the usual manner. The heaters and puddlers performed their duty below, while the water feeder occupied a platform above. The flues of the boilers marked (Nos. 1 and 2) had been repaired, the brick-work being out of order, and had been out of use for several days. On the morning of the 25th of June (about 3.35 o'clock) the boilers marked Nos. 1, 2, 7, and 8 exploded with terrific force, completely demolishing the wing of the rolling mill in which the boilers were located and doing other and serious damage, as will be explained further on. The explosion occurred in the interim of a change of "turns." The night hands had all retired, and only a few of the morning "set" had arrived. Had the explosion occurred fifteen minutes later the loss of life would have been appalling. As it was, the water-feeder, who was on his platform attending to his

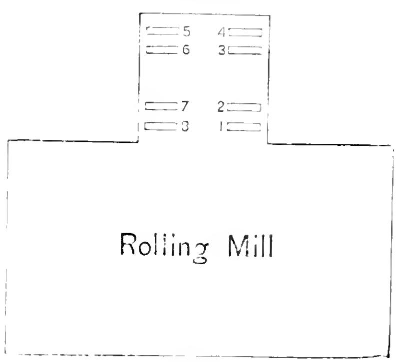

FIG. 2.

duty, as is believed, was instantly killed, and several others were seriously and two fatally injured. Diagram No. 1 shows the relative position of the buildings and the direction of the flight of the boilers. A great many theories have been advanced as to the cause of the explosion, as is usually the case. From a careful examination of the fragments of the boilers, no indications of special weakness could be found. The iron was thinned slightly on the bottom of the boilers, but not sufficient to cause any apprehension on account of the pressure used. The boilers were not overworked and were not strained. They were examined externally and internally twice each year, and no persons were more ready to have every defect, even the slightest, looked after and repaired at once, than their owners. The portion of the boiler marked C, near the store-house, had somewhat the appearance of burned iron from an external examination. The color of the

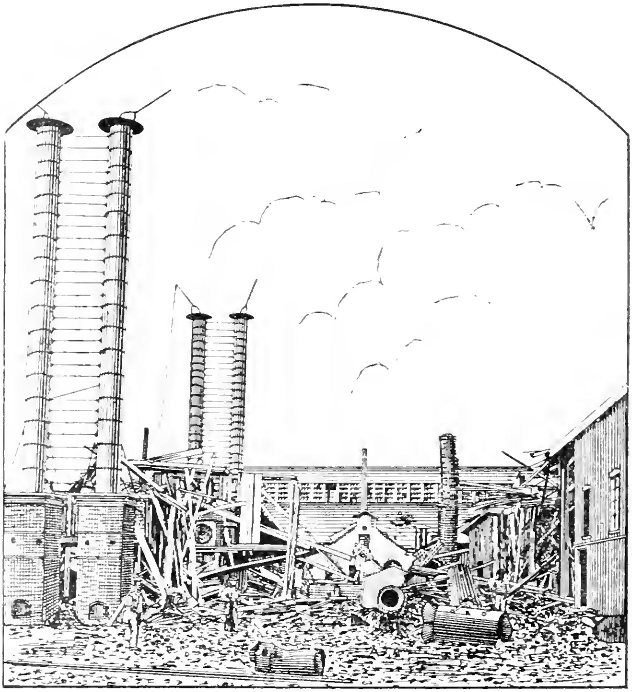

FIG. 3.

iron indicated that the water had been low, if not entirely out. Tests made by breaking the iron showed, however, a good degree of strength, and the fracture, while a little brittle and dull, did not indicate so great a deterioration as one would infer from a surface examination. I have said above that the brick setting of the boilers 1 and 2 had just been overhauled. During this time they were of course cold and out of use. On the morning of the 25th of June the puddling furnaces were started up, and steam was being raised on the boilers. It was the custom when boilers were blown down for repairs to move the weight on the safty-valve lever in, and when the boilers were again put under steam to move the weight out to the point of maximum pressure. I should have said that all these eight boilers were connected with one main steam pipe. Just what the water-feeder did while on the platform will never be known, but I am of the opinion that he opened the connections of boilers Nos. 1 and 2 before the steam in them had arrived at maximum pressure, or near it. The greater pressure of steam outside would cause a violent rush toward the point of least pressure, and a disturbance might be occasioned which would be sufficient to rend a boiler in pieces. Now, if in addition to this the water-feeder had neglected to fill the boilers with water when the furnaces were started, and was engaged in that business at the time of the explosion, no other cause need be sought. What gives some probability to this theory is that a wrench which he was accustomed to use for such purposes was found near his body after the explosion.

Boiler No. 1 appears to have exploded first, and started off its companion No. 2. The breaking of steam connections caused such a sudden release of pressure that Nos. 7 and 8 were sent flying off toward the old distillery, a stone building with walls 2 feet or more thick. They tore a large hole in the wall and were left projecting out as indicated

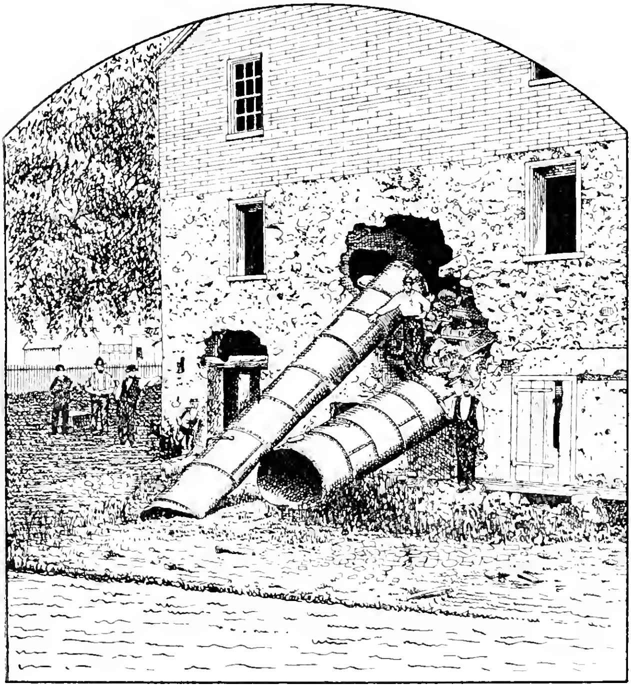

Fig. 4.

at A, diagram No. 2. Boiler No. 1 passed along by the blacksmith shop, taking off part of its cornice; it then passed through the roof of the nail mill, and declining somewhat crashed into the store-house, through several piles of kegs of nails and out through an 18 inch brick wall, resting as shown at C. Boiler No. 2 sailed not less than 60 or 75 feet into the air, passing over the nail works and storehouse, crashed through the ventilator of the new mill, fell into a vacant lot, rebounded and landed near a private dwelling. Its position when found is shown at D. It is not often that such destructive explosions occur. But they go to show that the best-managed establishments are liable to destructive accidents sometimes.

Too much importance cannot be placed upon the matter of opening the steam ways between boilers which are under different pressures. Serious accidents not unfrequently occur from carelessness in this matter. The openings should be made very gradually, the steam being almost or quite "wire drawn" until equilibrium is established. The man who had charge of feed and steam connections had been in the employ of the company for many years, and is said to have been a sober, careful, and faithful man. After careful examination I became satisfied that no blame could be attached to the proprietors. These boilers were insured by this company. They were inspected about six months before the explosion, and our inspector was in the neighborhood at the time of the explosion, with a view to making arrangements for another inspection. I should have

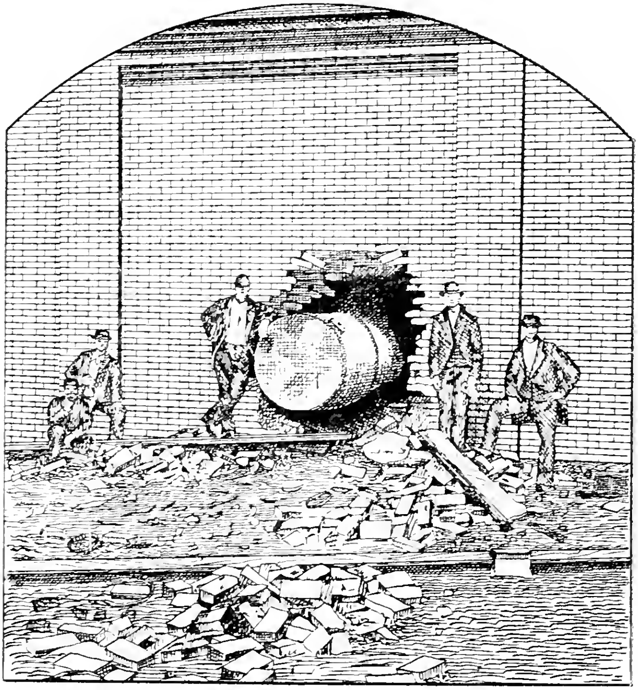

FIG. 5.

said that boilers 3, 4, 5, and 6 remained undisturbed, with their stacks perpendicular and in good condition. This is a strange fact, when we consider that the portion of the mill in which they were located was entirely demolished.

J. M. ALLEN, *President*.

It is proper to state that the loss by the above explosion, when adjusted, amounted to $9,500, and was paid as soon as the amount of damage was arrived at.

Inspectors' Reports.

SEPTEMBER, 1886.

There were made during the month of September last, by the inspectors of this company, 3,669 inspection trips, in the course of which 6,709 boilers were examined, 2,374 were thoroughly inspected, both externally and internally, and 540 others, mainly new boilers, were tested by hydrostatic pressure. 6,631 defects were reported, of which 1,039 were considered dangerous, and led to the condemnation of 42 boilers. Our usual detailed statement of defects is given below:

Nature of defects.	Whole number.	Dangerous.
Deposit of sediment,	411	57
Incrustation and scale,	560	58
Internal grooving,	16	8
Internal corrosion,	196	13
External corrosion,	371	24
Broken, loose, and defective braces and stays,	173	23
Defective settings,	190	19
Furnaces out of shape,	259	12
Fractured plates,	109	64
Burned plates,	87	20
Blistered plates,	177	15
Cases of defective riveting,	1,912	215
Defective heads,	37	17
Leakage around tube ends,	1,052	355
Leakage at seams,	611	21
Defective water-gauges,	81	23
Defective blow-offs,	42	16
Cases of deficiency of water,	8	4
Safety-valves overloaded,	31	12
Safety-valves defective in construction,	42	10
Defective pressure-gauges,	222	38
Boilers without pressure-gauges,	4	4
Defective man-hole rings,	1	0
Defective hand-hole plates,	7	5
Defective re-enforcing rings,	2	2
Defective hangers,	23	0
Split tubes,	3	3
Defective fusible plugs,	4	1
Total,	6,631	1,039

It is a mistake to suppose that because a man-hole or hand-hole plate is packed with a gasket made of rubber or other yielding material that any sort of surface on the plate and frame or ring is good enough to ensure a tight joint when the plate is screwed up, for it is far from being the case. A man-hole plate and ring should each have a flat, smooth surface, for then a joint can always be made perfectly tight with a minimum amount of screwing up on the plate. Where the frame is uneven it is quite possible to screw up a plate with sufficient force to crack the ring, and some very destructive explosions have occurred from this cause. This is especially apt to occur where the frame is one of the ordinary external kind, for then the weakest part of the frame, owing to the convexity of the shell, is exactly where the greatest strain from steam pressure occurs, and as such frames are generally constructed they are altogether too light to give a proper margin of strength. It should not be forgotten that the cutting out of the shell on top for a man-hole weakens it very much, and the man-hole frame should be strong enough to restore the full amount of strength thus lost. This is best fulfilled by an internal frame, for although the internal frame is much more inconvenient for entering the boiler than the external one its strongest part comes just where the greatest amount of strength is needed, and it should always be used on boilers over thirty-six inches in diameter.

When a joint supposed to be well packed leaks when steam is raised, excessive tightening up of the plate should not be resorted to; the pressure should be relieved, the plate removed, and the joint examined to discover the cause of the trouble.

Hand-holes, although they require no strengthening ring to compensate for the loss of material where they are cut out, should, nevertheless, be very carefully made. Especial attention should be given to making a smooth seat on the interior surface for the gasket to rest against. This is, of course, an easy matter to attend to in new work, but, as often happens, where a hand hole is cut in the back head of an old boiler, and the iron is laminated or of an inferior quality, it is not always an easy matter to make a good job. Under such circumstances it is sometimes nearly impossible to get a smooth seat. When this is the case it is very difficult to pack the joint so that it shall be tight with the ordinary rubber gaskets found in the market. Unless it *is* tight, corrosion very soon completes the bad job already begun, and in many cases a patch on the head has been found necessary. All this may be avoided by the exercise of care and a choice of suitable material for packing.

Boiler Explosions.

SEPTEMBER, 1886.

THRESHER: PORTABLE (128).—The boiler of a steam threshing machine exploded at North Greenbush, N. Y., September 2d, killing David Phillips, owner of the machine, A. Hankle, the engineer, and fatally injuring M. DeFreest, fifteen years of age. The barn in which the machine stood was burned. The boiler was considered unsafe, and the owner was cautioned not to use it a few days prior to the explosion.

——— MILL (129).—At Lou Bacon's camp in Freshwater, Humboldt bay district, Cal., the boiler belonging to a donkey engine owned by the Occidental Mill Company, exploded September —, injuring John Ryan seriously and Andrew Nelson slightly.

SUGAR REFINERY (130).—The North River sugar refinery has six boilers at No. 33 Corlears street, New York. September 1st the tubes and furnace of boiler No. 5 were blown out. The explosion was a very violent one, and James Roach and Francis Kerns, firemen, were badly scalded. The accident was due to weakness of the tubes, and it will take $1,200 or $1,300 to repair damage to the boiler and building. The boiler which was wrecked was a locomotive tubular, twenty-three feet long and sixty-six inches in diameter, made five years ago. It was last tested on June 9th.

LOCOMOTIVE (131).—As the south-bound train on the Ashtabula & Pittsburg Railroad was standing at Ashtabula, Ohio, station, September 4th, the locomotive boiler exploded, hurling the dome one hundred and fifty feet into the air, but doing no other damage.

SALT BLOCK (132).—A boiler in the salt block of J. H. Pearson & Son, Saginaw, Mich., exploded August —. No one was seriously injured, and the damage was but $500.

SAW-MILL (133).—The saw-mill of Hiram Wilkerson, located two miles north of Booneshoro, Mo., was blown to pieces at 1 o'clock P. M., September 3d, by the explosion of the boiler. The engineer, George Bobbitt, was fearfully mangled and his remains scattered about the ground, portions of his limbs having been carried so far that they could not be found. The proprietor was so badly injured that he died the next day. The boiler was not a new one, but was thought to be a good one, and the only theory is an insufficient amount of water. The mill had been in operation all the forenoon, and the accident occurred just as they were attempting to start up after dinner. Mr. Wilkerson's young son, who was near him at the time of the explosion, was blown some d s-tance by the concussion, but escaped serious injury.

Ice Factory (134).— By the explosion of its boiler on the evening of September 2d, the ice factory at Meridian, Miss., was somewhat damaged. The fireman was slightly injured ; no one else hurt.

Locomotive (135).— Just after a passenger train on the Cincinnati, Hamilton & Indianapolis road had entered Indianapolis September 9th, the boiler of the locomotive exploded with such terrific force that not a vestige of the engine was left standing. The cab was carried through the air a distance of three hundred yards and fell in a vacant lot. A piece of one of the driving wheels fell through the roof of a house two hundred yards away, and fragments were thrown in all directions for a distance of two squares. On a neighboring telegraph wire was found, in pieces, the clothing of the engineer and fireman, which had been placed under the seat in the cab. All the tracks and ties under the engine were driven into the ground. The engineer was not on the locomotive at the time of the explosion, and the escape of the fireman, Frank Coburn, was miraculous, as, besides a slight scald about his shoulders, he received no other injury than a severe shock from falling violently after being blown several feet in the air.

Colliery (136).— A boiler at the Philadelphia & Reading Coal and Iron Company's Merriam breaker, Mt. Carmel, Pa., exploded September 15th, wrecking four other boilers, greatly damaging the boiler-house and breaker, and seriously injuring Jacob Shult, John Crow, and Michael Patrick. Five hundred miners will be idle for a week in consequence of the explosion.

Cider-Mill (137).— An explosion of a boiler of an engine used in a cider-mill near Riverton, Ill., September 18th, caused the instantaneous death of Barney Elling and Patrick Kelly, workmen, and severely scalded Harry Williams, son of A. Williams of Springfield, Ill. Elling's body was picked up one hundred and twenty feet, and Kelly's forty feet, from the boiler after the explosion.

Nail Factory (138).— The boiler in the nail factory of the Top mill, Wheeling, W. Va., exploded September 22d, fatally scalding John Emery, the engineer, dangerously wounding several other employees, and damaging the factory.

Locomotive (139).— The engine attached to the Baltimore & Ohio train from New York, due at Baltimore at half-past eight, burst her boiler about a mile outside the city limits, Baltimore, Md., September 26th. The engine was completely wrecked and the baggage and smoking cars telescoped. Fireman Charles Lizer was scalded fatally and Engineer Jeremiah Morningstar was badly injured. Two passengers were slightly hurt.

Print Works (140).— One of the boilers at the American Print Works, Fall River, Mass., exploded with terrific force September 26th. A large hole was blown in the crown sheets, almost directly over the fire box, and the whole force of the explosion was downward, scattering the burning coals in every direction. Some of the woodwork was set on fire, but quickly extinguished. John Harrington, one of the firemen, was badly scalded about the arms, breast, and back. On account of the accident about one-half the works were shut down.

Saw-Mill (141).— The boiler at the saw-mill belonging to David Harvey at Greenwich, Ohio, exploded September 25th. The fireman, Thomas Allen, was instantly killed and others were injured. Mr. Harvey is at a loss to account for the explosion, as the fireman has always been a careful and trusted employee.

Domestic Boiler (142).— By the collapse of a flue in a boiler at the Charlton Club House, 18 West Twenty-fifth street, New York, September 29th, damage to the extent of $1,900 was done. The engineer was somewhat scalded.

The Locomotive.

HARTFORD, NOVEMBER, 1886.

J. M. ALLEN, *Editor.* H. F. SMITH, *Associate Editor.*

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 *cents per year when mailed from this office.*
Bound volumes one dollar each.

To those who put implicit faith in the steam-engine indicator we would say: Be sure your indicator is *right*. Not long since an indicator which had been in use several years was sent to this office, for the purpose of having the springs tested. We found that the vent-holes in the outer body were completely closed by the screwed portion of the inner body to which the cylinder is attached, so that the only outlet for the steam escaping around the indicator piston, was what could leak out through the hole in the cap through which the piston-rod passes. This was entirely insufficient, so much so that the pressure accumulating on top of the piston amounted to from five to eight pounds per square inch at ordinary engine speeds, and with a boiler pressure of eighty pounds per square inch, with the result of course that the pressure shown on the indicator diagram was just that much too low. This may be the only case of the kind that ever occurred, but as this particular indicator, after being used several years, had been sent to the makers, with the request that they put in thorough order, and it had been returned and pronounced all right by them, we believe the chances are good that there *may* be others in the same condition. At any rate, owners of these instruments, especially if they possess but one, would do well to examine them carefully for this or some other source of error.

ANOTHER fraud has been exposed. This time it was "over the water." Some sort of a new fangled engine was said to yield a brake horse power with a fuel consumption of $\frac{8}{10}$ of a pound of coal per hour. A syndicate was of course immediately formed, for the purpose of floating the stock. It has since transpired that the brake was doctored, that is, the brake wheel or rather the lower portion of it was run under water in a pit, ostensibly for the purpose of keeping it cool, but really it seems to conceal a system of springs and other appliances by which the reading of the spring balance showing the pull on the brake when the engine was running was enormously increased. A test with this apparatus removed showed a fuel consumption of something over four pounds of coal per horse power per hour. We presume this affair, like some others of a similar stripe, will now "go west."

IN refreshing contrast to the accounts of the above engine a recent number of *Engineering* contains a full report of trials of a compound non-condensing portable engine which shows excellent results for an engine of its type. The high pressure cylinder was $12\frac{1}{4}$ inches in diameter, the low pressure 20 inches in diameter, the stroke of both being 24 inches. The boiler was of the ordinary locomotive style having 711 square feet of heating surface and $19\frac{2}{10}$ square feet of grate surface. The trial lasted 5 hours, 42 minutes, the average steam pressure was 107 pounds per square inch, the horse-power developed was $109\frac{1}{2}$, the weight of steam used in the engine per indicated H. P. per hour was $24\frac{15}{100}$, the coal burnt per indicated H. P. per hour was $2\frac{56}{100}$ pounds, $9\frac{42}{100}$ pounds of water being evaporated from a temperature of $55\frac{1}{2}$ degrees into steam of the above pressure. Although the duration of the test was somewhat short, yet the results are excellent for a non-condensing portable engine.

THE article on the *Friction of Non-Condensing Engines* by Prof. R. H. Thurston, extracts from which we publish in this issue, is an interesting and valuable contribution to the literature of the steam engine. The entire article with illustrations may be found in the current number of the *Journal of The Franklin Institute*, and will be found worth careful study. Experimental work of this character, accurately done and the results carefully noted without reference to the theoretical deductions of eminent men, is what is needed to extend our knowledge of the actual operations of the steam engine.

On the Friction of Non-Condensing Engines.

BY R. H. THURSTON, ITHACA, N. Y.

[*Extract from a Paper read at the Meeting of the American Society of Mechanical Engineers, New York, November 30, 1886.*]

The assumption of the distinguished engineer, De Pambour, that the wasteful resistance of a steam-engine consists of a constant quantity, the friction of the unloaded engine, increased by some increasing function of the added load, has been accepted as correct by probably all recognized authorities since his time. Calling R_0 the resistance of the engine running free and under no other load than its own friction, and calling R_1 the resistance coming upon it as a useful factor of its work, and making f the coefficient measuring the proportion of increased friction due to the load, the total resistance to be overcome by the engine piston is thus

$$R = (1+f)\,R_1 + R_0 \qquad (1)$$

So far as the writer has observed it has never been questioned whether the quantity f is constant or variable, and no recent attempts have been made to ascertain its value by experiment.

It has long been the intention of the writer to settle this question, which had for years existed in his own mind, and the opportunity has recently been offered to do so, at least as that question affects the modern forms of non-condensing high-speed engines now so generally in use, especially for electric lighting purposes. The first investigation was made at the suggestion of the writer and under his general direction, in the winter of 1883–84, upon a "straight-line engine," exhibited that year at the Annual Exhibition of the American Institute, by the Straight-Line Engine Company of Syracuse, N. Y., and built by them from the designs of Professor John E. Sweet. the inventor of its special features. The work was done with equal care and skill by Messrs. Mitchell & Aldrich, graduates of Stevens Institute of Technology, of the class of 1884. The results were sufficiently exact and satisfactory in every respect to have been made the basis of the conclusions here to be stated; but it seemed to the writer desirable that they should be checked by similar work upon another engine, if possible of a different make, before attempting to state definite conclusions of any kind. The opportunity to secure such a repetition of the investigation was offered, during the past winter, at Cornell University, using a straight-line engine which could be fitted with a brake, and conveniently submitted to test. The engine is of the same make as the first described, but of a different size, and the results of the two sets of experiments are considered to accord so thoroughly as to justify publication. The following are the data and results of these two sets of determinations:

The first of these two engines was built from designs brought out in the year 1880, of which illustrations may be seen in the *Electrician* of December, 1883. As is well known, the engine derives its name from the fact that, in its design, the attempt has been made to take all stresses through straight members, the frame thus being made to consist of two straight compression and thrust members, connecting the cylinder-heads directly with the main pillow-blocks, and giving a characteristic appearance to the whole machine. The valve-gear is of the "positive" type, the expansion made variable by the introduction of a governor on the main shaft actuating the eccentric, in the manner familiar to all who have seen the more common forms of high speed engines. In the design of this governor, as throughout the whole engine, special care has been taken to provide against the impeding action of friction, the machine being intended to be as nearly frictionless as possible. The engine rests upon three points of support, and thus is not liable to be thrown out of line by any inequalities of foundation or bolting. When tested, the engine to be experimented with was simply set on blocking, and had no foundation; but so well was it balanced, and so perfectly was its alignment maintained, that it ran with absolute smoothness, and as steadily as if it had been given the heaviest foundation possible.

The following are the data obtained from the brake and indicator readings:

Number of Card.	Revolutions.	Steam-Pressure.	Brake H. P.	Indicator H.-P.	Difference.	Friction per cent.
1	232	50	4.06	7.41	3.35	45.
2	229	65	4.98	7.58	2.60	34.
3	230	63	6 00	10.00	4 00	40.
4	230	69	7.00	10 27	3.29	32.
5	230	73	8.10	11.75	3.65	32.
6	230	77	9.00	12.70	3.70	29.
7	230	75	10.00	14.02	4.02	28.
8	230	80	11.00	14.78	5.78	25.5
9	230	80	12.00	15.17	3.17	21.
10	230	85	13 00	15.96	2.96	18.5
11	230	75	14.00	16.86	2.86	17.
12	230	70	15.00	17.80	2.80	15.75
13	231	72	20.10	22.07	2.06	9.
14	230	75	25 00	28.31	3.36	11.75
15	229	60	29.55	33.04	3.16	9.5
16	229	58	34.86	37.20	2.34	6.3
17	229	70	39.85	43.04	3.19	7.4
18	230	85	45.00	47.79	2.75	5.8
19	230	90	50.00	52.60	2.60	4.9
20	230	85	55.00	57.54	2.54	4.4

For the purposes of test, it was fitted with a pair of carefully standardized indicators and a Prony brake. Cards were taken simultaneously from both ends of the cylinder, and readings from the brake were at the same instant obtained. A comparison of the power indicated by the diagrams with that shown by the brake, gave a difference which measured the friction of the engine. During the trial, the engine, when working at its rated power, consumed, according to the indications of the diagrams, 28.2 pounds of steam per horse-power per hour, or probably between thirty-five and thirty-eight pounds, allowing for the loss by cylinder condensation not accounted for on the indicator card, a very excellent performance for an engine of but thirty-five horse-power. The action of the governor was extraordinarily perfect. The engine was adjusted to make 230 revolutions per minute under ninety pounds steam-pressure. The observers reported that it made the same number of turns whether loaded or unloaded, an evident impossibility with a governor of this class, in which only approximate isochronism can be attained. The writer, to settle the question, counted the revolutions, minute by minute, with a hand-speed counter, and made it 230 revolutions with the whole rated load on the engine (thirty-five to forty horse-power), and 231 when entirely unloaded, the brake-strap being loosened until it could be shaken about on the pulley, by the hand, with perfect ease. This was repeated until no question could longer exist in regard to the matter. The variations with variable steam-pressure was greater.

This engine was 8 inches in diameter of cylinder, 14 inches stroke of piston, having a rod 44 inches long between centers, a balanced valve with stroke of 2 to 4 inches, according to position of governor and eccentric, a fly-wheel 50 inches in diameter, weighing 2,300 pounds, the steam and exhaust-pipes having diameters of $2\frac{1}{2}$ and 4 inches, respectively, and the whole machine weighing two and one-half tons. The space occupied by the engine was 9 feet 4 inches in length, by 4 feet 8 inches in width, and 3 feet 10 inches in height.

Examining the above table of powers, it is seen that the difference between indicated and dynamometric power, *i. e.*, the friction of the engine, varies somewhat with varying steam-pressures, and varying total power; but in such manner as to indicate the controlling cause to be irregular in action, and possibly to some extent due to errors of observation and to accident. The maximum is four horse-power, the minimum about two horse power. The usual difference is about three and the variations are irregularly distributed throughout the whole range of experiments. It is evident at a glance that the law of De Pambour does not hold, and that it is much nearer correct to say that the friction of engine is constant as otherwise. The column of friction, as given in percentages of the total power, exhibits the same fact. There is continual, though somewhat irregular, reduction of the percentage of friction, throughout the range from the lowest to the highest power, and very nearly inversely as the power exerted. . . . . It is evidently more nearly correct to assert that the friction of a non-condensing engine of this class is constant, and independent of the total power developed, than to accept the rule of De Pambour. The power for which the engine is proportioned is thirty-five to forty horse-power. At this power, the friction of engine is but about six per cent. of the total, or less than one half that assumed by De Pambour, and accepted as correct by Rankine, for engines generally, and presumably for locomotives especially. The result is exceedingly gratifying, and the friction seems to the writer extraordinarily low for so small an engine.

The repetition of the experiment upon an engine of another make, having a cylinder 9 inches in diameter and a stroke of piston of 12 inches, which would naturally give a somewhat increased percentage of friction, in consequence of the proportionally smaller stroke, at twenty, thirty, fifty, and sixty-five horse-power, by brake, and running free, revolutions 300 per minute — a speed which may also have caused some increase in frictional resistance, not only in rubbing parts, but by increasing back pressure — gave a friction of engine measuring from 2.66 horse-power unloaded, to four horse-power at twenty to thirty horse-power, 4.8 horse-power at fifty, and 5.3 at sixty-five horse-power, the total friction increasing perceptibly, as assumed by De Pambour, but decreasing in percentage of load, from 16 to 7.5, between twenty and sixty-five horse-power. It is very nearly constant throughout the whole range of power that the engine would be worked through under ordinary circumstances, and may be so taken without serious error; while the adoption of the Pambour formula would give a value of f' so small that its use would not be attended, ordinarily, with sufficient increased exactness to compensate the additional trouble involved in its application. At their rated powers the two engines thus exhibit efficiencies of mechanism of about ninety-four and ninety per cent. respectively.

The second series of experiments were made by Messrs. W. A. Day and W. H Riley, at Cornell University, during the latter part of last college year, confirming the deductions already given, while some very interesting and original modifications were made in the details of method and trial. The engine taken for test was a machine recently built, and sent to the Cornell University, for purposes of experimental investigation in electrical measurement and other work of the college. It is an engine 7 inches in diameter of cylinder and 12 inches stroke, or, more exactly, $6\frac{1}{2}$ inches in diameter, the cylinder having been bored slightly under size. The general plan of the engine is similar to the first of those already described, and, like that, is carefully designed with a view to reducing friction to a minimum and giving a regulation of maximum efficiency. The brake was precisely like that used in the first described experiments, and was built for the engine constructed in the college work-shops, under the direction of the inventor, and exhibited at the Centennial Exhibition in 1876. It was constructed by the Straight-Line Engine Company, and adapted, with very little alteration, to the new engine. The indicators were carefully standardized and put in good order in every respect, by the makers, for the purposes of these investigations. The reducing mechanism used in connecting the indicator barrel to the cross-head of the engine was designed and built by the observers, and fitted with a very firm connecting arrangement, and with an ingenious detaching device. . . . . A sector was constructed which was pivoted above the cross-head and hung in the vertical plane above the latter, the engine being horizontal. The arc of the sector carried a pair of steel ribbons, one attached to each end, each carried around the arc and secured, at its opposite end, to the end of a bar fastened on the cross-head in such manner that, the two ends of the ribbons at the cross-head bar being well secured and tightly drawn up by means of screws placed conveniently for the purpose, all back-lash was prevented, and an absolutely exact synchronism of movement of indicator-line and cross-head was obtained. The engine was driven at 285 revolutions per minute, and it was, therefore, very important that this rigidity of connection should be secured. A smaller sector at the upper part of the larger one was the carrier of the cord, and the combination was thus a perfect means of reproducing the motion of the engine on the smaller scale required in working the paper-barrel of the indicator. The "cord" was piano-wire, a material much less liable to cause difficulty by stretching than any other that was available. Its free part was kept taut by a "spiral" (helical) spring, attached beyond the point of connection with the paper-cylinder.

In the first of these experiments, as already described, Thompson indicators were used; in those about to be considered, Crosby instruments. It was hoped that the new Tabor indicator could be used also, but none were received in time. The instruments used worked perfectly, and gave no trouble from beginning to end. The speed indicators were of several kinds. Hand instruments of two or three kinds were used to check the records of the automatic instruments. A "tachometer" was attached and belted to the engine-shaft, and afforded a very convenient means of watching the momentary fluctuations due to variations of load, of steam-pressure, and to accidental disturbances. A chronograph was also attached, connected with the standard clock in the physical laboratory, to beat seconds. A commutator was placed on the engine-shaft, making contact at each revolution, and a key near the engine, for the purpose of breaking contact. A Brown mercury speed-indicator served excellently well for a constant speed-indicator. It exhibited instantly any variation of speed from the normal. The chronograph was set in operation when the indicator-cards were taken, and thus gave the exact speed of the engine at that instant. Great care was taken to keep the instruments, and the engine as well, in good order and well lubricated throughout the series of experiments. Some stiffness of the governor, however, the cause of which was not discovered until after the work had been completed, caused it to work less perfectly than in the engine first used, and the speed varied more than in that series of determinations. When the governor was in its most perfect adjustment, the engine was capable of holding the standard speed within a fraction of one revolution throughout a wide range of work, and nearly down to the lowest power that such an engine is at all likely ever to be called upon to supply.

(To be continued.)

(From the *Engineering and Mining Journal.*)

On Blast-Furnace Slag and Slag Cement, as Compared with Portland Cement.*

BY DR. C. SCHUMANN.

The investigations detailed in this paper were undertaken with the view of ascertaining what amount of importance may be attached to blast-furnace slag or slag cement as an ingredient of mortar, especially as compared with Portland cement. Hard, vitreous slag is almost devoid of hydraulicity, even when finely pulverized, and the same may be said of the powder that results from the spontaneous disaggregation of certain kinds of slag. Where, however, the slag is granulated, that is, chilled in water, it hardens under water when mixed with lime. Such granulated slag has recently been ground with lime and other ingredients, and sold under the name of "pozzolana cement," although the term "slag cement" would be more correct. In order to test the accuracy of statements that had been made respecting such cement, a quantity was obtained and subjected to examination. In making the comparative tests with Portland cement, care was taken to use both materials of the same degree of fineness; the mortars were also of the same consistency, and were rammed into the molds by a mechanical rammer, so as to secure uniformity. No expansion was found to take place with slag cement mortars; but cracks, due to contraction, were noticed in the test cakes.

In testing the porosity of slag cement mortars, the cement was mixed with three times its weight of standard sand, and moulded into cakes 0.59 inch (1.5 centimeters) thick. These were allowed to harden for seven days, either under water or in moist air, and were then subjected to a water pressure of 16.4 feet (5 meters) for a week, the surface exposed to the water pressure being 3.87 square inches (25 square centimeters). When allowed to harden under water, the slag cement mortar allowed 0.0976 cubic inch (1.60 cubic centimeters) of water to pass, while the Portland cement mortar remained water-tight. The slag cement cakes that hardened in moist air allowed 0.366 cubic inch (6.05 cubic centimeters) of water to pass, while the Portland cement cakes showed a filtration of 0.11 cubic inch (1.8 cubic centimeters).

The slag cement sets very slowly — in from twelve to twenty hours — and after the initial set has taken place, the increase in strength is much slower than with Portland cement. In seven days, the strength of a mortar composed of three parts standard sand and one part slag cement was 93.87 pounds per square inch (6.6 kilograms per square centimeter), as compared with 248.22 pounds per square inch (17.1 kilograms per square centimeter) attained by Portland cement mortar of similar composition. The crushing strength of the 1 to 3 mortar was 1522.73 pounds per square inch (107.2 kilograms per square centimeter) for the slag cement, and 2056.02 pounds per square inch (200.8 kilograms per square centimeter) for Portland cement; both after remaining twenty-eight days under water. When exposed to the air for fourteen days, after having been immersed for a similar period, the difference between the two cements was still more marked. The tensile strength of the Portland cement was 516.30 pounds per square

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* From the *Deutsche Bauzeitung,* through Proceedings of the Institution of Civil Engineers.

inch (36.3 kilograms per square centimeter), as against 182.06 pounds per square inch 12.8 kilograms per square centimeter) for the slag cement. When a larger proportion of water was used in making the briquettes, the difference became still more marked. While Portland cement increased its strength 64 per cent. under these conditions, as compared with an immersion period of twenty-eight days, slag cement lost 18 per cent. of the strength that it would have attained if kept under water for the whole of the twenty-eight days. This is regarded as a point of great importance in building operations.

[Notwithstanding the faint praise that Dr. Schumann vouchsafes to blast-furnace slag, it has been very favorably reported on by good authorities, and the production of this article is increasing with enormous rapidity. The German iron-masters were not slow to take advantage of this invention, by which they can utilize at least a part of these slags, which at present cost them so much to take care of, with no return, and it will not be long before a slag cement works will be considered as a necessary adjunct to the ordinary blast-furnace plant. We already learn of one concern, which after running a small trial works for about a year, has now under construction a plant capable of turning out 40,000 tons of slag cement every year. — EDITOR ENGINEERING AND MINING JOURNAL.]

Dimensions of the Bartholdi Statue.

	Feet.	In.
Height from base to torch,	151	1
Foundation of pedestal to torch,	305	6
Heel to top of head,	111	6
Length of hand,	16	5
Index finger,	8	0
Thickness of index finger,	1	9
Circumference at second joint,	7	6
Size of finger nail,	13 x 10 in.	
Head from chin to cranium,	17	3
Head, thickness from ear to ear,	10	0
Distance across the eye,	2	6
Length of nose,	4	6
Right arm, length,	42	0
Right arm, greatest thickness,	12	0
Thickness of waist,	35	0
Width of mouth,	3	0
Tablet, length,	23	7
Tablet, width,	13	7
Tablet, thickness,	2	0
DIMENSIONS OF THE PEDESTAL.		
Height of pedestal,	89	0
Square sides at base, each,	62	0
Square sides at top, each,	40	0
Grecian columns, above base,	72	8
DIMENSIONS OF THE FOUNDATION.		
Height of foundation,	65	0
Square sides at bottom,	91	0
Square sides at top,	66	7

The statue weights 450,000 pounds, or 225 tons.

The bronze alone weighs 200,000 pounds.

Forty persons can stand comfortably in the head, and the torch will hold twelve people.

The number of steps in the statue, from the pedestal to the head, is 154, and the ladder leading up through the extended right arm to the torch has 54 rounds.

A Stenographer Turned with a Crank.

Professor Tainter, at the Bell laboratory, recently gave a private exhibition of his curious invention, the graphophone, reports a correspondent of the Philadelphia *Times*. The machine is an improvement on the Edison phonograph. It is of the simplest construction, consisting, apparently, of a small brass cylinder and a couple of rubber-bound wheels connecting with another smaller brass shaft and operated by a small balance wheel, with a thumb crank. On the larger cylinder or shaft is placed a close-fitting tube, covered with wax and paraffine. On the lower shaft, which is about four inches distant from and parallel with the other, is cut a fine screw thread. On this rests a gutta-percha tube, the lower end fastened to a socket piece, which fits to the threads, the upper end resting lightly on the wax cylinder. Close inspection shows that the upper end of this gutta-percha tube has a small lancet-like knife, and this connects by fine silk thread with a vibrating diaphragm. To this diaphragm, which corresponds to the drum of the ear, is attached a speaking tube about a foot long, in the flaring end of which the operator talks.

As he speaks he turns the wheel, the wax cylinder revolves, and the threaded shaft carries the gutta-percha lever along, the lancet cutting a fine thread in the wax corresponding with the spiral thread. The depth of the cutting is regulated by the force of the sound waves on the diaphragm through the thread connection. As soon as the operator has concluded speaking, the tube or receiver is removed and a sounding tube substituted. The lancet tube is set back at the beginning, the wheel turned and the knife running through the same lines of the wax gives back the same sounds.

The professor read from a newspaper in a natural tone of voice, and the same tone was repeated loud enough to be heard by every one in the room. He then talked in a rich Irish brogue, with the rising and falling inflection, and the instrument repeated it as many times as it was ground over. Then Mr. Maguire, Professor Bell's private secretary, sang "Annie Laurie" to it, the sweet strains being given off afterward at the will of the operator. The voice of the singer and every peculiar intonation would have been recognized by those who had ever heard him sing.

The utility of the graphophone is its use as an amanuensis, doing away with a stenographic expert. The receiver may be a mere copyist. He or she sits in front of the instrument and writes out from it as fast or slow as the occasion and rapidity of the writer may require. The wax thread cut on the cylinder is a matrix, from which the sound can be taken at any time. The cylinder has a basis of paper and can be mailed and the talk produced anywhere from a similar machine. Newspaper dispatches may be dictated and taken from it by the telegraph operator without going through a stenographer and written out. This machine is about as big as the early hand sewing machines that were fastened to a table.—*The Paper World.*

A Story of the Toilet.—It is reported of a pretty Parisienne who was in the habit of "whitewashing herself, so to speak, from the soles of her feet to the roots of her hair with chemically prepared cosmetics," that she took a medicated bath one day, and emerged black as ink. Horrified she sent for her doctor. On seeing her he laughed as though he would never stop, but at last found voice to say:

"Madame, you are not ill, you are a chemical product. You are no longer a woman, but a 'sulphide.' It is not now a question of medicinal treatment, but a simple chemical reaction. I shall subject you to a bath of sulphuric acid diluted with water. The acid will have the honor of combining with you; it will take up the sulphur, the metal will produce a 'sulphate,' and we shall find as a 'precipitate' a very pretty woman."

The doctor went through with his "reaction," and the "belle" was restored to her membership with the white race.

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

NEW SERIES—VOL. VII. HARTFORD, CONN., DECEMBER, 1886. No. 12.

Explosion of the Boiler of a Threshing Machine Engine.

The illustrations herewith presented are from photographs taken under the directions of a special agent of this company, of the parts of an exploded Threshing or Agricultural Engine. The boiler, having the engine at its left side, was of the locomotive type, and

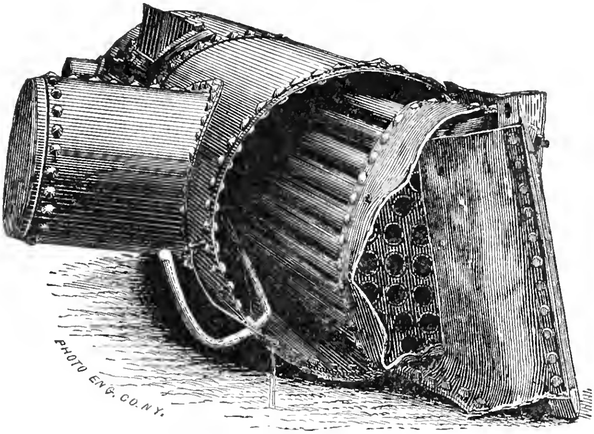


FIG. 1.

was mounted on a truck. It was built in the year 1878, of one-fourth inch iron plates, and intended to be worked at a pressure of about eighty pounds per square inch, had a steam dome, and contained thirty-nine tubes two inches diameter, by about five feet

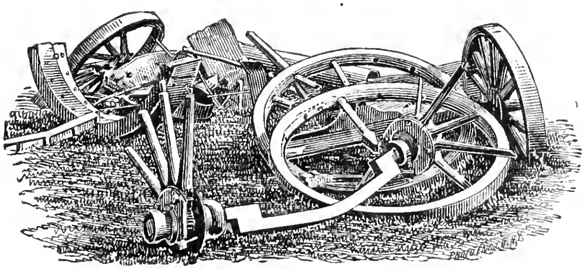


FIG. 2.

long. The owner, who was also the engineer, had started a brisk fire on the second day it had been in use — had gone to breakfast, and on his return, while steam was, or had been, blowing off, he was engaged in oiling his engine, standing upon it or the truck wheel, when the explosion took place. His body was blown high in the air, and found scattered in an adjoining orchard, where it arrived over the tops of the trees, leaving his entire apparel in the top of the tree nearest to the spot where the engine stood. Three other persons were injured, two of them seriously.

Fig. 1 represents the principal part of the boiler, with dome and tubes, which was thrown to the rear into the barn where the separator stood, upon which it landed, passing in its flight near two men who stood in the doorway.

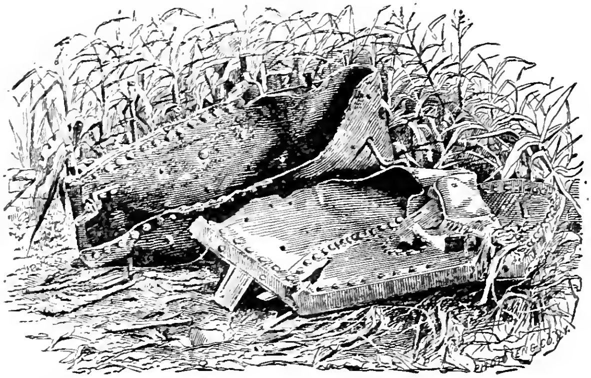


FIG. 3.

Fig. 2 represents the wreck of the truck, the parts of which were collected from different directions and distances, and photographed.

Fig. 3 represents the fire-box and its envelope as it lay where it was found in a corn-field, two hundred yards in the opposite direction from that taken by the principal part shown in Fig. 1.

The engine was found in a field in an opposite direction nearly from that taken by the unfortunate owner. One of the inducements offered to purchasers by the builder of this machine was, that *no skilled engineer* would be required to take charge of it, as it could not get out of order, or words to that effect.

Inspectors' Reports.

OCTOBER, 1886.

There were made during the month of October last, by the inspectors of this company, a total of 3,565 inspection trips. The total number of boilers visited foots up 7,067, of which 2,815 were thoroughly examined, both internally and externally, and 638 were subjected to hydrostatic pressure. The whole number of defects reported were 7,463, of which 1,053 were considered dangerous. Fifty-two boilers were considered unfit for further use and were condemned. The defects in detail are shown by the following table:

Nature of Defects.	Whole Number.	Dangerous.
Deposit of sediment,	456	43
Incrustation and scale,	725	67
Internal grooving,	33	9
Internal corrosion,	176	16
External corrosion,	306	32
Broken, loose, and defective braces and stays,	334	43
Defective settings,	165	17

Nature of Defects.	Whole Number.	Dangerous.
Furnaces out of shape,	180	15
Fractured plates,	157	79
Burned plates,	86	22
Blistered plates,	200	12
Cases of defective riveting,	2,166	177
Defective heads,	42	13
Leakage around tube ends,	1,274	347
Leakage at seams,	688	37
Defective water gauges,	103	22
Defective blow-offs,	55	10
Cases of deficiency of water,	8	6
Safety valves overloaded,	30	16
Safety-valves defective in construction,	29	13
Defective pressure-gauges,	227	50
Boilers without pressure-gauges,	6	5
Defective man-hole rings,	2	1
Defective hangers,	13	0
Defective fusible plugs,	1	0
Split tubes,	1	1
Total,	7,463	1,053

The choice of a material for man-hole gaskets cannot be too carefully made. The material should be yielding, elastic, tough, and these qualities should not be very much affected by the temperature of steam at ordinary pressures. It should be yielding, because this property enables it to adapt itself to any trifling inequalities of the seat or surface of the plate, thereby insuring a tight joint with a minimum of trouble. It should be elastic, to enable the gasket to accommodate itself to slightly different sizes and shapes of man-holes of the same nominal size. It should be tough and strong, as this is most important to prevent serious accident, and if it is affected but slightly by a temperature of, say, 350° F., a gasket may, if care be exercised, be used repeatedly, which is quite an important item when there are several boilers and the water is so bad as to necessitate frequent opening for cleaning purposes. Such gaskets can be procured without much trouble; but, to tell the truth, those lacking most, if not all, of the above desirable qualities are much more readily obtained. We have before us, as we write, a portion of a gasket which came very near causing serious trouble, a short time since. Owing to its weak and incompressible nature a portion of one of the man-hole gaskets blew out, and the shock was so great when it let go, that all the seams of the shell were so sprung that it was necessary to calk them, and the tubes were loosened so that they had to be rolled before the boiler could be used again. The boiler was an excellent one, or the probability is that it would have been ruptured and an explosion would have resulted from the shock. It is very likely that many explosions have resulted from this cause alone.

Boiler Explosions.

OCTOBER, 1886.

STEAMBOAT (142).—The steamer *La Mascotte*, a passenger boat plying between St. Louis and Cape Girardeaux, a hundred miles down Mississippi, exploded her boilers October 5th, at Neely's Landing, Mo., a point remote from telegraph communication. Thirty lives are so far reported to have been lost.

STEEL WORKS (143).—The boiler in the Bolton Steel Works, Canton, O., burst October 6th, wrecking several of the small buildings connected with the works. Two hammer men, William Marshall and Robert Templeton, were buried in the ruins, but fortunately, were only slightly injured. A fragment of the boiler was carried 400 feet away, and crashed through the brick wall of the Diebold Safe Works. There was a pressure of only twenty pounds of steam, and the cause of the explosion is a matter of conjecture. The loss is about $10,000.

QUARRY (144).—At about 7.15 A. M., October 15th, the boiler in the engine-house of Stephen N. Maloney, in the Quarry district, West Quincy, Mass., exploded and set fire to the engine-house, which was totally destroyed. Loss on building and machinery, $1,000.

SAW-MILL (145).—The boiler of D. Davis saw-mill at Citronelle, Ala., exploded Oct. 19th, killing one white man, William Bailey, and a negro, James Roberts, and wounding two men and a boy. The cause was lack of water.

SAW-MILL (146).—The steam mill operated by William Haney and Moss Hoffman, Kenton, Ky., blew up October 22d, killing Haney instantly, and scalding Hoffman so that there is little hope of his recovery. Both men were married and had large families.

ROLLING MILL (147.)—Harper's Rolling Mill, in Newport, Ky., was the scene of the wildest excitement October 18th, caused by the bursting of a steam boiler. The shaking-up occurred a few minutes before 7 o'clock, just as the day force commenced work. The noise with which the boiler let go was heard for squares around, and many of the buildings in the neighborhood got a severe shaking, and in a very few minutes after the explosion crowds blocked every avenue to the mill. The explosion occurred in one of the battery of six boilers, two of the sheets being blown out, and bent back almost double against the other portion of the boiler, allowing the steam to escape with such force as to blow the entire roof from the building. Fortunately no one was in the least hurt, although workmen surrounded the battery on all sides. The escaping steam went directly upwards, and the flying bricks and mortar passed over the men's heads. The boiler must have been well rusted and worn with age, Captain John Link, of the Fire Department, having run the identical battery over twenty years ago, and it was then by no means a new boiler. The break in the boiler occurred below the water line, and the engineer, Henry Otte, is of the opinion that it was caused by a flaw in the iron. The damage can be repaired for $300.

BOTTLING WORKS (148).—The boiler attached to the engine at Kloos & Bauer's bottling works on Main and Third streets, Nebraska City, Neb., blew its head out, October 22d, doing considerable damage. The accident was not attended by any personal injury. The boiler was an old one but supposed to be in good condition. It was an upright affair, the head screwing on. The thread of this screw became rusty and worn and failed to stand the pressure. Bauer was standing with his hand on the water valve at the time, and five or six men were close by; that all escaped injury is hardly short of miraculous. The head went through the roof and fell about twenty five feet east of the house. The smoke stack was blown over the two-story building adjoining, striking the ground about sixty-five feet from where it started. It knocked a chimney to pieces in its passage. The roof is badly damaged and the entire loss will be $300 or $400.

SAW-MILL (149).—The boiler operating D. S. Calvin's saw-mill, Orville, Ala., exploded October 19th, completely wrecking the shelter, throwing the boiler a distance of twenty or thirty yards in the middle of the public road. A portion of the timber fell upon Mr. Calvin, and the escaping steam badly scalded him on the back. He managed however, to disengage himself, and looking around beheld his engineer, Willis Pettaway, buried in the debris. Disabled as he was, Mr. Calvin endeavored to assist Pettaway, and others coming up who had been attracted to the spot by the explosion, the unfortunate man was extricated, but expired in a few moments. The escaping steam scalded Mr. Calvin's three-year-old child from head to foot, so badly that he died in a few hours. After Mr. Calvin and his child were borne to the house, fire broke out where the remains of the mill stood, and everything thereabouts was consumed, including the gin-house and all the cotton stored in it, besides corn and other articles.

Saw-Mill (150).— The boiler of John Fisher's portable saw-mill exploded on Henry Saylor's farm, near Long's Corner, Pa., October 25th, injuring four men. Calvin Scheetz, the engineer, was blown through the engine-house roof into the trees overhead, and landed in a pile of saw-dust. Scheetz was scalded from head to foot, his head was lacerated, and the leaders of one leg are broken. His condition is precarious. His home is at Richland, Lebanon County. Cyrus Zerbe, sawyer, of Womelsdorf, had his back hurt, and is injured internally; probably fatally. Henry Strohm of Newmanstown, and Howard Bagenstone of Chester County, were slightly bruised and scalded, while Andrew Arnold of Newmanstown, escaped injury, though his cap was knocked from his head by a piece of the fly-wheel. The boiler burst with great force, and the report was heard three miles away. Portions of the engine were thrown a distance of 140 yards. The engine and house were completely wrecked.

Cotton Gin (151).— The boiler in the gin-house on H. L. Fletcher's plantation, near Little Rock, Ark., exploded October 28th, blowing the engine-house to atoms, and killing Frank Waters, and fatally wounding his wife. George Chandler, his wife, and four others were seriously burned. The parties had just arrived, and were warming themselves preparatory to going to work, when the explosion occurred.

Fire-works.

Since the first anniversary of the Fourth of July, Yankee ingenuity has made more improvement in the art of pyrotechnics than the Chinese in all the 4,000 years since their alleged discovery of gunpowder, and this year is particularly prolific in popular novelties. Water fire-works are entirely new. There are flying fish, and "diving devils," which skip and dive and finally explode most beautifully. Flying pigeons on wire 200 feet long scoot through the air discharging stars forward and backward, and at the same time having a rotary motion. But the most amusing of all are balloons of animal figures. These are very large and made of strong tissue paper in the shape of elephants, fishes, and pigs. These are easily heated and are warranted to ascend a mile. The sky is expected to be full of these laughable shapes. Great ingenuity is expended on those cheap toys which the peddlers sell. There are three of these which contest the youthful favor this year — the bomb dart, the cup and ball, and the dynamite fiend. The bomb dart is a slender piece of wood with arrow wings at one end. The other end is loaded and covered with a movable sheet-iron disk which receives a mammoth cap. The dart can then be accurately hurled at short range. The cap explodes with a loud report. The cup and ball consists of an iron cup with a wooden handle. The cup has a slight orifice at the bottom which receives a blank cartridge, and then the ball is pushed home. The end of the cartridge is then struck on a convenient stone and the ball is sent flying forty feet in the air. The dynamite fiend is the invention of a genius. A hollow sectional figure is held together by an elastic spring, a fire-cracker is placed inside and then a movable head with the most wildly contorted features, fits tightly on the fuse of the cracker, coming through the mouth. When the cracker explodes the head is shot toward the sky, and the figure undergoes a series of frightful spasms. All these attractions sell for the uniform price of five cents, and they disappear by the gross.—*The Mechanical Engineer.*

The Locomotive.

HARTFORD, DECEMBER, 1886.

J. M. ALLEN, *Editor.* H. F. SMITH, *Associate Editor.*

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 *cents per year when mailed from this office.*
Bound volumes one dollar each.

IF our Naval Department is obliged to send to England for plans for war vessels, we shall soon expect to see their Naval Department sending over here for plans from us, for judging from the tone of the English press their navy is in a very poor condition. England has spent money enough on her war vessels to have some magnificent ones in her fleet, as doubtless she has, but we hazard the prediction that the value of heavy iron-clad ships of war will, in a very short time, be simply nothing. The submarine torpedo boat is the vessel of the future, against which these heavy lumbering iron clads will be simply powerless, and money spent in their construction, or in the construction of very heavy guns will be wasted. When the boat is perfected which can remain under water for two hours, and which can be driven to any desired point under water and there leave a torpedo, then the day of heavy vessels is past. Already such progress seems to have been made in this direction that success seems to be an assured fact.

THE article on Boilers for high Steam Pressure in our October issue has brought out several inquiries from intending purchasers as to details of construction, limit of pressure allowed in different cases, kind of material &c., to which we would say: that our specifications, furnished gratis to our patrons, and to none others, give full details of materials, strength, quality, and thickness, specify the tests which they must pass in order to be accepted, and also give explicit directions regarding the style and proportions of the riveting, bracing, and all other data necessary to enable the purchaser to obtain a boiler which we can safely guarantee to any reasonable amount, and for any reasonable time.

WE have received the Report of the Sixth Annual Meeting of the American Water-Works Association, held at Denver, Colorado, on the 23d, 24th, and 25th of June last. It is a very interesting document of 135 pages. Among the most interesting papers read and discussed we notice the following: "Self-closing Work, and Rules which should Govern the same," by B. F. Jones, Kansas City, Mo.; "Water Meters, their Setting and Care," by L. A. Taylor, Worcester, Mass.; "Discipline in the Pumping Station," by Chas. B. Brush, Hoboken, N. J.; "Lead Poisoning," by L. H. Gardner, New Orleans, La.; "Fungus, or Mossy Growth in Clear Water," by E. H. Keating, Halifax, Nova Scotia; and "The Relation of Private Water Companies to Municipal Authorities," by J. G. Briggs, of Terre Haute, Ind. The Secretary of the Association is Mr. J. H. Decker, Hannibal, Mo.

WITH the December number of *Van Nostrand's Engineering Magazine* closes it existence as such and becomes consolidated with the *American Railroad Journal.* The consolidated publication will bear the name of the *American Engineering Magazine and Railroad Journal*, and with Mr. M. N. Forney, formerly connected with the *Railroad Gazette* as proprietor and editor, will undoubtedly prove one of the best of our engineering periodicals. The price of the new journal will be three dollars per annum, and the office of publication will be at 23 Murray street, New York.

A few Hints on Warming and Ventilation.

The ideas advanced by some writers on the subject of heating and ventilation of buildings are as strange and crude as their knowledge of the subjects of which they treat is limited. One of the latest of these remarkable productions appears in the current number of the *Popular Science Monthly.* The writer condemns unsparingly, even to the point of denunciation, all methods of warming buildings during the winter season other than by open grates. A large proportion of people, who base their opinions of matters and things on what they read in a general sort of way, without taking the trouble to think for themselves, hold the same opinion, though they would be puzzled to explain why, if asked their reason therefor. The present writer dissents from these views, and for the following reasons.

First : — because it is simply impossible to warm a room of any considerable size by means of an open grate, in our climate. To use a cant phrase, there isn't "business" enough in the grate to do it. The writer of the article above referred to admits this, and says that rooms should be provided with several grates set at different heights from the floor. The absurdity and inconvenience of such an arrangement is obvious at a glance, and requires no further consideration. It would be practically impossible to carry it out even in dwelling houses. To further help out his plan, he would line all his walls and ceilings with polished tin, or some similar bright reflecting metal, to aid in the diffusion of the heat to the bodies of the inmates of the apartment. Decorated houses would be a thing of the past if this idea were carried out.

Second : — because we do not believe that an open grate is the fountain head of health, or even that it is the healthiest arrangement that can be adopted for warming our houses. The great argument used by its advocates is that it insures good ventilation : so it does, but if we leave the grate and chimney just as it is and warm the room by means of a stove, direct or indirect steam, hot water, or furnace heat, we obtain an equally well ventilated room, and one which is warmed in a much more equable, pleasant, and healthy manner. The open grate is the fire which above all others is productive of local draughts ; where these are strong, colds are frequent, it is almost impossible to avoid them and comfort is unknown. A person in such a room is always "burned on one side and frozen on the other."

The proper ventilation of apartments is a subject which should receive the fullest attention. It does not follow, that because a room is warmed by steam or furnace heat, either direct or indirect, that perfect ventilation is impossible ; on the contrary, rooms so heated can easily be ventilated in the best possible manner. One great mistake which is usually made in ventilation is to attempt to draw out the foul air at the top of the room. When the temperature of the external air is lower than the temperature of the room to be ventilated, and the room is warmed by any kind of indirect heating apparatus the foul air should be removed at the *bottom* of the room instead of the top. This is evident from the following considerations. The warm air when admitted immediately rises by reason of its levity to the ceiling where it diffuses itself throughout the upper part of the room and gradually settles down toward the floor. In contact with the floor it is the coolest and also the foulest, and it should therefore be removed at this point. In this case the natural movement of the air in the room as a whole is downward.

When there are no artificial methods of warming, and colder air is admitted from without, as for instance in a large hall filled with people, the most natural way to ventilate would seem to be to admit the air at the bottom of the room, and as it became warmed and vitiated by contact with the audience it will rise toward the ceiling, and should be there removed. In this case the natural movement of the air of the room as a whole is upward.

When these facts are recognized it will be seen that at different seasons of the year, or under different circumstances, the ventilation of the same room may require to be radically changed. This may be effected without difficulty by making two openings or registers into the chimney or ventilating flue, one at the bottom of the room, and one at the top, either of which may be used as circumstances require.

It is a difficult matter to properly warm and ventilate very large rooms or buildings by the indirect system alone, unless the warm air is driven in by a fan, when it becomes much easier. This system is the only one which should ever be used for large schoolhouses, hospitals, and similar buildings. A properly designed system on this plan never fails to give perfect results.

A Useful Table for Boiler Attendants and Engineers.

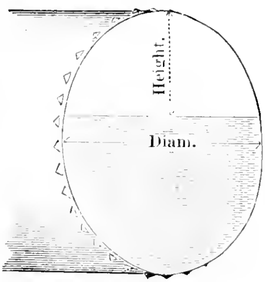
Some simple and convenient method of calculating the volume of the steam or water space in steam boilers is many times of great assistance to engineers and others who are connected with their management; the following table will be found most convenient for this purpose, and with the accompanying explanations will be found most useful.

TABLE OF THE AREAS OF CIRCULAR SEGMENTS FOR DIAMETER = 1.

THE HEIGHTS ARE IN PARTS OF THE DIAMETER OF THE CIRCLE.

Height.	Area.	Height.	Area.	Height.	Area.	Height.	Area.	Height.	Area.	Height.	Area.	Height.	Area.
.001	.000042	.073	.025714	.145	.070329	.217	.125634	.289	.188141	.361	.255511	.433	.325900
.002	.000119	.074	.026236	.146	.071034	.218	.126459	.290	.189048	.362	.256472	.434	.326891
.003	.000219	.075	.026761	.147	.071741	.219	.127286	.291	.189956	.363	.257433	.435	.327883
.004	.000337	.076	.027290	.148	.072450	.220	.128114	.292	.190865	.364	.258395	.436	.328874
.005	.000471	.077	.027821	.149	.073162	.221	.128943	.293	.191774	.365	.259358	.437	.329866
.006	.000619	.078	.028356	.150	.073875	.222	.129773	.294	.192685	.366	.260321	.438	.330858
.007	.000779	.079	.028894	.151	.074590	.223	.130605	.295	.193597	.367	.261285	.439	.331851
.008	.000952	.080	.029435	.152	.075307	.224	.131438	.296	.194509	.368	.262249	.440	.332843
.009	.001135	.081	.029979	.153	.076026	.225	.132273	.297	.195423	.369	.263214	.441	.333836
.010	.001329	.082	.030526	.154	.076747	.226	.133109	.298	.196337	.370	.264179	.442	.334829
.011	.001533	.083	.031077	.155	.077470	.227	.133946	.299	.197252	.371	.265145	.443	.335823
.012	.001746	.084	.031630	.156	.078194	.228	.134784	.300	.198168	.372	.266111	.444	.336816
.013	.001969	.085	.032186	.157	.078921	.229	.135624	.301	.199085	.373	.267078	.445	.337810
.014	.002199	.086	.032746	.158	.079650	.230	.136465	.302	.200003	.374	.268046	.446	.338804
.015	.002438	.087	.033308	.159	.080380	.231	.137307	.303	.200922	.375	.269014	.447	.339799
.016	.002685	.088	.033873	.160	.081112	.232	.138151	.304	.201841	.376	.269982	.448	.340793
.017	.002940	.089	.034441	.161	.081847	.233	.138996	.305	.202762	.377	.270951	.449	.341788
.018	.003202	.090	.035012	.162	.082582	.234	.139842	.306	.203683	.378	.271921	.450	.342783
.019	.003472	.091	.035586	.163	.083320	.235	.140689	.307	.204605	.379	.272891	.451	.343778
.020	.003749	.092	.036162	.164	.084060	236	.141538	.308	.205528	.380	.273861	.452	.344773
.021	.004032	.093	.036742	.165	.084801	.237	.142388	.309	.206452	.381	.274832	.453	.345768
.022	.004322	.094	.037324	.166	.085545	.238	.143239	.310	.207376	.382	.275804	.454	.346764
.023	.004619	.095	.037909	.167	.086290	.239	.144091	.311	.208302	.383	.276776	.455	.347760
.024	.004922	.096	.038497	.168	.087037	.240	.144945	.312	.209228	.384	.277748	.456	.348756
.025	.005231	.097	.039087	.169	.087785	.241	.145800	.313	.210155	.385	.278721	.457	.349752
.026	.005546	.098	.039681	.170	.088536	.242	.146656	.314	.211083	.386	.279695	.458	.350749
.027	.005867	.099	.040277	.171	.089288	.243	.147513	.315	.212011	.387	.280669	.459	.351745
.028	.006194	.100	.040875	.172	.090042	.244	.148371	.316	.212941	.388	.281643	.460	.352742
.029	.006527	.101	.041477	.173	.090797	.245	.149231	.317	.213871	.389	.282618	.461	.353739
.030	.006866	.102	.042081	.174	.091555	.246	.150091	.318	.214802	.390	.283593	.462	.354736
.031	.007209	.103	.042687	.175	.092314	.247	.150953	.319	.215734	391	.284569	.463	.355733
.032	.007559	.104	.043296	.176	.093074	.248	.151816	.320	.216666	.392	.285545	.464	.356730
.033	.007913	.105	.043908	.177	.093837	.249	.152681	.321	.217600	.393	.286521	.465	.357728
.034	.008273	.106	.044523	.178	.094601	.250	.153546	.322	.218534	.394	.287499	.466	.358725
.035	.008638	.107	.045140	.179	.095367	.251	.154413	.323	.219469	.395	.288476	.457	.359723
.036	.009008	.108	.045759	.180	.096135	.252	.155281	.324	.220404	.396	.289454	.468	.360721
.037	.009383	.109	.046381	.181	.096904	.253	.156149	.325	.221341	.397	.290432	.469	.361719
.038	.009764	.110	.047006	.182	.097675	.254	.157019	.326	.222278	.398	.291411	.470	.362717
.039	.010148	.111	.047633	.183	.098447	.255	.157891	.327	.223216	.399	.292390	.471	.363715
.040	.010538	112	.048262	.184	.099221	.256	.158763	.328	.224154	.400	.293370	.472	.364714
.041	.010932	.113	.048894	.185	.099997	.257	.159636	.329	.225094	.401	.294350	.473	.365712
.042	.011331	.114	.049529	.186	.100774	.258	.160511	.330	.226034	.402	.295330	.474	.366711
.043	.011734	.115	.050165	.187	.101553	.259	.161386	.331	.226974	.403	.296311	.475	.367710
.044	.012142	.116	.050805	.188	.102334	.260	.162263	.332	.227916	.404	.297292	.476	.368708
.045	.012555	.117	.051446	.189	.103116	.261	.163141	.333	.228858	.405	.298274	.477	.369707
.046	.012971	.118	.052090	.190	.103900	.262	.164020	.334	.229801	.406	.299256	.478	.370706
.047	.013393	.119	.052737	.191	.104686	.263	.164900	.335	.230745	.407	.300238	.479	.371705
.048	.013818	.120	.053385	.192	.105472	.264	.165781	.336	.231689	.408	.301221	.480	.372704
.049	.014248	.121	.054037	.193	.106261	.265	.166663	.337	.232634	.409	.302204	.481	.373704
.050	.014681	.122	.054690	.194	.107051	.266	.167546	.338	.233580	.410	.303187	.482	.374703
.051	.015119	.123	.055346	.195	.107843	.267	.168431	.339	.234526	.411	.304171	.483	.375702
.052	.015561	.124	.056004	.196	.108636	.268	.169316	.340	.235473	.412	.305156	.484	.376702
.053	.016008	.125	.056664	.197	.109431	.269	.170202	.341	.236421	.413	.306140	.485	.377701
.054	.016458	.126	.057327	.198	.110227	.270	.171090	.342	.237369	.414	.307125	.486	.378701
.055	.016912	.127	.057991	.199	.111025	.271	.171978	.343	.238319	.415	.308110	.487	.379701
.056	.017369	.128	.058658	.200	.111824	.272	.172868	.344	.239268	.416	.309096	.488	.380700
.057	.017831	.129	.059328	.201	.112625	.273	.173758	.345	.240219	.417	.310082	.489	.381700
.058	.018297	.130	.059999	.202	.113427	.274	.174650	.346	.241170	.418	.311068	.490	.382700
.059	.018766	.131	.060673	.203	.114231	.275	.175542	.347	.242122	.419	.312055	.491	.383700
.060	.019239	.132	.061349	.204	.115036	.276	.176436	.348	.243074	.420	.313042	.492	.384699
.061	.019716	.133	.062027	.205	.115842	.277	.177330	.349	.244027	.421	.314029	.493	.385699
.062	.020197	.134	.062707	.206	.116651	.278	.178226	.350	.244980	.422	.315017	.494	.386699
.063	.020681	.135	.063389	.207	.117460	.279	.179122	.351	.245935	.423	.316005	.495	.387699
.064	.021168	.136	.064074	.208	.118271	.280	.180020	.352	.246890	.424	.316993	.496	.388699
.065	.021660	.137	.064761	.209	.119084	.281	.180918	.353	.247845	.425	.317981	.497	.389699
.066	.022155	.138	.065449	.210	.119898	.282	.181818	.354	.248801	.426	.318970	.498	.390699
.067	.022653	.139	.066140	.211	.120713	.283	.182718	.355	.249758	.427	.319959	.499	.391699
.068	.023155	.140	.066833	.212	.121530	.284	.183619	.356	.250715	.428	.320949	.500	.392699
.069	.023660	.141	.067528	.213	.122348	.285	.184522	.357	.251673	.429	.321938	......	......
.070	.024168	.142	.068225	.214	.123167	.286	.185425	.358	.252632	.430	.322928	......	......
.071	.024680	.143	.068924	.215	.123988	.287	.186329	.359	.253591	.431	.323919	......	......
.072	.025196	.144	.069626	.216	.124811	.288	.187235	.360	.254551	.432	.324909	......	......

The table gives the area of circular segments of various heights for a circle whose diameter is unity. The first column marked height is the height of the segment (denoted by the unshaded portion on the upper part of the figure) in parts of the diameter of the boiler. Thus the first number .001 refers to a segment whose height is $\frac{1}{1000}$ of the diameter of the boiler, the second, to one whose height is $\frac{2}{1000}$ of the diameter of the boiler, and similarly for each one-thousandth part of the diameter up to a complete semicircle. $\frac{1}{1000}$ of the diameter of a 6 foot boiler would be the $\frac{1}{14}$ of an inch.



As the area of circles, or similar parts of circles of different sizes are directly proportional to the squares of their diameters it follows that if we wish to find the volume of steam space of any given boiler, for instance one whose diameter is six feet, with water line 2 feet from the top, it will only be necessary to find what part of the diameter, 6 feet, the 2 feet height of steam space is, find the quotient in the column of heights in the table, take out the corresponding area and multiply it by the square of the diameter which in this case would be $6 \times 6 = 36$. Thus : — $2 \div 6 = .333$. In the table the area of a segment whose height is .333 is seen to be .228858. This multiplied by $36 = 8.238888$ square feet for the area of the cross section of the steam space. This area multiplied by the length of the boiler will give the volume of the steam space in cubic feet. In the case of a 16-foot boiler this would be $8.238888 \times 15 = 123.58$ cubic feet.

The table is extracted from Trautwine's *Engineers' Pocket Book* and as it gives results for such small increments of height and contains no errors, it will be found of great value where accuracy is desired.

The volume of water space is easily found by subtracting the area of steam space from area of whole boiler, deducting area of tubes, and multiplying by the length of boiler, as in the former case.

The table will also be found useful when designing boilers in calculating the area of portions of the head above the tubes which require bracing, or for any purpose where it is required to know the area of a segment of a circle.

On the Friction of Non-Condensing Engines.

BY R. H. THURSTON, ITHACA, N. Y.

[*Extract from a Paper read at the Meeting of the American Society of Mechanical Engineers, New York, November* 30, 1886.]

(Concluded from page 173.)

The mean effective pressure required to drive the engine itself, loaded and unloaded, throughout the whole range of the trials here made, was 4.55 pounds per inch of piston, and was nearly constant, as in the first investigation. The steam-pressure usually ranged between sixty-five and seventy-five pounds per square inch at the steam-chest; but, when it was desired to secure a more easily worked-up card, the pressure was dropped to twenty pounds. A series of special experiments made to determine the question whether the friction of engine is variable with boiler-pressure, although not in all respects satisfactory, indicated a slight increase in engine friction as steam-pressures rose. The conclusion already arrived at by the writer, as deduced from the work previously done, that the engine-friction, in this class of steam-engine, is constant, or sensibly so, under all loads is thus here again confirmed. The following are the data obtained, arranged as before, to exhibit the relation of the indicated to the dynamometric powers:

1. No. of Card.	2. Rev. per Minute.	3. Steam-Pressure.	4. Brake-Power. H.-P.	5. Ind. H.-P. per Card.	6. Diff. Frict. H.-P.	7. Mean F. Press.	8. Frict. per cent.
1	282	19	0	2·26	2·26	3 70	100
2	288	65	4·87	8·43	3·56	5 56	42
3	286	66	7 61	10·95	3·33	5·25	30
4	284	65	10·30	12·93	2·89	4·13	20
5	285	71	13·10	15·99	2·61	4·25	18
6	284	76	15·80	18·79	2·99	4·71	16
7	284	74	18·55	20·73	2·65	4·18	12
8	280	67	21·00	23·73	2·73	4·37	11
9	279	65	23·61	25·95	2·33	3·73	9
10	280	75	26·39	29·95	2·36	5·38	11
11	280	72	29·03	32·22	3·19	5·15	10

The first glance at column 6 or at column 7 of the above table, in which the horse-power absorbed by the friction of the engine, and the mean effective pressure corresponding to that power are presented, shows that, as already concluded, the resistance of this class of engine at constant speed, is practically constant at all loads, and that the differences and irregularities observed are due to accidental causes. The variation of speed recorded here is in some cases due to differences of steam-pressure, partly purposely produced, and partly coming of the fact that it was necessary to take steam as it could be obtained, and was impracticable to secure steady pressure, and in other instances was due to the fact, afterward discovered, that the governor had been adjusted in such a manner as to be slightly cramped, and thus deprived of its wonderful sensitiveness and accuracy, as exhibited before this defect had been introduced, and after it had been remedied. Chronograph records, made later by Professor Anthony, exhibit the most extraordinary smoothness.

Number of Cards.	Rev.	St.-Press.	I. H.-P.	Mean Press.	Mean F. Press.	Per cent. Frict.	
1	250	25	6 01	10·84	1·95	18	Ten pounds on the brake.
2	271	39	6·52	10·85	2·71	27	
3	285	42	7·17	11·35	3·63	32	
4	280	46	7 08	11·60	3·59	31	
5	271	58	6·81	11·28	3 16	28	
6	289	63	7·85	12·25	4·65	38	
7	286	68	7·77	12·25	4·90	40	
8	283	77	7·88	12·47	3·74	38	
9	296	82	7·87	12·00	4 68	39	
10	275	71	2·10	3·46	3·46	100	
11	279	66½	1·995	3·22	3·22	100	No load on the brakes.
12	277	44	1.708	2·78	2·78	100	
13	275	35	1·71	2·80	2·80	100	
14	275	30	1·613	2·64	2·64	100	
15	272	25	1·876	3·11	3·11	100	
16	270	19	1·724	2·88	2·88	100	
17	270	15	1·712	2·86	2·86	100	

These variations of speed served the useful purpose of calling attention to the fact that the engine-friction varied, at constant load and speed, with variation of steam-pressure, and to a very noticeable amount, within the usual range of pressures met with in practice. It is seen that, in rising from nineteen to seventy-six pounds steam-pressure, the pressure demanded to give the engine its normal speed unloaded, ranged from below four to above five pounds per square inch of area of piston, the pressure required in the cylinder rising, on the whole, though irregularly, as steam-pressure rose. In order to determine whether this, which might prove to be a hitherto unobserved law, were true, the foregoing data were obtained by a series of experiments made for the purpose of settling this new question.

In the first set of experiments, here numbered 1 to 9, inclusive, the weight on the brake-arm was kept constant at ten pounds; in the remaining experiments, all weight was removed. In both sets, the same general effect is seen. As the steam-pressure rises, the speed being the same and the resistance the same, the friction of the engine increases; from two pounds, at twenty-five pounds pressure in the steam-chest, to nearly five pounds per square inch of piston at the maximum, eighty-two pounds steam in the valve-chest. As the steam-pressure fell from this point to fifteen pounds in experiments 9 to 17, the load being thrown off entirely and the speed being nearly constant, the mean pressure measuring the friction of engine falls again below three pounds per square inch of piston. The difference is considerably less in the last series than in the first, which apparent discrepancy is accounted for by the fact that the variation of steam-pressure in the first series was accompanied by a greater change of speed of engine than in the second. The resistance is seen to increase slowly, therefore, with increase in speed of rotation. The effect of change of pressure is, in these cases, more marked than that of alteration of velocity of the engine.

After a survey of this work, it may be asked, How does it happen that rise in steam-pressure produces evident increase of the frictional resistance of the engine? It was long ago shown by the writer, and is now well established by many independent investigations, that, with good lubrication, increase of pressure on a journal gives decreased coefficients of friction, and this would seem to show that the friction of engines in which the resistance caused by friction is mainly due to journals and lubricated surfaces, should become less as pressures increase, the useful load and the speed of engine remaining constant. This query is a very natural one, and is based upon a correct statement of fact, however inconsistent it may seem to be with the results above derived. The cause of the apparent discrepancy is attributable, probably, to the variation produced by the action of the governor in the distribution of steam. It will be seen that the effect of increase of steam pressure is to cause acceleration of speed of engines, a change essential to produce the action of the governor at all, and that it results in the readjustment of the set of the valve, in such manner as to cause the greater proportion of the nearly constant amount of work performed to be done more nearly at the commencement of the stroke, at a point in the orbit of the crank-pin at which the work is mainly lost by friction, and to reduce the proportion of total work done at or near the "half-center," where it is principally useful. The proportion of useful to lost work is thus varied in such manner as to give a mean final result which is the less favorable as the steam-pressure is higher, and the cut-off shorter, giving a higher ratio of expansion. It is also evident that, if this explanation is correct, the difference here noted will be less as the point of cut-off approaches and passes the half-stroke position of piston and cross-head. Could the valve be set with negative lead for all positions at the point of cut-off, as is considered right by some experienced engineers, the work would be more nearly performed at positions removed from the "dead points," and the variation here described would be thus reduced, while the efficiency of the engine would be increased.

Professor Rankine proposed the formula:

$$R = R_1 (1 - f) \tag{2}$$

This formula is evidently inadmissible, at least for the class of engine which was made the subject of the experiments which have been described. Since the friction of engine is, so far as can be here seen, sensibly independent of the magnitude of the load and of the resistance produced by it, the correct formula would seem to be

$$R = R_1 + R_0 \tag{3}$$

the total resistance met at the piston being the sum of the resistance of the engine itself and that of the load, being both determinable, both being independent, and being governed by entirely different laws.

The conclusions to be drawn from what has preceded are obviously the following:

(1.) The friction of the non-condensing engine of the class here described, is sensibly constant at any given speed at all loads, and is at different speeds entirely independent of the magnitude of the load.

(2.) The friction of engines of the type described is variable with variation of speed of engine, increasing as speed increases, in some ratio as yet undetermined, but probably different with every engine, and, for the same engine, with every change of conditions of operation.

(3.) The friction of engines increases with increase of steam-pressure, in the case of the class here referred to, in a probably similarly variable manner with that observed with alteration of speed, neither method of variation being capable of representation by any convenient algebraic expression.

(4.) The total resistance measured at the piston of the engine is composed of two parts, the one sensibly constant at the working speed, the other variable with external load, and may be, for practical purposes, at least, represented by the expression,

$$R = R_1 - R_0,$$

in which R is the total resistance, as shown on the indicator diagram, R_1 the resistance due to the external load: *e. g.*, as measured by a Prony brake, and R_0 the resistance of the unloaded engine, as shown by a "friction-card" taken with the steam-engine indicator.

It is sufficiently obvious that these conclusions are, at present at least, only certainly applicable to one class of engine. It is not improbable that the condensing engine may be subject to quite different laws. It is to be hoped that this question may be settled by direct experiment at an early day. The custom has obtained, hitherto, of allowing a certain pressure per square inch of piston as the equivalent of the friction resistance of the engine in marine practice — this pressure being taken at from two and one-half pounds in the case of engines of moderate size, to one and one-half with the largest engines. It has never yet been ascertained whether, or to what extent, the friction of engine is augmented by the imposition of load. The assumed figure represents from five to ten per cent., usually, of the total indicated power of the engine. Isherwood has taken seven and one-half per cent. of the useful load as the amount of increase of friction of engine due to its action. This estimate is stated to be made on the basis of the data given by General Morin, whose coefficients for friction of lubricated surfaces are now known to be enormously larger than those customarily met with in practice in well lubricated journals of large size working under heavy pressures. In such cases, when the surfaces are in good order, the coefficient is known to fall to below one per cent., instead of being from three to five, as given by Morin, as determined under the different conditions of his experiments. Where the journals are not well lubricated, and especiall when they are rough or cut by abrasion, friction may increase enormously and may pass far beyond the figures given by Morin even; but such exceptional conditions cannot be taken into account to establish laws for application in design, or in good practice. For all cases in which the friction varies, as in the examples here above illustrated, the "friction-card" sensibly represents the correct tare, whether the engine be loaded or unloaded.

A word in explanation of the fact here shown, that the increased load thrown upon the shaft, crank-pin, and cross-head journals does not noticeably increase the friction of engine, will be considered not out of place here. The friction of engine consists of the resistances due to the motion of the various piston, valve, and other rods through stuffing-boxes and in guides, the friction of the piston-rings on the cylinder-surface, the friction of the eccentrics, and often other parts which are independent of the magnitude of the load thrown upon the engine by the useful resistance, in addition to the friction of the journals transmitting the effort of the steam to the exterior resisting work, and of the cross-heads guides and other parts indirectly affected by its variation. It thus happens that the resistance due to the friction of the latter may be, and often is, but a small proportion of the whole friction of engine. The total friction of engine, as has been seen, in engines of the class here studied and of the size described, amounts to about ten per cent. of the total power developed when fully loaded; but the coefficient of friction of any one journal, if well lubricated, has been found by the writer, by hundreds of experiments, under such pressures as are usual on the main journals of the steam-engine, to fall below one per cent., and the absorption of work and energy is thus a still lower proportion of the work of the steam in proportion as the speed of rubbing is less than that of the piston. The loss of power along the line of connection is thus exceedingly small. It should never exceed probably two per cent. of the work done, or between ten and twenty per cent. of the total friction. Again, the coefficient of friction, within the usual range of pressures on these journals and the guides, with good lubrication, increases rapidly as pressures fall, and decreases as greatly when the pressures increase with variation of engine-power and load, and this change often occurs so rapidly that the total frictional resistance, on these parts even, varies very slowly with variation of load, while the friction of the other portions of the engine, above mentioned, remains quite constant. The resultant effect is, as shown by the investigation here described, a practically constant friction of engine under all loads, the speed and steam-pressure being constant. Whether this is true of condensing engines is doubtful, and it would be an important extension of this research could similar investigations be made of the friction of other forms, and especially the marine steam-engine and pumping-engines.

The Hand-Made Controversy.

The editor of the *Paper World* has been experimenting on the qualities of English hand-made and American machine-made paper with the following results:

The controversy over the relative merits of hand-made and machine-made papers has evoked a great deal of theory, but, so far as we have heard, not a bit of experiment to determine with some precision the truth of the matter. There is little use in trying to argue down a hand made craze of any kind, such is the force of the expression, "it's old," or "it's antique," or "it's hand-made," with those who are deficient in good taste, in ideas of utility, and who reverence everything that has mold on it. Against all this and against the popular prejudice in favor of everthing that is manufactured in foreign countries, it is singular that hand-made paper is little used and little known in this country. About half a ton a day of this paper is made in a mill in Adams, Mass., owned by the L. L. Brown Paper Company, but the paper is mostly used for Christmas cards and various art work. No imported hand-made paper is kept in stock here, and, indeed, none is imported, except for special purposes, and the amount of this is exceedingly small.

When *The Paper World*, nearly a year ago, made some disparaging remarks concerning English hand-made record papers as compared with the machine-made papers of Dalton, Adams, Holyoke, and other places, the subject awakened considerable interest, and various opinions were offered here and abroad on the merits of the two papers. With the intention of experimenting on them we lately obtained samples of hand made and machine-made record papers, and tested them for strength, folding, and erasure.

In experiments on the ledger or record papers, the Morrison tester showed substantially no difference between them. A 25-pound paper tested 62 and 65 pounds for the American, and 63 and 53 for the English; a 54-pound American paper tested 71 pounds; English, 76. The Morrison tester could not break any of the other samples of the English paper, it was so stretchy. For the purposes of these experiments we obtained the very best papers made.

But the firmness of the machine-made and the more perfect closing of the fibers, gave it marked superiority over the hand-made in points of more practical excellence. So far as strength goes to resist tearing, either paper would be just as good if it tested half as much as it did.

We took a sheet of 54-pound hand-made paper and folded over a corner, so that there was a crease an inch and a quarter long, then reversed the folding on the same crease and repeated the operation till the folded piece broke off; at each folding the crease was twice pressed down with a bone folder, with considerable pressure, yet without scraping off any of the fibers. In two trials, the English paper broke on the 44th folding in each case. The American paper, when the crease was at an angle of 45 degrees to the principal trend of the fibers, broke on the 114th folding; when the crease was transverse to the principal fibers, there were 121 foldings; when parallel to them, 61. So that the folding most unfavorable to the American paper made a showing nearly 50 per cent. better than the English. The result of another folding of both these papers varied but slightly from those mentioned.

In erasure, too, the firmness of the American paper was telling. A 56-pound paper suffered erasure of ink writing in the same place nine times, and the knife tore through on the tenth time; in this case the erasure was at right angles to the principal direction of the fibers. When the erasure was made parallel to the fibers, the knife broke through on the eleventh time; and, just before breaking through, the paper held its texture so well that it looked like very fine lace work, the numerous interwoven fibers showing minute interstices. The English paper gave promise of doing as well until the seventh erasure, when the inferior closing of the fibers prevented another erasure. Pains were taken in all these experiments to observe the same conditions — to make the same ink lines and without pressure of the pen; to have a very sharp knife, the sharpening of which was renewed each time; and to forbear pressing the knife edge against the paper more than absolutely necessary.

While the hand-made paper shows no point of superiority over the machine-made, and in folding and erasure is inferior (though erasure would never go far enough to show this, in use), there are other points of practical inferiority, as well as folding. In binding the hand-made paper the sheets are very apt to cockle, which is a great annoyance, and wherever the paper is pulled or put under tension, baggy places are formed. This is finely shown by the Morrison tester, which can only now and then break a hand-made paper, on account of its great stretching. A sample of American machine made ledger paper broke at 78 pounds, while the hand-made paper of the same weight stretched like rubber, though without its elasticity.

Again, the hand-made paper is not uniform in thickness, as the other paper is. The Morrison tester, applied to the English paper, tested 53 and 63 pounds in two places only eight inches apart on the same sheet. So far as the question is English versus American, we may add that the English samples have none of that perfect whiteness of the American papers, nor so fine an appearance when held up to the light. A person with no prejudices against either paper would at once choose the American machine-made paper on its good looks, and, in its use, considerations of utility would confirm his choice. Notwithstanding the fact that the fibers lie more one way than another, the machine-made paper takes the prize.

A Fierce Struggle in a Creek.

Sunday morning, October 10th, Henry Boland, a harvest hand on Dennis Warren's big farm four miles north of Andalusia, Ill., started for a neighbor's to borrow some axle-grease. On the way he had to cross Warren's creek, which runs through the farm into Rock river. Boland reached the middle of a long and heavy plank which spans the creek just below the farm-house, when he noticed a young boar acting strangely on the opposite bank, not far from the end of the plank. The animal was grunting angrily and backing rapidly around a willow near the creek. Boland stepped on the plank, and in a few moments discovered that the cause of the animal's excitement was a big rattle-snake lying on the side of the tree away from the stream. The snake evidently recognized a deadly enemy in the boar and was cautiously preparing for action. It deliberately twisted itself into as small a coil as possible, and, from the slowness of its movements, seemed bent on being the attacked and not the attacking party. The boar also apparently preferred the defensive. He backed half way around the tree again and grunted defiantly, but made no aggressive move. The rattler lay perfectly still. Its head was in plain view, and Boland could see its eyes following the boar's movements. The boar continued his skirmish around the willow, always within easy striking distance from the snake, but sometimes half hidden by the tree. This continued for two or three minutes.

At length, just as the greatest portion of the boar's body was hidden from the snake, Boland saw a slight palpitation of the rattler's coil. As the young boar wheeled in full view again, the big reptile rose straight in the air, trembled aloft for an instant, and then with a vicious hiss and rattle, struck for the boar like a flash of lightning. Sudden as the attack was it did not seem unexpected by the boar. He dodged back, squatting upon his haunches, with surprising agility. The snake's head shot past his snout, barely missing it. Boland then became aware of the purpose of the boar's tactics in backing around the tree. The animal had evidently expected the rattler's strike to carry the snake clear into the creek, when the current would have carried it away. In this the boar was disappointed, for the snake, although long enough to have landed in the water, fell with a thump on the end of the plank upon which Boland stood. But the boar was up and at it with a rush. Before the snake could recover from the momentum of its strike the young boar seized its tail. As his teeth closed upon it the rattles crunched like beans in a coffee-mill. The boar's advantage was but momentary, however. Turning with amazing rapidity, the snake struck his antagonist in the side three times in less than a second. Another blow struck the boar full in the right side of the head. He squealed with pain, but gave no sign of weakening. Again and again he charged at his adversary, snorting viciously, and beating the ground with his hoofs in an endeavor to trample the snake under foot. At the same time he made frantic efforts to get the rattler's body in his teeth. Twice he seemed to have a firm hold of the snake. Each time the rattler wriggled itself clear of the dangerous tusks, all the time showering blow after blow upon nearly every part of the boar's body. The battle waged fiercely in this way for several minutes. Finally the boar made another desperate rush at his opponent, and this time his tusks passed through the snake's body. He held on like a bull-dog and shook his head back and forth wickedly. The rattler writhed and flashed through the air like a whiplash in his efforts to assail some vulnerable point in the boar's anatomy. It was no use. The boar clung to him with a death-like grip, and after a few seconds' struggle, the rattlesnake's body was completely torn asunder just above the middle. Even then the snake made several attempts to strike its venom where the boar would remember it; but the plucky young boar disposed of his ugly antagonist in short meter, tearing the rattler's body apart with his teeth, and finally stamping the life out of the hissing head. When Boland examined the tail portion of the snake after the battle, he found eighteen big shining rattles. The boar's first onslaught must have destroyed two or three more, so that the snake, which Boland thinks was fully seven feet long, must have been a very old one.

The farm was formerly overrun with rattlesnakes so that the cattle were frequently killed by them and the hired men occasionally had narrow escapes, and four or five were bitten to death in as many years. About twelve years ago, however, a drove of hogs was turned loose in the fields. Hogs have a particular antipathy to rattlesnakes, and in a month they had driven every reptile from the farm. Snake bites never have the slightest effect on hogs, and a half hour after Sunday's contest the young boar that killed his rattleship was wallowing in the yellow mud of Warren's creek, as sound as a dollar.—*Hartford Times.*