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

The Locomotive.

PUBLISHED BY THE

HARTFORD STEAM BOILER
HARTFORD
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NEW SERIES.
Vol. VI.

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INDEX TO VOL. VI. NEW SERIES.

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NEW SERIES—VOL. VI. HARTFORD, CONN., JANUARY, 1885. No. 1.

Feeding Boilers at the Bottom.

One of the most important things to be considered in boiler construction is the position and arrangement of the feed apparatus, but it is, unfortunately, one of the elements that is most often overlooked, or, if considered at all, only in a very superficial manner. Many seem to think that it is only necessary to have a hole somewhere in the boiler—no matter what part—through which water may be pumped, and we have all that is desired. This is a very grave error. Many boilers have been ruined, and (we make the assertion with the confidence born of long experience) a large number of destructive explosions have been directly caused by introducing the feed water into boilers at the wrong point.

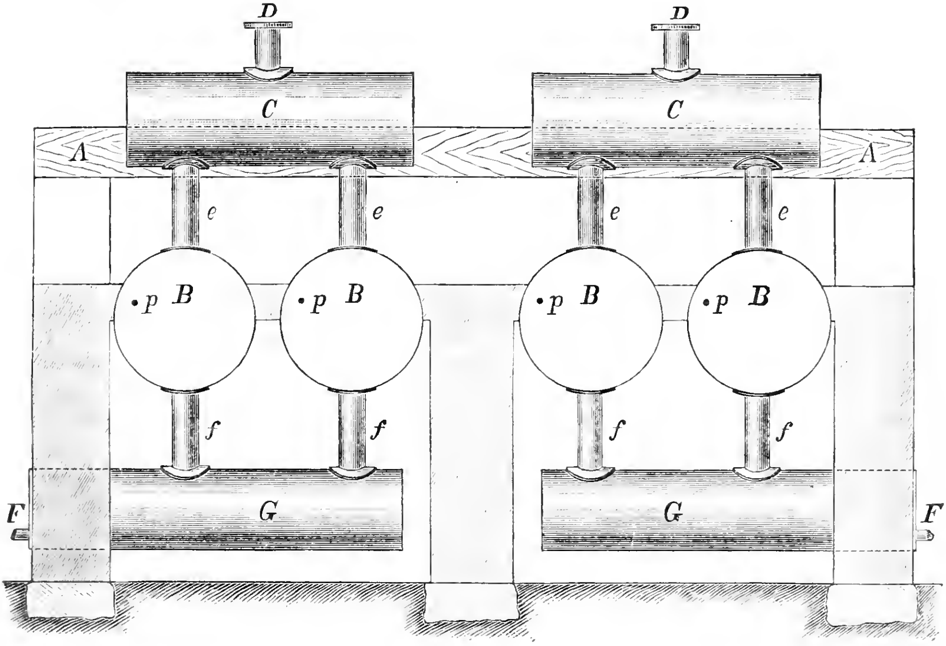

FIG. 1.

On the location and construction of the feed depends to some extent the economical working of a boiler, and, to a great extent, especially with certain types of boilers, its safety, durability, and freedom from a variety of defects, such as leaky seams, fractured plates, and others of a similar kind. And it is unfortunately true that the type of boiler which from its nature is most severely affected by mal-construction, such as we are now speaking of, is the very one which is the oftenest subject to it. We are speaking now more particularly of the plain cylinder boiler, of which there are many in use throughout the country.

Plain cylinder boilers are, as a rule, provided with mud drums located near the back end. As a rule, also, these boilers are set in pairs over a single furnace, and the mud drum extends across beneath and is connected to both, and one end projects through the setting wall at the side. Our illustrations show a typical arrangement of this kind. Fig. 1 shows a transverse section of the boilers and setting, while Fig. 2 shows a longitudinal section of the same. It is a favorite method to connect the feed pipe F to the end of the mud drum which projects through the wall, and here the feed water is introduced, whether hot or cold, and there is really not so much difference after all between the two, for no matter *how* effective a heater may be, the temperature to which it can raise water passing through is quite low compared with the temperature of the water in the boiler due to a steam pressure of say eighty pounds per square inch. The difference in the effect produced by feeding hot or cold water at the wrong place is one of degree, not of kind.

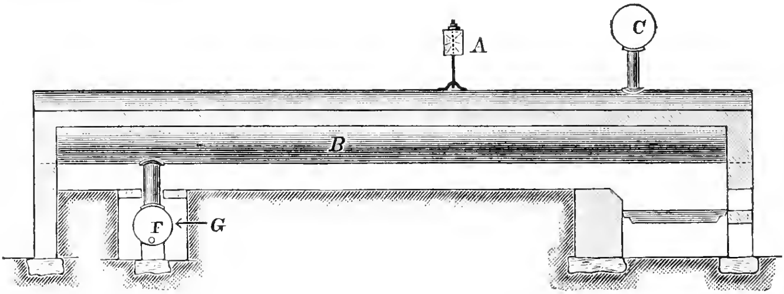

FIG. 2.

When a boiler is under steam of say eighty pounds per square inch, the body of water in it will have a temperature of about 324 degrees Fahr., and the shell plates will necessarily be somewhat hotter, especially on the bottom (just *how* much hotter will depend entirely upon the quantity of scale or sediment present.) Now introduce a large volume of cold water through an opening in the bottom, and what becomes of it? Does it rise at once, and become mixed with the large body of water in the boiler? By no means. It *cannot* rise until it has become heated, for there is a great difference between the specific gravity of water at 60°, or even 212° Fahr., and water at 324°. Consequently it "hugs" the bottom of the boiler and flows toward the *front* end, or hottest portion of the shell. Now let us examine the effect which it produces.

We know that wrought-iron expands or contracts about 1 part in 150,000 for each degree that its temperature is raised or lowered. This is equivalent to a stress of *one ton* per square inch of section for every 15 degrees. That is; suppose we fix a piece of iron, a strip of boiler-plate, for instance, $\frac{1}{4}$ of an inch thick and 4 inches wide, at a temperature of 92 degrees Fahr., between a pair of immovable clamps. Then if we reduce the temperature of the bar under experiment to that of melting ice, we put a stress of four tons upon it, or one ton for each inch of its width.

Now this is precisely what happens when cold water is fed into the bottom of a boiler. We have the plates of the shell at a temperature of not less, probably, than 350° Fahr. A large quantity of cold water, often at a temperature as low as 50° Fahr., is introduced through an opening in the bottom, and flows along over these heated plates. If it could produce its *full* effect at once the contraction caused thereby would bring a stress of $300 \div 15 = 20$ tons per square inch upon the bottom plates of the shell. But fortunately it cannot exert its full effect at once, but it *can* act to such an extent that we have known it to rupture the plates of a new boiler through the seams on the bottom *no less than three times in less than six weeks* after the boilers were started up.

The effect in such cases will always be the most marked, especially if the plant is furnished with a heater, when the engine is not running, for then, as no steam is being drawn from the boilers, there is comparatively little circulation going on in the water in the boiler, and the water pumped in, colder than usual from the fact that the heater is not in operation, spreads out in a thin layer on the lowest point of the shell, and *stays there*, and keeps the temperature of the shell down, owing to the fires being banked or the draft shut, while the larger body of water above, at a temperature of from 300 to 325 degrees, keeps the upper portion of the shell at *its* higher temperature. It will readily be see that the strain brought upon the seams along the bottom is something enormous, and we can understand why it is that many boilers of this class rupture their girth seams while being filled up for the night after the engine has been shut down. To most persons who have but a slight knowledge of the matter, we fancy it would be a surprise to see the persistence with which cold water will "hug" the bottom of a boiler under such circumstances We have seen boilers when the fire has been drawn, and cold water pumped in to cool them off, so cold on the bottom that they felt cold to the touch, and must consequently have had a temperature considerably below 100° Fahr., while the water on top, above the tubes, was sufficiently hot to scald; and they will remain in such a condition for hours.

The only thing to be done where feed connections are made in the manner described, is to change them, and by changing them at once much trouble, or even a disastrous explosion, may be avoided. Put the feed-pipe in through the front head, at the point marked *p* in Fig. 1, drill and tap a hole the proper size for the feed pipe, cut a long thread on the end of the pipe and screw the pipe through the head, letting it project through on the inside far enough to put on a coupling, then screw into the coupling a piece of pipe not less than eight or ten feet long, letting it run horizontally toward the back end of the boiler, the whole arrangement being only from 3 to 4 inches below the water line of the boiler, and hot or cold water may be fed indifferently, without fear of danger from ruptured plates or leaky seams. In short, put in a "top feed" and avoid further trouble.

Inspectors' Reports.

NOVEMBER, 1884.

Below will be found the usual summary of the work of this department for the month of November last. It is interesting and suggestive, as usual.

Visits of inspection made,	2,619
Total number of boilers examined,	5,581
" " internally,	2,121
Boilers tested by hydrostatic pressure,	341
" condemned,	50
Whole number of defects reported,	3,837
" " " dangerous defects reported,	647

The detailed statement of defects is as follows:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	508	52
Cases of incrustation and scale,	521	36
Cases of internal grooving,	23	5
Cases of internal corrosion,	150	18

Nature of defects.	Whole number.	Dangerous.
Cases of external corrosion,	210	30
Broken and loose braces and stays,	60	29
Settings defective,	212	15
Furnaces out of shape,	144	7
Fractured plates,	124	51
Burned plates,	119	31
Blistered plates,	176	18
Cases of defective riveting,	325	71
Defective heads,	44	13
Serious leakage around tube ends,	571	169
Serious leakage at seams,	221	43
Defective water gauges,	111	7
Defective blow-offs,	38	7
Cases of deficiency of water,	11	1
Safety-valves overloaded,	20	7
Safety-valves defective in construction,	17	7
Pressure-gauges defective,	230	30
Boilers without pressure-gauges,	2	
Total,	3,837	647

The *safety-valve*, as its name would seem to indicate, is one of the most important, if not *the* most important fitting that a boiler can be provided with, and it would seem that the most ordinary regard for life would be a sufficient incentive for any one who has charge either of the construction or operation of boilers to exercise every precaution that could be suggested or devised to keep it in good working order.

Yet this is not always the case. We frequently find, during the course of our periodical visits, the grossest violations of the simplest rules of mechanical construction and ordinary prudence, and this, too, by men of experience and recognized ability, and from whom we might expect better things.

A few of the many "outs" in the safety-valve line may be mentioned here. One of the most common is the method of connecting up the escape-pipes to safety-valves, whereby they are carried into some flue, or where there are several boilers in a battery, and consequently several safety-valves, connecting them all into one pipe, which leads sometimes into the chimney-flue, and sometimes out-of-doors. We would never advise connections to be made in this manner, for it will be found impossible to tell when the valves leak; or, if they do leak, it is sometimes a matter of considerable difficulty to tell which ones leak, and which don't; and, under these circumstances, neglect is apt to be the rule, and the leakage goes on indefinitely. It should be borne in mind that enough steam will blow through a very small hole in the course of a few weeks to amount to quite a sum of money expended for the coal necessary to generate it.

The best way to run the escape-pipe from safety-valves is to run one from each valve independently. In most cases, these may be dispensed with altogether to great advantage, and steam allowed to blow directly into the boiler-room. If this plan is adopted, more care will be exercised by the attendant with regard to the uniformity of the steam-pressure, and any leakage of valves will be at once noticed, and will be much more likely to be attended to.

We have known of cases where escape-pipes from safety-valves have been run into flues passing over the tops of boilers, and the drip from leakage of the valve dropping down on top of the boiler-shell corroded the plate through in a short time, rendering a patch necessary.

The causes of leakage of safety-valves are, of course, various, but the principal is either bad design or poor construction, bad design being responsible, in the majority of cases for too light casings, which spring in connecting up the valves, or from unequal expansion by heat, etc. Too broad seats are a fruitful source of annoyance, as it is impossible to keep them tight for any length of time, and such valves do not act with that sharpness and precision which is desirable.

Boiler Explosions.

NOVEMBER, 1884.

Paper-Mill (142).—On Nov. 4th a rotary boiler exploded at the paper-mills of Thomas Rice, Jr. & Son, in Newton Lower Falls, Mass., causing a loss of about $2,000.

Sugar-House (143).—The boiler in the sugar-house on the Eames plantation, near Lee Station, La., exploded Nov. 6th. The following were killed: Edward Eden, engineer; W. Booker, John Jones, Henry Nash, Joseph Richards, Paul Richards, James Rees, William Wilson, and Henry Marcellen, all colored. The last two were boys. August Rantz, Oscar Rantz, E. Rantz, and John Fricke were dangerously scalded, and John De Lord, and John McJune received slight injuries. The boiler was bought at second-hand twenty years ago. Large fragments of the boiler went 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. He was killed instantly.

Saw-Mill (144).—The boiler in Crisper's cooper shop, Hudson, Mich., exploded Nov. 13th, and shot across the street into a house, tearing the front completely out, and going inside. Four men were in the shop, and a man and his wife in the house, but not a person was hurt.

Steamer (145).—Steamer Captain Sam, Captain J. English, on her up trip from Selma to Montgomery, on the Alabama River, exploded her boiler near Headnot's Landing, twenty miles below Montgomery, Ala., Nov. 18th. There were twenty persons aboard, four of whom were instantly killed, and one has since died. Those killed were: Katie English, 11 years old, daughter of the captain, and three negro deck hands. Nearly all the others are more or less wounded and scalded. Dobos McNeilly of Antaugaville, Ala., has died since the accident.

Steam Tug (146).—The boiler of the tug-boat James McMahon of Jersey City, exploded off Sands Point, L. I., and Capt. Burr Hughes and his brother Christopher were lost. John Lyons, the fireman, was terribly scalded. The other members of the crew were rescued by a passing tug. The McMahon sank almost simultaneously with the explosion, the cause of which is unknown.

Saw-Mill (147).—The boiler of a saw-mill about seven miles from Elizabethtown, Ky., exploded Nov. 20th, tearing the building to pieces, and killing John Morgan, Richard Figg, and four others whose names are not known. Others were seriously injured.

Foreign.—The boiler of the French man-of-war *Rigault Genouilly*, off the coast of Formosa, where she was doing blockade duty, burst, Nov. 29th, killing fourteen persons. An inquiry showed that the injuries to the vessel were not of a character to prevent her performing active service.

The current number of the *Journal of the Franklin Institute* contains the first installment of a very interesting lecture by Prof. R. W. Raymond, on "The Divining Rod." It is well worth a careful perusal.

The Locomotive.

HARTFORD, JANUARY, 1885.

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

Editorial Notes.

IN the course of our periodical visits to manufacturing establishments operated by steam, we find engines running non-condensing, and loaded to such an extent that very high pressures are required on the boilers, to do the work with economy. Frequently, where the boilers are old or are not strongly made, the pressure required in such cases is more than can safely be borne by the boilers. In most cases, it would seem to be too great an expense to put in new and stronger boilers, and it is really quite unnecessary to do so when there is a comparatively inexpensive way out of the difficulty, and a way which, if followed, generally results in a considerable saving of fuel, and which, in most cases, especially if the plant is one of any considerable size, might be followed with advantage, regardless of any question relating to the safety of the boilers. We refer to the attachment of a condensing apparatus to the engine.

To illustrate: Suppose we have an engine, 20 inches diameter of cylinder, stroke of piston 48 inches, running with a steam pressure 90 pounds per square inch above the atmosphere, cutting off at $\frac{1}{5}$th of the stroke, and making 60 revolutions per minute. Then the power developed, if the engine is running without a condenser, will be about 200 horse power.

Now, if we add a good condensing apparatus to the engine, drop the steam pressure to 75 pounds per square inch, letting the cut-off remain at the same point, we get exactly the same power from the engine, and we shall get it at somewhat less cost; for, in the first case, we are using a certain *volume* of steam at 90 pounds pressure, and in the second case we use the *same volume* of steam, but its pressure being but 75 pounds per square inch, the weight of steam used will be less in the second case than it will in the first. In other words, the amount of coal required to make 1 pound of steam at 90 pounds pressure is almost exactly the same as that required to make 1 pound at 75 pounds pressure. In the first case, 115 pounds of steam would be required to do the work which 100 pounds would do in the second case; and this will represent very nearly the actual saving in fuel, everything else remaining the same.

Several makers of steam-pumps make a very excellent independent condensing apparatus, designed to meet such cases as that above illustrated.

We do not advise putting in a new engine with an independent condensing apparatus. It is always better to make it an integral part of the engine, as the power required to drive the air-pump can be furnished at less cost by the engine itself than it can be by the independent apparatus.

Under some circumstances, the builder of the engine might be able to furnish and attach his regular style of condenser to an engine cheaper than the independent condenser could be attached; if this is the case, we would generally advise its adoption in preference to the independent apparatus.

In special cases, however, circumstances might make the adoption of the independent condenser desirable regardless of any question of cost.

THIS being the initial number of the year, good resolutions are of course in order. We will only say, however, that during the coming year the LOCOMOTIVE will endeavor to keep on the track, and make time if possible.

The latest binary vapor or "bunkum borum" motor don't seem to pan out well. Instead of "getting the world," as one who was interested in the scheme expressed it, the world seems most decidedly to have "got them." An account of a test recently made with the patent mixture says: "Latterly this same compound was tried on an engine indicating 150 horse power, which was used to assist the water-wheels in driving a cotton mill. The solution contained about twelve per cent. of wood alcohol, but the alcohol, on account of its low boiling point, evaporated more rapidly than the water, and after six hours' use it was found that the solution in the boilers had reduced to seven per cent., while the condensed vapor in the hot-well contained thirty-eight per cent. of wood alcohol. The odor of the vapor was intolerable, being as much more offensive than that of the liquid as the fumes arising from rubber placed on a hot iron are compared with the smell of the rubber in an ordinary state. The vapor escaped through leaky valves into the heating boilers, and the smell from the vapor blown into the weaving-rooms through the vapor pots used to preserve the humidity of the atmosphere was so great that some of the help were taken with severe nausea. [This is a very common effect of "rum and water."—Ed. Locomotive.] In the engine-room the leakage around the stuffing-boxes filled the room with a noxious vapor, severely irritating to the eyes. The vapor is far more permeating than steam, and it seemed to be practically impossible to prevent numerous leakages."

After a four days' trial the stuff was dumped into the river, as it was found to be dangerously inflammable and the leaking vapor injurious to persons.

An economizer, one of the form constructed of cast-iron pipes placed in the flue between the boiler and the chimney, lately exploded in Oldham, England, with disastrous effect, killing four men and demolishing the flue and a portion of the boiler-house. It has been very generally supposed that vessels of this class or type of construction were safe from destructive explosion, but this occurrence would seem to indicate otherwise.

If our patrons and subscribers do not always receive the Locomotive on time, let them possess their souls in patience. They will always receive twelve numbers in the course of the year. We always endeavor to issue it about the middle of the month, but other duties of a pressing nature frequently prevent its preparation in season to be so issued.

A newspaper dispatch says of a recent boiler explosion:—"The engineer was on top of the boiler. He had poured some cold water into the boiler when the explosion took place."

This is the funniest way to feed boilers that we ever heard of. If there was an opening in the boiler big enough to pour water through, how in the name of the seven mysteries could they get up pressure enough to "bust" it?

In a recent number of *The Mechanical Engineer*, Bro. Watson gives a very interesting and succinct account of the construction of the first Monitor. We can conscientiously recommend its perusal to every one.

If a "Chelsea Engineer" sees fit to sign his name to his communication on bridge walls, it will receive the attention which its merits entitle it to. Otherwise, not.

A TRAMP called on us the other day. He had, under his arm, a cigar-box, in the box a few old ten-penny nails, some gimlet-pointed screws, half a spool of thread (warranted 200 yards), divers pieces of wire, some straight, others crooked, a couple of small eccentrics, probably stolen from some one who was making a small engine, half a crank (besides himself, there was not material enough left to make another whole one), and divers other odds and ends, picked from somebody's scrap heap.

His specialty was a dual motor, and the utilization of the grand dual force of nature. With grandiloquent style, facile tongue, and a copious outpouring of the delectable juices of "Mechanics' Delight" from the corners of his mouth, he expatiated (or expectorated) on the wonderful resources of the great Dual Force of Nature. When we questioned him with regard to this wonderful force, he thus made answer: "Who can tell its nature? Tell me what furnishes the force to keep a man's body in motion, and I will tell you what this great dual force of nature is." We suggested that what kept our frame going was what is generally known as "grub"—in other words, what we ate; but he laughed the assertion to scorn, and — spat out more of his favorite brand of tobacco juice.

What do you suppose he was doing? He was selling stock—twenty five cents per share—in his great invention. All he wanted was the paltry sum of $100 to complete a working model, and he would go into Wall street, and, in fifteen minutes, he could form a company with a capital of $10,000,000 to manufacture and sell his machines.

And yet his method was far more honorable than that taken by some other motor cranks that we could name.

Among the list of those who had taken stock were several well-known names. We have not heard of their receiving any dividends as yet.

Expert Boiler Test.

We are permitted to publish the following private letter to a gentleman in this city, relating to a recent test of a patent boiler. We give it verbatim, omitting, of course, the names. It is from the engineer in charge of the works where the boiler is located:

DEAR SIR: The great test of the boiler has been made, after waiting three months for the conditions to be right, and making three different changes under their directions, and deferring the test as many times. Last Saturday morning their expert with his fireman appeared to make the test. Everything was in readiness for them; but after running for half an hour some petroleum appeared in the glass water-gauge, which made him think there was some job put up on him. I told him I had been in the habit of pumping petroleum into the other boilers for some time to loosen the incrustation which had got into them, and had used the same pump which we were running the test with, and there was where it came from, but if he was afraid of it I would stop the test, and we did so. He was also afraid of the calorimeter test you sent me, but finally concluded he would like to see it tried. The trial showed 6° superheating, and his opinion changed to favorable right away. I afterwards asked him if it was possible that that petroleum got afire and superheated the steam. The test was put off until Tuesday, when he and his fireman again appeared. We weighed him out 2,350 lbs. coal in the forenoon and 1,460 in the afternoon, and at night after hauling out the fire we weighed back 493 lbs. They evaporated 23,916 lbs. water, or 7.21 lbs. per pound coal. This did not include wood used for firing up in the morning. In the test we made ourselves shortly after boiler was started, we counted the coal used to bank fires and get up steam, and we evaporated 7.47 lbs. water. It seems that this expert took a private test in this way: From the coal brought in in the morning, 2,350 lbs., he covered up his fires at noon; then from noon he kept account of the water, and from the 1,460 lbs. coal when it came night and the fires hauled he counted out all the coal hauled out, when he should have put more into the furnace so as to have left it the same as at noon. By counting the 493 out he claimed to have evaporated 9.09 lbs. water per lb. coal, and the company wrote a statement to Mr. —— that the test was for 4½ hours, and they evaporated 9.31 lbs. water per lb. coal, and 11.53 lbs. per lb. combustible, from feed at 48°. When he got wet steam he didn't set it down; when it was the other way it was all right. I think the boiler will evaporate about 7.75 or 8 lbs. water with new fires every morning. Yours truly, —— ——

We are indebted to Chief Inspector, R. K. McMurray, of our New York Department, for the following interesting table of information:

A Few Tall Chimneys.

Owners' Names.	Where Located.	Form.	Material.	Height above Ground.	Remarks.
Townsends Works,......	Pt. Dundas, near Glasgow, Scot.,	Circular,..	Brick and Stone, .	454	The highest in the world.
Messrs. Tennant & Co.,..	St. Rollox, near Glasgow, Scot.,	Circular,..	Brick and Stone,..	435	
Messrs. Crossleys,.......	Halifax, Eng.,..	Octagonal.	Stone,....	381	"Dean Clough" Mill.
Edinburgh Gas Light Co..	Edinb'gh, Scot.,	Circular,..	Stone,....	264	Cost $25,000.00.
Messrs. Brooks' Fire Clay Works, ...	Huddersfield, Eng.,.........	Circular,..	Brick and Stone,..	306	
Messrs. Mitchell Bros.,..	Bradford, Eng...	Octagonal,	Stone,....	300	
W. Cumberland Hematite Iron Works,.	W. Cumberland, Eng ,.........	Circular,..	Stone,....	251	
Clark Thread Co.,.......	Newark, N. J.,.	Square,...	Brick,....	196	9 feet flue.
Creusot Works,.........	France,.........	Circular,..	Iron,.....	*197	10 feet at bottom, 4 ft. 3 in. at top.
Creusot Works,.........	France,.........	Circular,..	Iron,.....	†279	22 ft. 11½ in. bot'm 7 ft. 6 in. at top.

* "This stack was riveted together horizontally and lifted into its place with a crane." 28 tons.
† Weight 80 tons. Cost $8,000.00.

COMPARE.

Townsends Works, Stack, - - - - - - - - - - - -	454 feet.
St. Peters, Rome, - - - - - - - - - - - - -	455 "
Notre Dame, Ronen, - - - - - - - - - - - -	465 "
Cathedral, Strasburg, - - - - - - - - - - - -	468 "
St. Nicholas, Hamburg, - - - - - - - - - - -	473 "
Cathedral, Cologne, - - - - - - - - - - - -	511 "
Washington Monument, - - - - - - - - - - -	555 "

To which we may add—

Merrimack Manufacturing Co.,	Lowell, Mass.,		-	285	feet high—		12 feet flue.
Tremont and Suffolk Mills,	"	"	-	250	"	"	10 " "
" " " "	"	"	-	238	"	"	Rectangular—not square.
Lawrence Manufacturing Co.,	"	"	"	[illegible]	"	"	8 feet flue.

CONSIDERABLE comment has been made in some of the newspapers over the death of the engineer at the Laflin & Rand Powder Works. It is asserted that he was overcome by carbonic acid gas in the boiler; but we do not see how the boiler could become filled with this gas. We have entered boilers in about every imaginable condition, and we have never found it yet. Possibly some of the nondescript boiler compounds may give rise to it under certain circumstances.

A more probable explanation of the man's death may lie in the fact that if the boiler was hot he tried to get out, and failing to do so as quickly as he wanted to, lost his presence of mind, and in struggling to get out injured himself badly. There is much in this, as any experienced inspector will readily testify A peculiarity of hot boilers is that they seem much hotter when first entered than at any other time. When perspiration is well established, a man can remain for a comparatively long time in a boiler so hot that if he touches it with his bare hand it will be very apt to raise a blister.

If suffocation by carbonic acid gas was the cause of the man's death, it seems to us that he was probably in some flue leading to the chimney, and not in the boiler itself as was reported.

A MERCHANT of Glasgow, Scotland, has hit upon a very simple though somewhat costly arrangement of telephone wires by which, it is asserted, the annoyances resulting from induction are prevented. His office is connected with his house, some thirty miles distant, by a private line. To prevent disturbance from the induction of other wires, he uses a return wire, and the wires are simply arranged in a spiral or helical form as follows: Suppose each post to be provided with four insulators, arranged at the four angles of a square. The sending wire is attached to insulator 1 on the first post, 2 on the second, 3 on the third, 4 on the fourth, 1 on the fifth, and so on. The return wire is attached to the insulators at the opposite corners of the square, or what would correspond to that position, thus forming the helix. The arrangement is said to work so perfectly that the passage of telegraphic messages on neighboring wires does not produce the least disturbance.

Fictitious Safety Coefficients.

The recently renewed discussion in the press of the country regarding the danger of the use of iron in permanent structures, owing, as is alleged, to the inherent tendency of the material to crystallize, thus becoming brittle and useless in the course of time, is a striking illustration of the many misconceptions which owe their origin to our fictitious safety coefficients.

In the general acceptation of the term, the safety coefficient expresses the ratio between the *ultimate strength* of the material and the calculated maximum strain to which it will be subjected in a given structure. Thus, for instance, iron is conventionally stated to have an ultimate tensile strength of 50,000 pounds per square inch. If the calculated maximum tensile strain to which it will be subjected does not exceed 10,000 pounds per square inch of effective section, the iron is said to be used with a *safety coefficient of five*, and the structure is, in common parlance, stated to be "five times as strong as the greatest load that can come upon it." The absolute fallacy of this assumption is well known to modern engineers; its pernicious influence, however, is hardly fully appreciated yet. It does not only mislead laymen, who, by reason of their official position, or as capitalists, are interested in construction, but it also encourages unscrupulous manufacturers to take hazardous risks, particularly under the spur of close competition, and gives a most undesirable latitude to incompetent designers.

The responsibility for this misconception of our margins of safety rests, primarily, with the deception covered by the term "*ultimate strength.*" If ultimate strength means anything at all, it ought to mean that extreme capacity of resistance to strain which the material will display prior to permanent injury, after which, of course, its strength grows gradually less and less. That is, *if* the ultimate strength of iron were really 50,000 pounds (per square inch), then a strain of say 40,000 pounds ought never to cause rupture. But is this the case? We know that a comparatively few repetitions of a strain of 40,000 pounds per square inch of section will produce rupture. And as we increase the number of repetitions of strains, the same holds true of strains not exceeding 35,000, or even 30,000 pounds. Whence, then, the fallacious assumption that 50,000 pounds represents the ultimate strength of iron, and what is its true ultimate strength?

For a reply to the first part of this question we must look to the methods employed in the earlier investigations of the strength of materials. Bars of wood, copper, iron, steel, etc., of any given length, and, let us say, 1 square inch of section, were broken by the application of cumulative loads. The average of the final loads which caused rupture in any one of the materials so selected was termed the breaking weight, and its equivalent, expressed in pounds, the ultimate strength of that material.

Strange as it may seem, the fact that nature had endowed us with the instinct that repetition of a *lesser* load than the breaking load would *also* produce rupture was entirely overlooked. Yet, do we not constantly avail ourselves of this instinct in effecting rupture of materials in everyday life? If a single pull proves insufficient, we naturally cease, and then pull again, and again, until rupture ensues. The force of our arm is not greater in the first than in the second or third attempt, but we are unconsciously aware that the oftener we pull the less strength will ultimately be required to produce rupture.

Yet all the earlier experiments of Perronet, Poleni, Telford, Brunel, etc., neglected to take this into consideration, and they held the remarkably one-sided view that a body which could sustain safely a certain stress *once* could resist the same stress if indefinitely repeated.

It was not until the year 1858 that Prof. A. Woehler of Germany pointed out this error, and by a series of exhaustive experiments, undertaken at the instance of the Prussian government, demonstrated the correctness of what is now known as *Woehler's Law*, which may be stated as follows, viz.:

Rupture may be caused not only by the application of a single load which exceeds the carrying strength (so-called ultimate strength) of the material, but also by repeated application of stresses, none of which are equal to this carrying strength.

Further experiments by later experimenters, such as Kirkaldy, Thurston, etc., etc., developed the following facts, viz.:

1. Successive increments of load put upon a test piece will produce corresponding elongations.

2. These elongations will be proportionate to the loads, and uniform for uniform increments of load up to a certain limit.

3. Within this limit of load, the piece, when released, will return to its original length.

4. When this limit is once exceeded, and the bar then released, it will not fully recover; a permanent elongation called "set" will be found to have taken place.

5. After permanent set has taken place, the elongation becomes irregular, and greater and greater for equal increments of loads; and every successive load will also increase the amount of permanent set until rupture finally takes place.

6. *Any load in excess of the one producing permanent set will ultimately produce rupture if sufficiently often repeated.*

The point at which permanent set takes place has been designated as the limit of elasticity of the material; but, in fact, the limit of elasticity is not reached at that point at all, but lies invariably very near the breaking point; for after permanent set has taken place, successive increments of load, if removed, will still show partial recovery of length, although with a constantly increasing set, until at last a point is reached where no recovery of length takes place—elasticity is destroyed and its limits reached—and from that point on a comparatively very small force suffices to produce rupture.

The permanent set is therefore indicative of the point of permanent injury to the material, rather than of its limit of elasticity. From the foregoing it is evident that any load equal to or in excess of the one producing permanent set will, by sufficient repetitions, produce rupture. This being the case, we may properly say that, *the load under which permanent set takes place is the equivalent of the ultimate working or safe strength of the material.* In wrought-iron permanent set takes place under a load of from 25,000 to 28,000 pounds per square inch of section, or about at one-half, or fifty per cent. of the so-called ultimate strength; and this answers the second part of the question under consideration.

It will readily be perceived that this reduces the margin of safety from *five* to *two and one half.* But, in reality, there never was an iron structure yet built that had even that margin. For this margin can only exist provided there is given *perfect uniformity* of material, *perfect workmanship*, and perfect *transmission of strains* throughout the entire structure, conditions which in practice can never exist, and which are only closely approached in cases of rare excellence of construction. It is the purpose of safety coefficients to provide for just these unavoidable defects, but never for the doubling or trebling of the loads for which a structure was designed.

With these considerations before us, the pernicious influence of overestimating the margins of safety becomes apparent at once. Bridges designed years ago for the passage of locomotives and rolling stock, such as were then in use, have been deliberately overloaded by the passage of trains representing nearly, and in many cases more than double the concentrated wheel-loads of former years. Proper consideration of wind-pressures, glaring defects of material and of workmanship have been deliberately overlooked, and all this and more has been saddled upon the fictitious margins of safety.

Is it to be wondered at that, under such circumstances, iron bridges fail? Or is it not rather a matter for congratulation that not more of them have failed thus far?

It is to be hoped that, with a clear understanding of the *safe working strength* of material—already fully recognized in our best bridge works—better methods of dimensioning, closer inspection of material and workmanship, and more care in maintenance, will generally supersede the old tendency of relying too much upon the safety coefficient. When this is attained, we shall hear no more about the inherent tendency of iron to—*crystallize.—The American Engineer.*

Production of the Precious Metals in 1884.

Mr. John J. Valentine, vice-president and general manager of Wells, Fargo & Co., has published the following annual statement of precious metals produced in the States and territories west of the Missouri River during 1884, which shows aggregate products as follows: Gold, $26,256,542; silver, $45,799,069; copper, $6,086,252; lead, $6,834,091. Total gross result, $84,975,954.

California shows a decrease in gold of $944,703, and an increase of silver of $513,597. In Nevada, the Comstock shows an increase of $1,668,524; Eureka District shows a decrease of $123,152. In the total product of the State there is an increase of $117,318. Montana shows a considerable increase. Colorado and Arizona show a decrease from the production of 1883.

As stated hitherto, the facilities afforded for the transportation of bullion ores, and base metals, by the extension of railroads into mining districts, increase the difficulty of verifying the reports of the products from several important localities; and the general tendency is to exaggeration when the actual values are not obtainable from authentic sources; but the aggregate result, as shown herein, we think may be relied on with reasonable confidence as approximately correct.

States and Territories.	Gold-dust and bullion by express.	Gold-dust and bullion by other conveyance.	Silver bullion by express.	Ores and base bullion by express.	Total.
California,	$12,282,471	$614,123	$1,504,705	$871,689	$15,272,983
Nevada,	1,527,859	....	5,905,304	1,455,776	8,888,939
Oregon,	368,315	184,157	2,695	....	555,167
Washington,	45,964	22,982	1,179	....	70,125
Alaska,	35,014	80,000	....	....	115,014
Idaho,	1,010,077	150,000	812,100	1,570,000	3,542,177
Montana,	1,875,000	....	6,175,000	3,812,000	11,862,000
Utah,	31,501	4,134	2,657,054	4,697,147	7,389,836
Colorado,	2,575,861	....	4,877,888	12,780,000	20,233,749
New Mexico,	157,688	60,000	906,248	2,536,678	3,660,614
Arizona,	360,791	100,000	3,139,628	3,455,960	7,056,379
Dakota,	2,726,847	150,000	110,000	....	2,986,847
Mexico (West Coast States)	285,256	....	2,257,144	12,000	2,554,400
British Columbia,	647,719	140,000	....	....	787,719
	$23,930,363	$1,505,396	$28,348,945	$31,191,250	$84,975,954

The gross yield for 1884, shown above, segregated, is approximately as follows:

Gold,	30.90 per cent.	$26,256,542
Silver,	53.90 "	45,799,069
Copper,	7.16 "	6,086,252
Lead,	8.04 "	6,834,091
		$84,975,954

ANNUAL PRODUCTS OF LEAD, COPPER, SILVER, AND GOLD IN THE STATES AND TERRITORIES WEST OF THE MISSOURI RIVER, 1870–1884.

Year.	Total Product.	The net product of the States and territories west of the Missouri River, exclusive of British Columbia and West Coast of Mexico, divided, is as follows:			
		Lead.	Copper.	Silver.	Gold.
1870	$52,150,000	$1,080,000	....	$17,320,000	$33,750,000
1871	55,784,000	2,100,000	....	19,286,000	34,398,000
1872	60,351,824	2,250,000	....	19,924,429	38,177,395
1873	70,139,860	3,450,000	....	27,483,302	39,206,558
1874	71,965,610	3,800,000	....	29,690,122	38,466,488
1875	76,703,433	5,100,000	....	31,635,239	39,968,194
1876	87,219,859	5,040,000	....	39,292,924	42,886,935
1877	95,811,582	5,085,250	....	45,846,109	44,880,223
1878	78,276,167	3,452,000	....	37,248,137	37,576,030
1879	72,688,888	4,185,769	....	37,032,857	31,470,262
1880	77,232,512	5,742,390	$898,000	38,033,055	32,559,067
1881	81,198,474	6,361,902	1,195,000	42,987,613	30,653,959
1882	89,207,549	8,008,155	4,055,037	48,133,039	29,011,318
1883	84,639,212	8,163,550	5,683,921	42,975,101	27,816,640
1884	81,633,835	6,834,091	6,086,252	43,529,925	25,183,567

The exports of silver during the past year to Japan, China, the Straits, etc., have been as follows: From London, $40,221,658; from Marseilles, $1,361,250; from Venice, $130,680; from San Francisco, $13,903,990. Total, $55,617,578.

—*The Engineering and Mining Journal.*

The Speed of English Express Trains

A Paper on English express trains, was lately read by Lieutenant Willock, R. E, before the Statistical Society. A table of the great increase of express services throughout the United Kingdom, forming a portion of the paper, is of more than usual interest at the present time, with the recent accident at Penistone still fresh in our minds. This may be our excuse for referring more fully to a subject which has a special bearing on the safety of railway traveling. In comparing the express services of 1871 and 1883, we find that the increase of express trains during that period has been 157, or 62.8 throughout the English and Scotch lines, the numbers being 250 per day in 1871, and 407 in 1883. The average journey speed has increased from $37\frac{3}{5}$ to $41\frac{3}{5}$ miles per hour, the running average from $40\frac{4}{10}$ to $44\frac{1}{3}$ miles, and the total express mileage from 23,672 to 42,693, a daily increase of 19,021 miles, or 80 per cent. The London and Northwestern stands at the head of the list as regards express mileage, with 10,405 daily miles, but it is not in the same position as regards running average, all the great companies, indeed, having increased in this respect by more than the average amount, with this one exception. The Great Northern stands first in the running average increase, being 42 miles per hour in 1871 and $46\frac{3}{4}$ in 1883, being an increase of $4\frac{3}{4}$ miles per hour. The total express mileage on this system has risen from 3,520 to 6,780, or 92 per cent. The great Northern, however, shows the greatest number of express journeys on each mile, though in the matter of long runs it of course cannot compete with the London and Northwestern, for it is comparatively a short line, and has no long runs extending like those from Chester to Holyhead or Preston to Carlisle. The Manchester, Sheffield, and Lincolnshire shows the largest increase of all the lines in the number of district expresses, having risen from 11 in 1871 to 49 in 1883—an increase of 38. As to its average journey speed also, that has mounted from 36 miles to 43—an increase of seven per hour; and in this matter it is surpassed by only one system—viz.: the Glasgow and Southwestern, which increased by $7\frac{1}{12}$ miles. The running average of the Manchester and Sheffield has of course increased from $38\frac{4}{7}$ miles to $44\frac{3}{5}$, or 6 per cent., and its total express mileage from 594 to 2,318, or the enormous number of 1,724, or 290 per cent. The Midland company ranks third in the number of its expresses, of which there are 66, but second as regards express mileage, being 3,175 in 1871, and 8,860 in 1881,—an increase of 6,685 miles, or 147 per cent. Its average journey speed is now $41\frac{3}{5}$ miles—an increase of $4\frac{1}{10}$ per hour since 1871; and its running average is 45 miles—an increase of $4\frac{1}{10}$. The Midland system shows a very large augmentation in the number of its daily long runs, these having been 20 in 1871, with a mileage of 1,135, while now there are 84, with a mileage of 4,377. With respect to the total express mileage, the Great Eastern has made more rapid progress than any other line, having jumped from the bottom in 1871, when it was 161 miles, to the fourth place in 1883, with 3,040 miles—an increase per cent. of 1,788. This is owing largely to the extension of the system to Doncaster. The number of district expresses has risen from 3 to 34, its average journey speed from $37\frac{9}{10}$ to 41, and its running average from $38\frac{8}{10}$ to $43\frac{1}{4}$. As representing the West of England, the Great Western, though it still stands fifth in the order of total express mileage, has actually reduced its number of district expresses from 28 to 18, and therefore, of course, its total express mileage, which now stands at 2,600 daily miles. Its average journey speed has risen from 38 to 42 miles, and its running average from $41\frac{1}{5}$ to $46\frac{1}{4}$. For the southern lines the changes are nothing like so great. The Chatham and Dover has increased its district expresses from 6 to 9, the Brighton from 12 to 13, while the Southeastern has reduced them from 15 to 12, and the Southwestern from 7 to 3. In speed, however, the latter company shows best of all the lines south of London, having risen from 40 miles to $44\frac{1}{3}$, the Chatham and Dover following suit from $41\frac{3}{4}$ to $43\frac{1}{8}$, the Southeastern from $40\frac{1}{2}$ to $41\frac{3}{4}$, and the Brighton from $41\frac{1}{2}$ to only $41\frac{2}{23}$. This very small increase is doubtless due to the crowded state of the line between London and Croydon, which would render a very high speed inadmissible. It ought to be added that, notwithstanding the increase of speed, accidents have become less rare, owing to the greater care employed and the more general adoption of efficient brake-power by the more enlightened railway companies.—*Iron.*

Photographic Methods.

FORMULAS FOR PRINTING SOLUTIONS.

Blue Prints. The best formula for this process, of many that I have tried, is that furnished by Prof. C. H. Kain of Camden, N. J., in which the quantity of ammonio-citrate of iron is exactly double that of the red prussiate of potash, and the solutions strong. This gives strong prints of a bright dark blue, and prints very quickly in clear sunlight.

Dissolve six grains of red prussiate of potash in one dram of distilled water; in another dram of distilled water dissolve twelve grains of ammonio citrate of iron. (I use Powers & Wightman's make.) Mix the two solutions in a cup or saucer, and at once brush over the surface of clean, strong paper. Cover the surface thoroughly, but apply no more than the paper will take up at once; it should become limp and moist, but not wet. The above quantity of solution, two drams, will suffice to sensitize ten square feet of paper, or three sheets of the "regular" size of plain paper, eighteen by twenty-two. As fast as the sheets are washed over with the solution hang them up to dry by one corner. The surplus fluid will collect in a drop at the lower corner, and can be blotted off.

Black Prints. Wash the paper with a saturated solution of bichromate of potash. made quite acid with acetic acid. After printing wash the prints in running water for twenty to thirty minutes; then float them face down in a weak solution (five to ten per cent.) of protosulphate of iron for five minutes, and wash as before. If preferred, the solution may be washed over the prints, or they may be immersed in it, but floating seems preferable. After the second washing wash the prints over with a strong solution of pyrogallic acid, when the print will develop black, and the ground, if the washings were sufficient, will remain white. A final washing completes the process.

If a solution of yellow prussiate of potash be used in place of the pyro-solution, a blue print is obtained. Bichromate prints can be made on albumenized paper by floating it on the solution, and by using a saturated solution of protosulphate of iron and a saturated solution of gallic acid. Very fine prints can be so produced nearly equal to silver prints, and at somewhat less cost, but with little or no saving of time or labor.

Cheap Proof Solution. If old oxalate developer be exposed in a shallow vessel in a warm place a deposit of light green crystals will be formed, composed of an impure oxalate of iron. If these crystals be dissolved in water, and the paper washed with a strong solution, when dry it may be exposed in the printing frame, giving full time. The image is very faint, but on washing in, or floating on, a moderately strong solution of red prussiate of potash for a minute or less a blue positive is produced, which is washed in water as usual to fix it. The unused developer produces the best crystals for the purpose, and the pure ammonio-oxalate of iron is vastly better than either.

All of the above operations, except the printing, should be carried on in the dark room, or by lamp or gaslight only. The solutions and the paper should also be kept in the dark and prepared as short a time as possible before use.—C. M. Vorce, *in Am. Mo. Microscopical Journal.*

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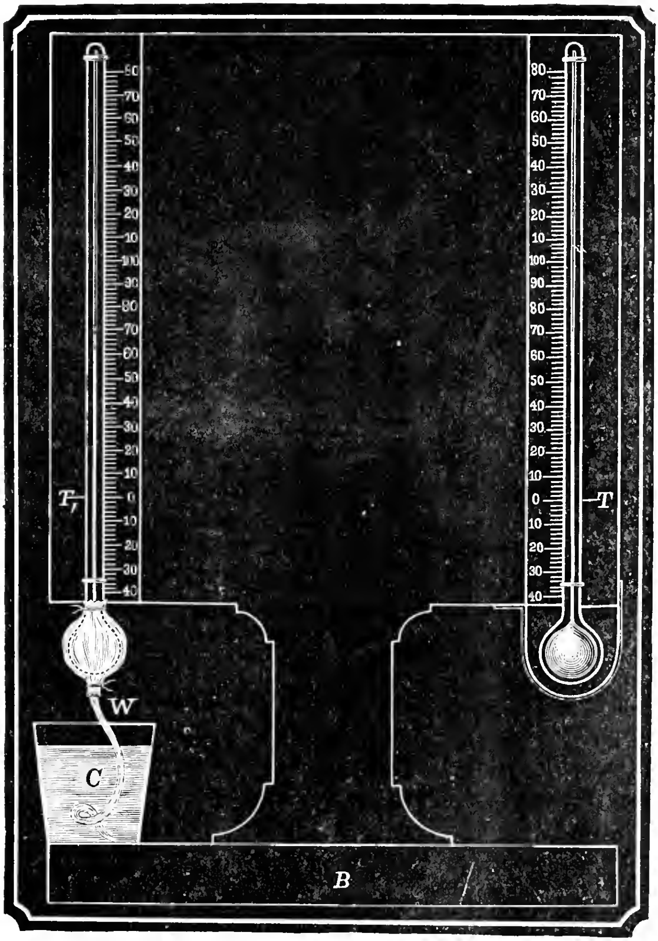
Notes on Atmospheric Humidity.

MOST occupants of rooms or houses heated by steam have probably experienced more or less trouble from the shrinking during the winter months, of furniture, or even the wood-work of the house itself, if it happens to be a new one, and is kept very warm.



This is very annoying as it seems to be impossible to buy furniture that will not shrink more or less under the circumstances, and indeed it matters not how well-seasoned it may have been originally, the variation of the humidity of the air from its natural state in the summer to the artificial dryness in winter will cause changes which affect it injuriously. The cause of this dryness may be explained as follows:

Air has the property of holding in suspension or solution a certain amount of watery vapor or moisture. The quantity of moisture which the air is capable of thus holding in solution depends on the temperature of the air, and the higher the temperature, the more vapor it is capable of holding. For all temperatures, however, there is a point where the air will hold no more moisture in solution, and it is then said to be saturated with moisture. If to air which is saturated we add more moisture, it refuses to absorb it, and it will be deposited on the various solid bodies in the vicinity in the form of dew. Thus it will be seen that the point of saturation is what is generally known as the dew-point.

On the contrary, air which is not saturated with moisture always has a tendency to absorb more. This is what gives it its drying or seasoning power.

Now it is evident that if we take a given volume of air at the low temperature which prevails in the winter season, say for example 40° Fahr., and containing two grains of watery vapor per cubic foot, which is about two-thirds of what it is capable of holding in solution, inclose it in a tight room, and warm it to 70 degrees, it will contain the same amount of moisture absolutely, but as air at 70 degrees requires about eight grains of moisture per cubic foot to saturate it, it is evident that the two grains form only about one-fourth of what it will take up at this higher temperature instead of two-thirds as before, and its tendency will be to greedily absorb moisture from everything in the room which contains a particle; and this is exactly what it does, and this action is made manifest by the warping and shrinking of furniture, floors, etc.

Some people are so constituted that this unnatural dryness of the air is not only oppressive, but actually unhealthy, and some means are desirable for supplying the air with the required amount of moisture. This is not only very easily done, but the actual state of the air in the room, as to its humidity, may be very easily ascertained at a glance, and accurately controlled.

All that is required for the purpose is a small air cock on the radiator, and a wet and dry bulb thermometer. The air-cock is for the purpose of admitting steam directly into the room for the purpose of obtaining the desired degree of humidity, and the thermometers are for the purpose of showing the percentage of humidity so that it may be regulated by admitting more or less steam into the room, as desired.

By the exercise of a very little ingenuity, any one will be enabled to construct a wet bulb thermometer that will fulfil the required purpose perfectly.

It is only necessary to cover the bulb of an ordinary thermometer with muslin, and connect it with a small vessel of water by a suitable wick which may be made of almost any light fabric. Ordinary cotton wicking answers admirably. The wick and the vessel containing the water should be so arranged that the muslin will be kept thoroughly moist, but not sufficiently so to allow a drop of water to collect at the bottom of the thermometer bulb, and the location of the thermometer should be such that a perfectly free circulation of air is obtained around it. Unless these precautions are observed, the indications will be erroneous.

The cut on first page shows a very convenient form of the above-described apparatus, which is called an hygrometer. T is the dry bulb thermometer, and which indicates the ordinary temperature of the room, T_1 is the wet bulb thermometer, C the cup of water, from which the wick W is seen rising to the thermometer bulb, the back of the instrument, to which the thermometers are fastened, forms a convenient place to paste the reference table which will be found further on. The whole instrument rests on the base B.

The principle involved in the working of the apparatus may be briefly stated as follows: When the liquid evaporates, it must absorb heat from some source, in this case it absorbs it from the bulb of the thermometer, which therefore indicates a lower temperature; but, as soon as the temperature falls below that of the surrounding atmosphere, it begins to receive heat from it. When the temperature of the wet bulb reaches the point where the heat abstracted by vaporization of the moisture just equals that received from the atmosphere, it becomes stationary. This point of course depends upon the temperature of the surrounding air, and the amount of moisture already in it. In general it may be stated—the higher the temperature of the surrounding air, and the less the amount of moisture in it, the greater will be the difference between the indications of the wet and dry thermometers. If the air is already *saturated* with moisture, the reading of the two thermometers would be the same, for then there would be no evaporation from the wet bulb.

The following table, which should be pasted to the back of the apparatus, will be found of use in connection with this article.

TEMPERATURE OF THE AIR. (Dry Thermometer.)	Difference of Temperature Between Wet and Dry Thermometers.													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Percentage of Humidity—Saturation = 100.													
42	92	85	78	72	66	60	54	49	44	40	36	33	33	27
52	93	86	80	74	69	64	59	54	50	46	42	39	36	33
62	94	88	82	77	72	67	52	58	54	50	47	44	41	38
72	94	89	84	79	74	69	65	61	57	54	51	48	45	42
82	95	90	85	80	76	72	68	64	60	57	54	51	48	45
92	..	..	..	..	..	..	..	..	..	..	..	..	..	..

The above table is copied from Box's *Practical Treatise on Heat.*

In an inhabited room a temperature of 70° on a dry thermometer, and 64° on a wet thermometer, giving about 70 per cent. of humidity, will be found about right for health and comfort in the winter months. This is easily regulated by admitting the proper amount of steam directly into the room by means of the air-cock above mentioned. The hissing noise of the escaping steam can be avoided by winding a few thicknesses of cloth around the outlet of the cock, thereby muffling it.

The following table shows the amount of moisture in *grains* required to saturate a cubic foot of air at different temperatures. It is from a very complete table in the *Encyclopædia Britannica.*

Temperature, Fahrenheit.	Grains per cubic foot.	Temperature, Fahrenheit.	Grains per cubic foot.	Temperature, Fahrenheit.	Grains per cubic foot.
32	2.35	50	4.24	70	7.94
35	2.59	55	4.97	75	9.24
40	3.06	60	5.82	80	10.73
45	3.61	65	6.81	85	12.43

It will be seen as the temperature rises the capacity of the air for absorbing moisture increases very rapidly, being more than three times greater at 70 degrees than it is at 35 degrees.

For further information on this important subject, the reader should consult some good work on physics.

Inspectors' Reports.

DECEMBER, 1884.

The summary of the work done in the inspection department for the closing month of the year 1884, is given below. The whole number of visits of inspection made was 3128, in the course of which 5913 boilers were examined. 2032 of this number were internally examined, and 273 others were tested by hydraulic pressure. 44 were considered unfit for further use, and were condemned. 4366 defects were found, of which 883 were considered dangerous, as per the following table.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	363	29
Cases of incrustation and scale,	655	59
Cases of internal grooving,	19	4
Cases of internal corrosion,	135	4
Cases of external corrosion,	194	26
Broken and loose braces and stays,	82	32
Settings defective,	195	27
Furnaces out of shape,	145	34
Fractured plates,	131	50
Burned plates,	126	39
Blistered plates,	276	32
Cases of defective riveting,	709	175
Defective heads,	31	12
Serious leakage around tube ends,	581	155
Serious leakage at seams,	307	67
Defective water-gauges,	102	23
Defective blow-offs,	37	9
Cases of deficiency of water,	22	14
Safety-valves overloaded,	35	16
Safety-valves defective in construction,	72	39
Pressure-gauges defective,	146	27
Boilers without pressure-gauges,	3	0
Total,	4,366	883

Tube ends are a source of annoyance in some types of boilers, that give rise to much trouble. This is especially apt to be the case with boilers of the vertical type. The upper ends are exposed to the action of the heated gases, and there being no water to prevent overheating, they are soon loosened and set to leaking badly. This gives rise to corrosion of the ends of the tubes and the upper head, which in many cases goes on with very great rapidity. It is no unusual thing to find the upper tube sheet of upright boilers eaten half-way through, and nearly all of the tubes leaking badly. This leakage is not so apparent from steam-pressure, as it is from water-pressure. To the unpracticed boiler attendant everything may appear to be all right, but when the boiler is filled to the top with water and pressure applied, there is generally some fun.

The lower ends of tubes are also very apt to give more or less trouble, especially where upright boilers are used for heating-purposes, and the blow-off does not quite drain the boiler. This is generally the way uprights of the pot-hung type are arranged, and during the summer months, when the boiler is standing idle, the interior of the shell and the tubes, just at the surface of the water left in the boiler, is subjected to severe pitting. Sometimes the tubes of this class of boilers are completely riddled in a very few seasons, whereas, if properly cared for, they should last many years.

Where the upper ends of tubes are loosened from the action of heat, they may be made tight, if they are not much corroded, by expanding. Where they are pitted, and the holes extend clear through, the only remedy is a new tube.

Summary of Inspectors' Report for the Year 1884.

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.

	1884.	1883.
Visits of inspection made,	34,048	29,324
Total number of boilers inspected,	66,695	66,142
" " " " " internally,	24,855	24,403
" " " " tested by hydraulic pressure,	4,180	4,275
" " " defects reported,	44,900	40,953
" " " dangerous defects reported,	7,449	7,472
" " " boilers condemned,	493	545

The following is the detailed analysis of defects reported during the year 1884.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	4,850	446
Cases of incrustation and scale,	7,078	552
Cases of internal grooving,	214	58
Cases of internal corrosion,	1,645	218
Cases of external corrosion,	2,608	358
Broken and loose braces and stays,	766	337
Settings defective,	2,123	222
Furnaces out of shape,	1,443	142
Fractured plates,	1,428	551
Burned plates,	1,236	321
Blistered plates,	2,833	300
Cases of defective riveting,	4,598	961
Defective heads,	418	145
Serious leakage around tube ends,	6,115	1,276
Serious leakage at seams,	2,488	559
Defective water-gauges,	1,230	182
Defective blow-offs,	544	124
Cases of deficiency of water,	165	80
Safety-valves overloaded,	327	129
Safety-valves defective in construction,	440	171
Pressure-gauges defective,	2,319	307
Boilers without pressure-gauges,	31	10
1 defect unclassified,	1	
Total,	44,900	7,449

Grand Total of the Inspector's Work since the Company began Business, to January 1, 1885.

Visits of inspection made,	275,223
Whole number of boilers inspected,	560,979
Complete internal inspections,	196,436
Boilers tested by hydrostatic pressure,	42,158
Total number of defects discovered,	303,718
" " " dangerous defects,	64,216
" " " boilers condemned,	3,716

The above record speaks for itself, and is, we think, the most convincing argument that can be offered in favor of our system of inspection and insurance. It has cost us something to keep up the inspection system under which this great number of defects have been brought to light, but we believe the money is better expended in this manner than in paying losses, to say nothing of the lives which are saved by the prevention of the destructive explosions, for we still adhere to the belief that it is far better to *preserve* life than it is to *insure* it.

Boiler Explosions.

DECEMBER, 1884.

Oil Works (148).—The cap of a boiler at the Belmont oil works, Philadelphia, Pa., blew out. John Simpson was fatally scalded, and Joseph Taylor and Hugh Gantz were badly burned.

Saw-Mill (149).—Henry Beatty, Henry Klinger, and Emanual Gross were fatally injured Dec. 13th, by the explosion of a boiler at Bittle's saw-mill in Union township, Penn.

Saw-Mill (150).—The boiler in Plummer's planing-mill, Jackson, Mich., exploded Dec. 19th, tore the building to pieces, and scattered the debris for many yards around, and Albert Keyport, a mill hand, who was standing by the boiler, was instantly killed, his head being nearly torn from his body. George Van Brunt, the mill superintendent, was severely hurt about the head. His son, who acted as engineer and fireman, had his leg broken and received other severe injuries. Fred Miller, George Pangborn, N. E. Breckenridge, and William Moll, mill hands, were injured severely; Miller will probably die.

Cotton Compress (151).—The boiler in the Bell street compress of the Atlanta Cotton Compress Company, exploded Dec. 22d, killing one negro and seriously wounding another.

Steamer (152).—An explosion at sea of a portion of the boiler of the steamship Scheidam, a few days ago, killed one fireman and seriously injured two others. The ship kept on undamaged.

Steam Tug (153).—The tug Admiral exploded its boiler at Chicago, Ill., Dec. 31st. The tug was totally demolished, and five men were instantly killed; considerable damage was done to other vessels in the vicinity.

Foreign.—A boiler on the Armonia sugar estate of Las Vegas, Cuba, exploded on the 30th ultimo. Ten persons were killed, and 15 others wounded.

When a boiler explodes from a scarcity of water, it is a case of "thought it was loaded."—*N. Y. Journal.*

Summary of Boiler Explosions Occurring in 1884.

We give below our usual annual summary and classified list of boiler explosions, with a list of the people killed and injured thereby.

The total number of explosions occurring in the United States during the past year was, so far as we could learn, 152, by which 254 people were killed and 261 others injured, many of them fatally.

Although this number falls slightly below that of the preceding year, it is still frightfully large, much greater than it ought to be:

CLASSIFIED LIST OF BOILER EXPLOSIONS IN THE YEAR 1884.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total per class.
Saw-mills and wood-working shops,	5	6	6	4	5	9	7	2	2	6	2	2	56
Locomotives,	..	..	2	1	4	..	3	2	1	2	..	..	15
Steamboats, tugs, etc.,	..	1	..	1	..	2	2	3	2	..	2	2	15
Portables, hoisters, and agricultural engines,	..	1	..	3	1	..	5	4	1	3	..	..	18
Mines, oil wells, collieries, etc.	1	..	..	..	..	1	2	..	2	..	..	1	7
Paper-mills, bleachers, digesters, etc.,	..	..	..	..	2	..	..	..	..	..	1	..	3
Rolling-mills and iron-works,	2	..	..	..	1	1	..	1	..	..	..	..	5
Distilleries, breweries, sugar-houses, dye-houses, rendering establishments, etc.,	..	1	2	..	1	1	..	..	2	..	1	..	8
Flour-mills and elevators,	..	..	2	3	1	1	..	..	1	1	..	..	9
Textile manufactories,	..	1	..	..	..	..	..	..	..	..	..	..	1
Miscellaneous,	6	..	3	..	1	1	..	2	1	..	..	1	15
Total per month,	14	10	15	12	16	16	19	14	12	12	6	6	152
Persons killed, total 254, per month,	17	7	25	18	30	26	37	13	15	31	22	13	...
Persons injured, total 261, per month,	19	13	27	15	31	23	35	16	20	17	25	10	...

From the above it will be seen that our old friend, the saw-mill boiler, heads the list as usual, though there is quite a falling off from the record of the preceding year. The percentage this year was 37 per cent. of all the explosions, instead of over forty the year before.

The number of marine boiler casualties was exactly the same during 1884 as in 1883, fifteen being the recorded number.

There was a falling off of two in the number of locomotive boiler explosions from the record of the preceding year.

There was an increase of three in the recorded number of agricultural engine explosions, a falling off of four in the mining class, a decrease of one in the iron works list, and an increase of five in the flouring-mill class.

The falling off in the aggregate number of explosions for the year is probably due to the fact that many boilers have been out of use owing to the business depression.

Our monthly list shows 153 explosions, an error due to a repetition of one of them.

The Locomotive.

HARTFORD, FEBRUARY, 1885.

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

Annual Meeting.

At the annual meeting of the Hartford Steam Boiler Inspection and Insurance Company, the old Board of Directors was unanimously re-elected. The statement of the Company for the year 1884, showed an increased amount in cash assets over the previous year of $44,103.80. The surplus as regards policy-holders is $336,904.58. The net surplus over and above all liabilities is $86,904.58. The capital of the Company paid up in cash is $250,000, and the total cash assets are $505,273.81.

The progress which the Company has made arises from an earnest, energetic, and intelligent prosecution of its business. It has been its aim, from its organization, to carefully study and investigate the principles of boiler construction and management, with a view to greater safety and economy. These investigations have extended over a period of eighteen years, and the patrons of the Company have received the benefit of this experience. It seeks in all ways to benefit those who place their boilers under its supervision. It has never sought to boom its business by issuing sensational circulars. What manufacturers want is solid and reliable information. And further, the Company never promises more than it can perform. There are possible contingencies which may arise at any time, and ample provision should be made for such possibilities. This cannot be done by an effort to secure premiums at any and almost no rate. Such a conduct of the business may seem to succeed for a while, but the day of reckoning will surely come. The fidelity with which the inspection of boilers is made will depend upon adequate compensation for such work. If the inspections are perfunctorily made, the steam-user derives little benefit. The cry "cheap insurance" has a catching sound. But if the most important feature of this form of insurance, viz., the inspection, is negligently performed, the steam-user is little benefited, even though his insurance is cheap. Unlike all other insurance, there is an effort here to prevent waste and disaster. The business is not completed when the policy is issued and the premium collected. There must be constant watch and care of the boilers by periodical inspections during the entire year. This is a part of the contract, and should be rigidly carried out.

The financial statement of the Hartford Steam Boiler Inspection and Insurance Company is all that it claims to be. It is not made up of doubtful or fictitious items in order to show a surplus. It has paid all its expenses, dividends, and losses, and shows a handsome increase in net surplus over the preceding year.

These facts demonstrate its ability to promptly meet any losses which may arise under its policies. If it had paid no dividends nor losses, and yet showed a surplus of less than $1,000, we think its management would be open to criticism, and its soundness questionable.

WE have received from the Publishers, *The American Engineer* of Chicago, a copy of *Steam Making, or Boiler Practice*, by the late Prof. Chas. A. Smith of St. Louis.

This is a thoroughly good work. It treats of the nature of heat, has some excellent remarks upon, and tables of, the properties of steam, treats the greatly mooted subject of combustion in a rational manner, and describes the various types of boilers and discusses their various good or bad points in a thoroughly impartial spirit.

There are extended tables showing the result of boiler trials, which include about every kind of boiler in use. These tables are very useful.

Boiler construction as regards strength and durability is treated, and the regulations of the U. S. Board of Supervising Inspectors, and the British Board of Trade, relating thereto are given.

We could wish the matter of settings for externally-fired boilers had been more fully treated, but there are so many different varieties of boilers, that to have done justice to the subject would have made the book inconveniently large.

Boiler attachments are discussed quite fully and some excellent hints given relating thereto.

The work contains 195 pages, and the cuts are excellent. It is a book that we can conscientiously recommend.

RECENT occurrences have furnished the mysterious explosions theorists with another possible cause of boiler explosions. Why not attribute them to dynamite? It would be a more sensible theory than electricity, generation of unheardof gases, or many of the other ridiculous things that have been gravely discussed. Now let some one patent this method of boiler explosions and prosecute the dynamiters for infringement.

Mechanics has some good suggestions to machinists about removing particles of dirt from the eyes of workmen, but it condemns the use of a pen-knife for this purpose. The instrument recommended is good for removing *loose* particles of dirt, iron, emery, etc., from the eyes, but in many cases it entirely fails, as the writer can testify from personal experience. When a bit of iron or a grain of emery from a revolving emery wheel strikes the eyeball, as is very frequently the case, it is driven into it so that it is impossible to remove it without the use of a knife or some similar sharp-pointed instrument. This must be sufficiently sharp and delicate to enable the operator to "dig" out the offending piece of "matter in the wrong place." This is easily done if one has a sharp eye and steady hand. We "officiated" many times at this operation, both as the digger and the diggee, and we have never known of a case of serious injury to the eye from this cause. But one thing should always be borne in mind in such operations. In removing anything from the eyeball with a knife, or similar instrument, always make a *downward* stroke at the object with the knife, *never upward*. If this precaution is observed, the eye is not apt to be injured.

THE calorimeter test for determining the amount of moisture or degree of superheating present in steam, as generally made, is liable to some error, unless very carefully made. The usual mode of procedure is as follows:

A barrel is placed on a platform scale, a convenient quantity of water run in, usually 100 pounds, a pipe is connected at some convenient point near the boiler, to the end of this pipe a rubber hose is attached, after the temperature of the water in the barrel is noted, steam is turned into the hose, allowed to blow through into the air until the hose is thoroughly warmed, when the end is thrust into the water in the barrel, and allowed to stay in until, say, five pounds of steam have been condensed and added to the water in the barrel. The steam is then shut off and the temperature of the water noted, from the increase of temperature the heat units added to the water is calculated. This enables us to tell by a simple calculation, whether the steam is wet, dry, or superheated.

This method, which was first proposed by Mons. G. A. Hirn of Colmar, Alsace, may be more easily performed as follows. For the exact language we copy from *Steam-making or Boiler Practice.*

"A barrel is set on a platform scale and a known weight of water run into it. It is convenient to put in 298 pounds of water. Steam is taken from the top of the steam-pipe by a rubber hose terminated by an iron pipe capped on the lower end and perforated with holes drilled obliquely to the radii, but in the plane thereof. This pipe is placed in the barrel of water and steam turned on: the scale is loaded two pounds more, and as the steam comes into the water the fluid increases in weight, and when the beam tips there is 300 pounds of water. The temperature of the water is then carefully noted. The disposition of the jets keeps the water stirred up thoroughly, and the flow of steam into the water being horizontal only, the water remains steady. The weight is then increased ten pounds, and when the scale tips at 310 pounds, the temperature is noted.

The number of heat units given to the water in the barrel, by the steam and water from the boiler, is found by multiplying the 300 pounds of water by its rise in temperature.

The portion which was dry steam gives up its internal heat of evaporation in condensing, and the external work done by the air upon the fluid in compressing it from steam to water, together make the latent heat of evaporation; and the whole fluid then falls in temperature from that due to the pressure in the boiler to the final temperature of the water in the barrel.

Deducting from the heat gained by the water in the barrel, ten times the difference between the boiler temperature and the final temperature in the barrel, and dividing the remainder by ten times the latent heat at the boiler pressure, the quotient will be the fraction of the whole which is dry steam.

It is easily seen that with any other weight [of steam run in and condensed, Ed. Loco.] the process would be the same; but in place of the ten we should use the number of pounds run in between the noting of the temperatures.

The preliminary two pounds is to provide for any water which may have collected in the hose and connections while standing, and to render the operation uniform.

An example by the above method would be worked as follows:

Steam pressure on boiler = 80 pounds per square inch.

Its temperature would be = 320 degrees Fahr.

Latent heat of one pound = 886 thermal units.

After putting 298 pounds of water into the barrel and running in two pounds of steam, its temperature is, say 75°.

Then after running in ten pounds more its temperature is, say 110°.

Then (110 — 75) × 300 = 10500 thermal units.
(324 — 110) × 10 = 2140 " "
886 × 10 = 8860)8360(.9044 +
7974
38600

Showing the steam to contain nearly 10% of entrained water.

The objection which we would raise would be against the quantity of water used, which makes the rise of temperature so small that a difference of one degree in the final temperature in the barrel makes a difference of three per cent. in the amount of entrained water, actually present in the steam.

A LATE number of *Engineering* containing an interesting article on the metric system is of interest, but we believe the advantages of the decimal system are more fancied than real. It is generally supposed that the decimal system of notation, originated from the use of the fingers in ancient times in counting. If this is the case, it is a great pity that the people of those days *didn't have six or eight fingers on each hand.*

Our enterprising contemporary, *The Mechanical News*, says:—The secrets of Free Masonry are well kept, considering everything; but for successful preservation they are not to be mentioned in the same day with the impenetrable mystery which surrounds the doings of gaslight companies. We offered some observations under this head in a former issue, and had the pleasure of recording the fact that in New York the price of gas had been reduced to $1.75 per 1,000 feet, instead of $2.25 as formerly. But there are some people who affirm that while maintaining the same rate of consumption as before, so far as they can judge, they find themselves paying more for gas at $1.75 than they did at $2.25. Another curiosity is offered by the developments of a gaslight war in Yonkers, just north of New York. One company came down from $2.00 to $1.50. Two other companies thereupon dropped to $1.25, and avowed their intention and ability to put the price at fifty cents per thousand feet, if circumstances should require. The question naturally arises, what is gas worth, or is there any logical or arithmetical process by which its proper cost to the consumer can be determined? It appears that it may range from $3 down to fifty cents, within a district of ten miles radius, with nothing in the climate or topography to account for its extreme elasticity. An offer to sell flour at $1 per barrel, as against a rival quotation of $6 or $4, would excite a profound surprise, being a clear agricultural and commercial impossibility. But there seems to be something in gas which enables it to rise superior to the laws of nature and the ordinary conditions of trade.

How long will the learned writers on Physics, or as some still call it, Natural Philosophy, continue to use for their illustrations the ancient and honorable cuts of steam boilers and engines, the originals of which are beyond the memory of the oldest inhabitants. This also applies to the publishers of Webster's Unabridged Dictionary. Let us have something not *over* a hundred years old. We pay enough for it.

The American Iron and Steel Association on the Condition of Business.

The Executive Committee of the American Iron and Steel Association, at a full meeting of its members, held at Philadelphia, on February 12th, issued this brief address to all iron and steel manufacturers in the United States:

1. We congratulate the American manufacturers of iron and steel, and the country generally, upon the prospect that the depression in business which has continued for about two years is apparently nearing its end. With an abundance of good money, with good crops of all leading staples, with prices for all products and for all reputable railroad and mining stocks so low that they cannot be expected to go any lower, with the wide liquidation that has taken place in all business circles, with our productive energies fairly adjusted to the country's wants, and with political excitement at an end, only one element necessary to secure a revival of business prosperity is lacking, and that is confidence in the future of values. This element we believe is now reappearing, and as the year advances we believe that it will become more and more manifest. There is much in the business situation to encourage a feeling of hopefulness, and there is absolutely no ground whatever upon which to base the apprehension that a prolonged continuance of the present depression is possible.

2. We regard as of much significance the fact that the production of iron and steel n this country during the past year, with the single exception of iron rails, reached an ggregate tonnage that was in excess of the production attained in any preceding year, xcept 1881, 1882, and 1883. It was much greater than in the boom year, 1880, and was

double the production of the centennial year, 1876. It may also be said that the country's large production of iron and steel during the yast year entered at once into consumption. There was no abnormal accumulation of stocks at the close of the year. These facts abundantly prove that the country's requirements for iron and steel are still large, indicating a less degree of depression than has been generally supposed, and that the financial condition of the country is so favorable that it is able to pay for the iron and steel it wants. The same healthy conditions, we believe, now surround many other manufacturing industries of the country.

3. As one important means of restoring business prosperity to the country we counsel the cultivation everywhere of a spirit of confidence in the incoming Administration of the General Government. Until the new Administration has announced or approved some policy that is unfriendly to American industry, or that threatens our financial stability, we believe the business community should accept the declaration of the successful party—that it will attempt no radical change in government policy in relation to either revenue or financial questions—as having been made in good faith. We do not say that there exists no evidence that leading members of the successful party will not propose disturbing financial legislation or a serious modification of our protective policy, but we do say that as yet there exists no evidence that the President-elect will call about him advisers who will recommend a reactionary course or who will approve it if recommended by others.

4. There is also in several well-established facts, further reason for confidence in the stability of our protective system and our existing financial system. An influential wing of the successful party is pledged to the continued support of our protective policy; the Southern people, who have heretofore been inclined toward British revenue theories, are now manifesting an earnest interest in the protective policy; the Senate of the United States will remain in the control of the party which has supported the protective policy for more than a quarter of a century, and a large majority of the new House of Representatives will be composed of members of the same party; and, finally, the so-called reciprocity treaties now pending before Congress are practically dead. In these facts and considerations we think that there may be said to exist every reasonable guarantee that duties on imports will be maintained substantially as they now are for many years to come. The same conservative influences that will preserve our protective policy will also take care that no disturbing financial measure is allowed to become a law.

5. We do not believe in borrowing trouble about future unfriendly tariff legislation that is possible, but not probable, and we therefore call attention to the additional fact that, even if legislation of this character should be attempted under the new Administration, it could not be proposed until after the meeting of the new Congress in December next, and it could not be considered and disposed of until after the expiration of many months thereafter. There is therefore no excuse whatever for the fears of timid or over-cautious people that business cannot improve because the tariff is in danger. We may have tariff agitation a year or two hence, just as we may have at some future time some other calamity that is not now threatened, nor even thought of; but let us hope that such misfortunes will not happen, and resolve to continue to conduct our business as if we had faith in the good sense of the American people and an American Congress.

A FUNNY story of a recent snow blockade on the New York Central railroad has been going the rounds of the press, and is as follows: "About a mile from Spraker's Basin was a drift fifteen feet deep. Gen. Priest ordered nitro-glycerine placed in the bank to blow it out. A drove of hogs strolled up the track, and one of them swallowed a quantity of the explosive. Shortly afterward a freight engine, in trying to force a way through the eastern end of the drift, struck the hog, and a tremendous explosion followed, damaging the engine and blowing a great hole in the drift."

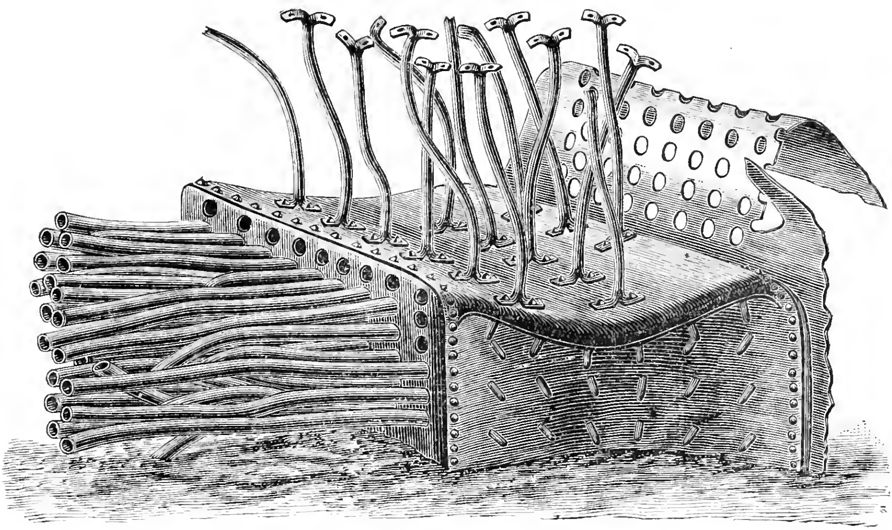
We wonder what became of the hog!

The Use of Steel in Boiler Construction.

We make the following extracts from an article in a recent issue of the *St. Louis Railway Register*:

"We cannot permit an occurrence of last week to go unnoticed. Locomotive No. 76, of the Hannibal & St. Joseph railroad, exploded, or collapsed, her fire-box at Laclede Station one day last week. In answer to our inquiries as to the circumstances attending the disaster, the master mechanic, Mr. N. J. Paradise, writes us from Hannibal as follows:

'Referring to your inquiry dated January 17th, in regard to the 'blowing up' of our engine, No. 76, at Laclede, I would say that it is a false report. The engine was stalled in a snow drift at the foot of a hill. After being cut from the train, she worked her way out and ran up to a station and stopped. The engineer found that his injector was frozen up, and so was unable to get any water into the boiler, it being very low at the time. Another engineer who happened to be there at the time helped him to get his



injector to working. By that time there was no water to be seen in the glass, as had been the case for some time. As soon as the injector got to working, the engineer put in a fire in order to get more steam, having about seventy (70) pounds at the time. When she got up to between ninety (90) and a hundred (100) pounds, the crown sheet gave down, pulling through about eighty (80) bolts in the fire-box. The fire-box was of Otis steel, and in a first-class condition, there being no patch about it, having been built in 1878.'

"In this report we find a lesson in boiler material that must be investigated. To us it carries its own condemnation of the practice of using steel plates in such important work.

"The steel plate-maker establishes his claims for excellence upon the result of cold tests. These cold tests are acceptable principally by reason of the fact that the steel contains such elements as manganese, silicon, and carbon, and the absence of any one would cause the plate to be condemned.

"Since the chemical properties are necessary in the steel plate, and it is conceded that this quality of steel is generally sought for and bought by the railways, let us investigate and learn, if possible, whether or not its use in this particular case, was the very best and most economical course that could have been adopted by the H. & St. J. R. R.

"First, however, we will ask the indulgence of our reader, while perusing the following extract from the *Jahrbuch fuer den Berg und Huttenmann*, which was embodied in a report of the proceedings of the British institution of Civil Engineers:

'The qualities of steel also undergo changes when heated to a high temperature, or when subjected to a lower temperature for too long a time. The richer the steel is in carbon, the lower the temperature at which the change takes place. Therefore, the harder the steel, the more carefully is it to be dealt with in the fire. Such overheated steel becomes coarse-grained and brittle—that is, cold-short. If the temperature be increased, showers of sparks are thrown off, and the steel is said to be 'burned.' The alteration brought about in this way has generally been attributed to a diminution in the proportion of the carbon constituent, though this assumption is not warranted by the results of analysis.

'The presence of manganese and silicon is of more weighty consequence. When steel containing these is heated, it is not the carbon, but the manganese and the silicon, that first become oxidized, and there results an important change in the properties of the steel. Later, the carbon is oxidized; and while the oxide of carbon escapes, those of the manganese and silicon remain behind, and the whole molecular structure of the metal is altered. If the heating be carried still further the iron will next be oxidized.

'A cast-iron furnace door, exposed for several years to the flame of a coal fire, is found to contain 27.8 per cent. of oxygen, in combination with iron, sulphur, nickel, copper, phosphorus, and arsenic. The cause of the sparks is not the combustion of the carbon and the consequent generation of carbonic acid gas, but the escape of gases imprisoned in the steel. Similar results may be brought about by exposing the steel to a lower temperature for a longer time; the oxidation of the constituents will in this case be effected in the order mentioned above, the only difference being in the slower action. Steel altered in this way is well described as 'dead.' A regeneration of the metal by mechanical treatment is hardly possible; since the original chemical composition cannot be restored by such means.'

"We find, from the above unquestioned authority, that a steel plate under a strong heat changes its structure, first by the oxidizing of the manganese and silicon, and if the heat is further increased, the carbon also oxidizes and escapes in a gas; this leaves nothing but the iron to be oxidized, should the heat be still further intensified. Mark well the point: the iron only is left after the other worthless elements have totally disappeared under the increasing heat. This is the principal point we have always maintained and urged, viz.: That the perfectly-made iron would endure after the steel had become worthless and dangerous.

"The daily effect upon the steel plate ultimately produces the same result as the sudden collapse of the fire-box in question, and though the process is slow, it surely changes the structure by gradually eliminating one element after another. *In this particular case the water supply suddenly stops, the water line drops below the crown sheet, the fire first oxidizes the manganese and silicon, then attacks the carbon, and after radically changing the character of the plate, at which stage nothing remains to be dissolved but the iron, it attacks this, the only remaining ingredient.*

"Had the plate been constructed of iron alone, it would have given far better results, even though the iron in a steel plate *partakes of the character of a stove casting.*

"What, however, would have been the result had pure refined charcoal bloom-iron been in use? Consider the thorough refining process it passes through, its fibrous and tenacious structure, its freedom from chemicals or impurities of any kind that will oxidize, its endurance under great heat. Would the pressure of only 100 pounds have collapsed a sheet under like conditions? We think not. Every make of boiler steel is subject to this kind of a change, and the Otis brand is no exceptional case.

"Our case as it stands is complete without referring to the rotten character of a plate of steel having upwards of eighty stay-bolt holes, nearly an inch in diameter, from which must necessarily extend thousands of ray fractures, so frequently discussed in this department."

With all due respect to the *St. Louis Railway Register*, we must say that we emphatically dissent from its views, for the simple reason that they are directly at variance with observed facts.

Mild steel boiler-plates as made at the present time, and for several years past, by the Otis Steel Works, and several other firms, are composed of a very fine homogeneous metal, which is stronger, and what is of more consequence, tougher and more elastic than wrought iron. The absence of the much-talked-of "fiber" in its constitution is one of the features which recommend it, for this is merely owing to its greater homogenity. It is more than possible that the fibrous appearance of rolled iron is due to the presence of cinder in the iron forming the billet or pile from which it is rolled, and which prevents perfect welding. This being the case, "fiber" must be looked upon as a defect in iron.

In consequence of its greater toughness and elasticity, steel plates resist the strains resulting from the expansion and contraction incident to every-day use better than wrought iron under the same conditions. This is manifest in the greater freedom from defects requiring repairs. Blisters, which are such a source of annoyance with iron plates are unknown in steel, for their cause, defective welding of the pile, is absent.

And just a word here in reference to setting up some almanac with an unpronounceable name to settle this question for us. American manufacturers will not be liable to abandon the use of mild steel for boilers, because some foreign theorist finds $27\frac{8}{16}$ per cent. of oxygen in a cast-iron furnace door which has been exposed several years to the flames of a coal fire. The chances are that if the same furnace door had lain out in the open air, away from all fire, for the same length of time, it would have been *entirely* rusted away.

It is time that American engineers relied upon their own brains and experience, and not upon the "say so" of some one who probably never had any practical experience, whatever, with boilers.

Regarding the collapse of the particular crown-sheet referred to, and the labored explanation of the *Register* relating thereto, which we have italicised, we will only say that crown-sheets generally, whether made ot steel, of iron which "partakes of the character of a stove-plate casting," or of charcoal bloom-iron, have the inconvenient peculiarity of "coming down suddenly" when they are heated red hot under a pressure of 90 to 100 pounds. It has been so since boilers were first made, and will probably continue to be so for some time to come.

The idea that flat surfaces are rendered "rotten" by the presence of stays, is also quite a novel one, to us, at least. Why not enact a law prohibiting stays for crown-sheets, if this is the case?

We insert on a preceding page, for the benefit of those interested, a cut illustrating an explosion which occurred some time ago. The complete account may be found in our issue of June 1883. The inspector who made the report says:

"The steel fire-box was badly bulged upon the crown, and also at the sides (see cut). and there were many indications that it had been badly overheated through lack of water, yet it did not fracture." This fire-box was made of Otis steel.

The remainder of the boiler, which was of iron, was torn into fragments. Which partook most of the character of "stove-plate castings?"

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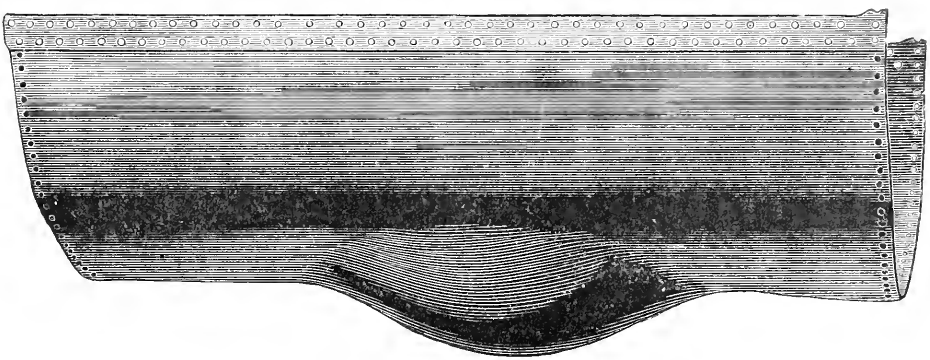
The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

NEW SERIES—VOL. VI. HARTFORD, CONN., MARCH, 1885. No. 3.

The Effect of Oil in Boilers.

We have often referred to the fact that the presence of grease or any of the animal oils in steam boilers is almost certain to cause trouble. Our illustration this month gives a better idea of the effect produced than pages of verbal description possibly could. It is from a photograph, and is nowise exaggerated.



The boilers from which the plate shown in the cut was taken, was a nearly new one. It was made of a well-known brand of mild steel, and that it was admirably adapted to the purpose for which it was used is proved by its stretching as it did without rupture. The dimensions of bulge shown are four feet lengthwise of the boiler, three feet girthwise, and nine inches deep. The metal, originally $\frac{5}{16}$ of an inch thick, drew down to $\frac{1}{8}''$ in thickness at the lowest point of the "bag" without the slightest indication of fracture.

The circumstances under which the bulge occurred may best be described in the words of the inspector who examined the boiler, and are as follows:

"Last Tuesday morning I was called in great haste to the ——— works. Upon arrival I found one of the boilers badly bulged, and with twenty pounds of steam up. I could give no explanation until I had thoroughly examined the internal parts of the boiler. I gave directions for cooling the boiler, and ordered top man-hole plate to be loosened, but not to be taken out until my arrival in the afternoon, that I might see everything undisturbed. This was done. On my arrival I took out the man-hole plates in top of shell and front head . . . . and made an examination.

"I found that the boiler had been cleaned the preceding Sunday, and at that time a gallon or more of black oil had been thrown into it. Monday morning the boiler was fired up and was run through the day at a pressure of 90 pounds per square inch. At 6 o'clock Monday night, the engine was stopped, the drafts were closed, and no more firing was done until 9 o'clock. Upon going to fire up at this time, the bulge was observed. From six to nine o'clock a pressure of only 40 pounds was carried.

"Upon examination, I found the entire boiler saturated with this oil."

This is almost certain to be the result of putting grease into a steam boiler. It settles down on the fire-sheets, when the draft is closed, and the circulation of water nearly stops, and prevents contact between the plates and the water. As a consequence the plates over the fire become overheated; and under such circumstances a very slight steam-pressure is sufficient to bag the sheets. Unless the boiler is made of very good material, the plate is apt to be fractured, and explosion is likely to occur.

When oil is used to remove scale from steam-boilers, too much care cannot be exercised to make sure that it is free from grease or animal oil. Nothing but pure mineral oil should be used. Crude petroleum is one thing; black oil, which may mean almost anything, is very likely to be something quite different.

The action of grease in a boiler is peculiar, but not more so than we might expect. It does not dissolve in the water, nor does it decompose, neither does it remain on top of the water, but it seems to form itself into what may be described as "slugs" which at first seem to be slightly lighter than the water, of just such a gravity, in fact, that the circulation of the water carries them about at will. After a short season of boiling, these "slugs" or suspended drops seem to acquire a certain degree of "stickiness," so that when they come into contact with shell and flues of the boiler, they begin to adhere thereto. Then under the action of heat they begin the process of "varnishing" the interior of the boiler. *The thinnest possible coating of this varnish is sufficient to bring about overheating of the plates*, as we have found repeatedly in our experience. We emphasize the point that it is *not* necessary to have a coating of grease of any appreciable thickness to cause overheating and bagging of plates and leakage at seams.

The time when damage is most likely to occur is after the fires are banked, for then, the formation of steam being checked, the circulation of water stops, and the grease thus has an opportunity to settle on the bottom of the boiler and prevent contact of the water with the fire-sheets. Under these circumstances, a very low degree of heat in the furnace is sufficient to overheat the plates to such an extent that bulging is sure to occur. When the facts are understood, it will be found quite unnecessary to attribute the damage to low water.

This accident also serves to illustrate the perfection to which the manufacture of steel for boiler plates has attained. It would be an extraordinarily good quality of iron that would stand such a test without fracture.

Inspectors' Reports.

JANUARY, 1885.

The total number of inspection trips made during the month of January last foots up 2,783, in the course of which 6,229 boilers were visited. Of this number, 2,038 were inspected internally, 301 were tested by hydrostatic pressure, and 48 were condemned.

3,610 defects were reported, of which 571 were considered dangerous.

The following table exhibits the defects in detail.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	406	43
Cases of incrustation and scale,	486	44
Cases of internal grooving,	26	13
Cases of internal corrosion,	99	31
Cases of external corrosion,	254	48
Broken and loose braces and stays,	56	10
Settings defective,	193	15

Nature of defects.	Whole number.	Dangerous.
Furnaces out of shape,	83	6
Fractured plates,	132	40
Burned plates,	81	23
Blistered plates,	236	10
Cases of defective riveting,	294	36
Defective heads,	49	18
Serious leakage around tube ends,	733	141
Serious leakage at seams,	171	23
Defective water gauges,	90	23
Defective blow-offs,	23	8
Cases of deficiency of water,	8	1
Safety-valves overloaded,	23	10
Safety-valves defective in construction,	25	8
Pressure-gauges defective,	130	18
Boilers without pressure-gauges,	12	2
Total,	3,610	571

As our inspectors are frequently questioned in regard to the Massachusetts State law relating to fusible plugs in boilers, its intent, date of enactment, etc., we insert it here in full.

From the Supplement to the Revised Statutes, 1854.

Chapter 139, Section 1. No person, or corporation, shall use, or cause to be used, any locomotive, or other steam engine, in this Commonwealth, unless the boiler of the same be provided with a fusible safety-plug, to be made of lead, or some other equally fusible material, and to be of a diameter of not less than one-half an inch, which plug shall be placed in the roof of the fire-box, when a fire-box is used, and, in all cases, shall be placed in a part of the boiler fully exposed to the action of the fire, and as near the top of the water-line as any part of the fire surface of the boiler.

Sec. 2. If any person shall without just and proper cause, remove from the boiler of a steam engine, the safety-plug thereof, or shall substitute therefor any material more capable of resisting fire than the said safety-plug so removed, he shall be punished by a fine not exceeding one thousand dollars.

Sec. 3. If any person, or corporation, shall use, or cause to used, in this Commonwealth, for the space of six consecutive days, a steam engine unprovided with the safety-plug as described in the first section, such person, or corporation, so offending, shall be punished by a fine not exceeding one thousand dollars. (April 25, 1849.)

The foregoing was amended to read as follows, in 1850.

Chapter 277, Section 1. No person, or corporation, shall use, or cause to be used any steam boiler in this Commonwealth, unless the same be provided with a fusible safety-plug, to be made of lead or some other equally fusible material, and to be of a diameter not less than one-half an inch, which plug shall be placed in the roof of the fire-box, when a fire-box is used, and, in all cases, shall be placed in a part of the boiler fully exposed to the action of the fire, and as near the top of the water-line as any part of the fire-surface of the boiler; and for this purpose it shall be lawful to use Ashcroft's "protected safety fusible plug."

Sec. 2. If any person shall without just and proper cause, remove from the boiler of a steam engine, the safety plug thereof, or shall substitute therefor any material more capable of resisting the action of the fire than the said safety-plug so removed, he shall be punished by a fine not exceeding one thousand dollars.

Sec. 3. If any person, or corporation, shall use, or cause to be used, in this Commonwealth, for the space of six consecutive days, a steam-boiler unprovided with a safety fusible-plug as named in the first section, such person, or corporation, so offending, shall be punished by a fine not exceeding one thousand dollars.

The statute of 1849 is hereby repealed. (Approved, May 3, 1850.)

The following amendment was enacted in 1852.

Chapter 247, Section 1. If any person, or corporation, shall manufacture, set up, or knowingly use, or cause to be used, in this Commonwealth, a steam-boiler unprovided with a safety-plug as described in the first section of "An Act to prevent the explosion of steam-boilers," passed in the year 1849, such person, or corporation, so offending, shall be punished by a fine not exceeding one thousand dollars.

(Approved, May 18, 1852.)

The Statute as it now stands was adopted at the revision of the statutes in 1859–60, and reads as follows, in the Revised Statutes of Mass., Edition of 1882.

Chapter 102, Section 51. No person shall manufacture, set up, use, or cause to be used, a steam-boiler, unless it is provided with a fusible safety-plug made of lead or some other equally fusible material, and of a diameter not less than one-half an inch, placed in the roof of the fire-box, when a fire-box is used, and in all cases in a part of the boiler fully exposed to the action of the fire, and as near the top of the water-line as any part of the fire-surface of the boiler; and for this purpose Ashcroft's "protected safety fusible-plug" may be used.

Sec. 52. Whoever without just and proper cause removes from a boiler the safety-plug thereof, or substitutes therefor any material more capable of resisting the action of the fire than the plug, so removed, shall be punished by fine not exceeding one thousand dollars.

Sec. 53. Whoever manufactures, sets up, or knowingly uses or causes to be used for six consecutive days a steam-boiler unprovided with a safety fusible-plug as described in section fifty-one, shall be punished by fine not exceeding one thousand dollars.

Boiler Explosions.

January, 1885.

Tug Boat (1).—The boiler of the tug Sol Thomas exploded Jan. 6th, off Empire City, Or. The crew consisted of J. Hill, Captain; George Wadleigh, engineer; J. Tripp, fireman; Louis Nelson, deck hand, and J. Graham, cook, all of whom, except Captain Hill, were instantly killed.

Tug Boat (2).—By the explosion of her boiler, the steam-tug Mike Dougherty was completely demolished near Elizabeth, Pa., Jan. 11th. Two of the crew were killed, and three others badly hurt. The boat had put ashore near Bellevue landing, to make repairs, and the explosion occurred while she lay there.

Phosphate Works (3).—The phosphate works at Pon-Pon, S. C., were blown up Jan. 11th, by the explosion of the boiler. The works leased and operated by a Mr. F. C. Fishbourne. Seven men were seriously injured.

Saw-Mill (4). A fearful explosion occurred in a saw-mill on the south side of the river at Williamsport, Pa., Jan. 12th. The mill was located on what is known as the Weigel tract, near the base of the mountain. Hardly a vestige of the structure is left. Eight men were in the mill. Peter Houser and Thomas Purvis were killed, and Daniel Bobst, William Betz, Joseph Brady, Andrew Bowers, August Regelmann, and Leon Weigel were severely injured. The boiler had been considered unsafe for some time.

Portions were blown 500 feet. One plate struck the earth, ploughed the ground several feet deep, then bounded off over the edge of a hollow fifty feet beyond. Daniel Bobst, one of the injured men, was the owner of the mill.

Machine-Shop (5).—A large boiler in the basement of the Bauerle & Starck Sewing-machine Manufacturing Company's building, Nos. 224 to 230 West Ohio street, Chicago, Ill., exploded with terrific force, Jan. 12th, tearing through the walls of the building and shaking the earth for several blocks. Ten minutes before the boiler blew up the engineer went away from the building, leaving the watchman, Paul Boerner, in charge, and Boerner had the good luck to be out in the alley dumping ashes when the explosion occurred.

Saw-Mill (6).—The steam saw-mill belonging to J. R. William, eight miles south of Smithfield, Ohio, exploded Jan. 13th, wrecking the building. The boiler was blown a mile away. Loss $5,000. Three persons—John Evans, Hiram Evans, and Willie Armstrong, a boy—were instantly killed. J. G. Evans was horribly burned. Walter Morrison was badly hurt. The cause was too much mud in the boiler.

Chemical Works (7).—At the Solvay Process Soda Ash Works, three miles west of Syacuse, N. Y., a large distilling vessel, weighing four tons, exploded Jan. 13th. It was blown 75 feet in the air and landed inside a building, carrying away the entire roof of a large main building, wrecking the machinery generally and doing damage estimated at about $40,000. Fifty men were at work at the time, twelve of whom were considerably injured by scalding and flying missiles, one seriously.

Rendering Works (8).—An explosion occurred Jan. 13th, in the rendering vats at the pork-packing establishment of James Morrison & Sons, corner of Bank and Riddle streets, Cincinnati, Ohio. The loss will reach $50,000.

Saw Mill (9).—Five men were killed by the explosion of a saw-mill boiler near Good Spring station, between Tremont and Tower City, Pa., Jan. 17th. The mill was owned by Abraham Ernest, and was located on the Schuylkill and Susquehanna branch of the Philadelphia & Reading Railroad. The mill had been run by Ernest for fifteen years, engaged in making mine timbers for the Philadelphia & Reading Company's collieries in the west end of the county. It employed from eight to ten men. The explosion is supposed to have been caused by a defect in the boiler. The killed are Albert Ernest, Henry Collen, Jacob Gehres. Two others, whose names have not yet been learned, are known to have been killed.

Rendering Tank (10).—The lard rendering tank in the pork-packing house of J. E. Booge & Co., Sioux City, Iowa, exploded Jan. 20th, tearing down the building. A very few men were about the tank at the time, but of these John O. Morrall, Joseph French, and John Keelers, were instantly killed. Another man named Joseph Brener, received injuries from which he will probably die. The factory employs 270 men, and had the accident occurred a few minutes later the loss of life would have been terrible. The damage to the building is $25,000.

Saw-Mill (11).—The boiler of a portable saw-mill engine, in Summerhill, Cayuga Co , N. Y., exploded Jan. 22d, with terrific force. Two persons were blown to pieces, and two were shockingly mangled. The engine was being used for sawing lumber. Mr. Benedict's head was crushed and one leg blown off. He cannot recover. His young son was killed outright. Byron, an older son, had one leg torn off and will die. Edward Phelps, the engineer, was blown to pieces.

Saw-Mill (12).—The boiler in Brennan's mill, in the ninth concession of Tyendinaga, Ont., exploded Jan. 24th, blowing the building in pieces and wrecking the machinery, portions of the latter flying 300 yards. The engineer, McMillan, was killed. Simons, the fireman, was also mangled about the legs, and it was thought that he would die.

COLLIERY (13).—The boiler used at the Pierson coal shaft, two miles north of New Castle, Pa., exploded with terrific force, Jan. 27th, shattering the engine-room and the surrounding buildings, and injuring two young men, one, named Benjamin Mullin, probably fatally. The other, Ed. Harris, was pretty badly injured, but will recover. The boiler, thirty feet in length, had been in use only three months. The cause of the explosion is not definitely known.

PAPER MILL (14).—A rotary bleacher at the works of the Reed Paper Company, Versailles, Conn., exploded Jan. 27th, doing much damage to the works, but fortunately no one was seriously injured.

Large Per Cents.

We noticed in one of our exchanges, very recently, an article which treats quite too concisely for the fact and the importance of it, of the stunning recommendations furnished by people with regard to the use of certain steam appliances. The writer of that article reflects very strongly, but very truly, upon the almost infamous practice of some steam users as well as steam engineers, who are always ready to sign a certificate stating that the use of so-and-so's patent ash-barrel cleaner, or whatever else it may be, has saved by careful noting of effects for three months exactly thirty-one per cent. of the fuel used. Or that some other fellow gives a certificate that so-and-so's patent soft soap has removed all the scale and sediment of every kind and description, and has also removed one ton of coal a day, making thirteen, fourteen, or seventeen per cent. less coal than used before. The writer then goes on to show what all practical engineers know full well, that as a rule, several changes are made as well as the particular one referred to, or possibly a change in coal might make the whole difference of eight or ten per cent. without the slightest exaggeration or misconstruction of the fact. The fault to which this gentleman alludes, and he does it very truthfully too, is one which is no particular credit to engineers, superintendents or agents, and such a certificate should be received for exactly what it is worth. We might inquire into all the facts, whether the engineer in a certain case had not perhaps been paid a commission, not only upon the particular attachment used, but perhaps upon any other which had been influenced through or by him; or, that the manufacturer had received a large discount for the attaching of the appliance about which he wrote. It is rather a curious statement, but nevertheless true, and it is equally as true that such a state of affairs should not be allowed to exist. It only brings it down to the fact that men who really do this kind of business are robbing themselves of credit and their own reputation, while at the same time they are doing an injustice, not only to their employers, but also to every one who comes in contact with them in a business way.

There seems to be room for a decided change in these particulars, and there is no good reason why it should not occur very soon. These large percentages only prove the correctness of our oft-repeated assertion that, if a combination of these percentages had any approximation to the truth, our steam-engine users would be running with less than no fuel at all, and a handsome margin left. But the trouble is these percentages do not work, and they not only do not work, but they do work a power of mischief, dissatisfaction, extra expense, loss of time, annoyance, etc., while occasionally one may make a reasonable saving, and in that way influence the introduction of many others. Taken altogether it is a practice which should be stopped. Engineers should be forbidden to sign any such misleading articles, and if they did do it, should be promptly dismissed from their places and sent back among the knownothings, where they belong.—*Manufacturer's Gazette.*

The Locomotive.

HARTFORD, MARCH, 1885.

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

Sensational Circulars.

Our attention has been repeatedly called to a circular, the aim of which is to show that manufacturers are liable for injuries from accidents which may occur on their premises to their employees or others. The object of this circular is evidently to create a public sentiment hostile to the manufacturer, by conveying the impression that anybody who is injured on his premises has a just claim against him, whether the accident was the result of carelessness or negligence on the part of the proprietor or not.

A letter from Messrs. Bulman and Brown is published, showing that under advice of eminent counsel they paid a large amount of money to satisfy claimants for damages and injuries resulting from the explosion of a boiler on their dry dock. The impression conveyed is that under the laws there was no help for them; but the circumstances under which the boiler exploded are not given, nor the verdict of the coroner's jury making the inquest. An account of this explosion was given in the LOCOMOTIVE for November, 1881. The case was examined by a competent person in the employ of this company, in connection with others. It was ascertained that the safety valve had been neglected, and that the stem was corroded fast in the bonnet, so much so that it required a pressure of 3,200 lbs. to lift the valve $\frac{1}{32}$ of an inch, and 4,000 lbs. to lift it $\frac{1}{4}$ of an inch from its original position. Four thousand pounds on the whole area of safety-valve would be equivalent to 816 lbs. per square inch on the boiler. This pressure was not probably attained, but sufficient pressure was reached to rend the boiler in pieces, the inoperative safety-valve (?) being of no use. But this was not all. The testimony before the coroner's jury went to show that the boiler, although believed to be a very good one, not more than three years old, had very indifferent care, by an incompetent and overworked engineer. He acted as fireman and engineer, and arranged the blocks for the reception and discharge of vessels, sometimes did caulking or keel work on vessels. He was sometimes absent assisting in moving barges, and admitted being absent forty-five minutes from the boiler at the time of the explosion. In view of the facts the coroner's jury rendered a verdict censuring the firm for their negligence in leaving the boiler without an engineer for nearly an hour. We quote from the verdict as follows:

"*That the effective cause of the explosion on the morning of Sept.* 13, 1881, *of the boiler on the dry dock of Bulman and Brown, located at the foot of Essex St., Jersey City, N. J., causing the death of Lionel D. Decker, was from an imperfect safety-valve in the hands of a careless, incompetent engineer, in the person of George Everson. And we further censure Messrs. Bulman and Brown for leaving the boiler without an engineer from* 7 *to* 8 *o'clock in the morniag.*"

In view of the foregoing, the counsel for Messrs. Bulman and Brown had no alternative but to advise them to settle with claimants at once. Gross negligence was proved by the coroner's inquest, and the courts would have endorsed their findings with heavy penalties. Had there been no negligence proved on the part of Bulman and Brown, there could have been no case against them. There are numerous decisions by the courts, that where in such cases negligence is not proved, liability is not established. We have successfully fought a persistent effort, more than once, to fasten liability upon us, outside of our policies of insurance, for the carelessness or negligence or both of some other person. Boiler explosions may occur from circumstances entirely beyond the control of proprietor or engineer, and the life and accident feature of boiler insurance is as legitimate as any other insurance. But the steam user should fully understand what the liability is in such cases, and not be misled by circulars that state only half the facts; and further, he should be careful to secure a policy that will not unwittingly commit him to a greater liability than he insures against.

In the January Locomotive we made some comments upon an article that had appeared in several Journals, concerning the death of an engineer at the Laflin & Rand Powder Works, who was overcome and lost his life by carbonic acid gas, while inside of a boiler. We questioned whether a boiler could be filled with such gas, and suggested that there might be a cause for the foul condition of the boiler which was not explained, or that the man was in some flue which was connected directly with the furnace, where a smoldering or nearly extinguished fire might give off such gas. We are now unable to account for the gas being in the boiler, for if the "*blow*" connected with the sewer was open, any foul gas from that source would be heavier than air. Any pressure, however, in the sewer would, no doubt, force the gas up into the boiler, and if the "blow-valve" was left open after the water was drawn out of the boiler its foul condition might be accounted from that fact. The following letter from Chief Inspector Fairbairn of our North-Eastern department, relates a similar experience which he once had. We also cheerfully publish a letter from Egbert P. Watson, editor of the *Mechanical Engineer*, in whose paper the notice of the accident appeared.

Boston, Mass., March 3, 1885.

Editor Locomotive, Hartford, Conn.

Dear Sir:—With regard to the assertion that the engineer at the Laflin & Rand Powder Works died from the effects of carbonic acid gas in a steam-boiler, I would say, from my own experience, that I do not doubt it. Some years ago I had occasion to inspect two boilers at the Berkley Hotel, in Boston, Mass. They were blown off the night before into a sewer or cess-pool. As soon as the water was blown out the steam that remained condensed, formed a vacuum taking up carbonic acid gas, or any other gas that might be generated, or in, the sewer at the time. I took off the man-hole plate and got into one of the boilers, and almost instantly respiration stopped, and it was with difficulty that I got out. After getting out I put in a lighted candle and that went out instantly. I then took out the hand-hole plates in order to create a current of pure air through the boiler before I could again enter. I cannot see any reason why even an explosion cannot be produced if a gas main should leak and fill the sewer with hydrogen-gas and a lighted candle should be held at the man-hole.

I remain yours respectfully, WM. U. FAIRBAIRN.

New York, February 26, 1885.

Editor Locomotive:—In reference to the article in the Locomotive of January, on the death of the engineer at Laflin & Rand Powder Works, I may say that this boiler had been out of use a long time, and was very foul. It is possible that it was not carbonic acid gas which overcame the engineer, but "marsh gas," arising or generated by the rubbish in the boiler. The facts as stated in our paper were correct.

Recently, a boiler in the Elizabethport shop, Philadelphia & Reading R. R., which had *been standing two weeks in the shop with two or three bursted flues*, was approached by a man with a light, searching for the leaky tubes. A terrific explosion ensued. This seems to me more anomalous than anything yet chronicled.

Respectfully, EGBERT P. WATSON.

We have received from Mr. J. B. Warner, Chief Inspector in our San Francisco office, a photograph and description of a steam bicycle, which seems to display considerable ingenuity in its design. The machine is the invention of Mr. L. D. Copeland of San Francisco.

The attachment consists of boiler and engine complete, which weigh (for a 51-inch wheel) 18 pounds, the weight of the engine and fly-wheel alone being only $1\frac{3}{4}$ pounds.

The height of boiler is 18 inches, its diameter $4\frac{1}{2}$ inches, except the steam room at top, which is 6 inches in diameter. Benzine is used for fuel, and the boiler is fitted with water gauges, steam guage, safety-valve, whistle, and fuel pump complete.

The engine is fitted with a slide valve and Myer's independent cut-off. The speed attained is said to be from twelve to fifteen miles per hour.

In a recent number of the Boston *Journal of Commerce* is an interesting illustrated article on a new method of showing an indicator card on a screen by means of an instrument attached to the cylinder of the engine. In this instrument is a diaphragm which undergoes a slight movement under the varying pressures of steam, when the engine is at work. This motion causes a beam of light to be reflected from a mirror, which is hung upon a spring pivot communicating with the diaphragm. Other appliances give the horizontal motion, and as a result the beam of light traces the card on a screen placed on the wall of the room or at some convenient distance. It is a new departure in steam engine indicators, and will no doubt be carefully studied by those who are interested in the general subject of indicators.

An apparatus for cleaning the flues of vertical boilers is also described in the same Journal. It consists of two strips of spring-steel encased in a bent iron tube, which is introduced through the furnace door of the boiler to the flues to be cleaned. The flexibility of the strips of steel enable them to travel through the bent tube by means of a device which is worked by hand on the outer end of the tube. To the inner end of the flexible strips of steel the flue brush or scraper is attached. The strips of steel are sufficiently stiff to prevent buckling. If the apparatus accomplishes all that is claimed for it, and we understand that it has been thoroughly tested, it is a good thing. The difficulty of cleaning the tubes in vertical boilers in the ordinary way, especially where the ceiling of the boiler-room is low, is well known to all who have had to do with such work.

Compound Engines.

Editor of Locomotive:

Sir: It may be of sufficient interest to note in the Locomotive the early manufacture of compound steam-engines in Hartford, by Mr. John Smart. He claimed the invention of that method of using steam expansively, but though his idea had been anticipated, he still stands entitled to high credit for his discernment in advocating compound engines, which were then unknown (almost) and quite unapproved, but are now regarded by engineers as indispensable for marine service.

Very truly yours. E. W. Ellsworth.

Extract from "Supplement" to the *Courant*, Hartford, Saturday, January 6, 1849.

"*Notes by a Man about Town.*—In the rear of the Post Office is located a pile of irregularly constructed buildings occupying the central portion of the city. . . . Entering through a long gangway we come first to the coffee and spice factory of Mr. Gurdon Fox. In the basement you will observe a steam-engine of ten-horse power, in which a new principle or modification of steam power is developed. The steam is worked twice over. passing as live steam into one engine, and from thence by a conduit pipe into another engine, which is run altogether by this exhausted or 'second-hand' steam. Formerly two engines of five-horse power each were here employed, both worked by 'live steam,' *i. e.*, steam directly from the boiler, or new steam. At present, one engine of five-horse power worked by live steam, and another engine of larger size, worked only by the exhausted steam, are run in place of the former, making a great saving in fuel, and at the same time giving, it is said, a greatly increased power. The discovery was made by Mr. John Smart, machinist, of this city, and for which he is about securing a patent."

The above, from Mr. E. W. Ellsworth of East Windsor Hill, Conn., is of considerable local interest, but as a matter of fact, while Mr. Smart may never heard of compound engines, in which case he is entitled to great credit for originality and ingenuity in working out the principle, the double cylinder or compound engine was first suggested by Jonathan Hornblower, an English engineer, who took out a patent on the use of two cylinders in which to effect the expansion of the steam on the 13th of July, 1781. His specification reads as follows:

"I use two vessels in which the steam is to act, and which in other steam engines are generally called cylinders.

"I employ after it has acted on the first vessel to operate a second time on the other, by permitting it to expand itself, which I do by connecting the vessels together, and forming proper channels and apertures, whereby the steam shall occasionally go in and out of the said vessels."

Hornblower's engine was a failure for two reasons: First, the pressures in use at the time were so low that no advantage was derived from the expansion: and second, because Watt owned patents on about everything of any value in connection with steam engines, so it would appear that if the engine had been of any value he could not have built it without Watt's consent.

Twenty three years later, when higher pressures began to be used, Arthur Woolf applied the same principle to the engines of Trevithick, for which he obtained a patent in 1804. In the Woolf engine the steam is exhausted from the high pressure cylinder directly into the larger or low pressure one.

Thirty years afterward Ernest Wolff (not Woolf) invented a compound engine, the essential features which distinguished it from those previously built being a receiver between the two cylinders. Wolff's patent was granted in 1834.

These two patents cover the distinctive features of the two styles of compound engines, — the Woolf, in which the steam exhausts directly from one cylinder into the other; and the Wolff, in which there is a receiver between the two cylinders.

Many patents have been granted since 1804, on various details and methods of arranging the parts of compound engines. Most of them have been of little value, with the exception, possibly, of that of Jonathan Dickson (1837), which proposes to reheat the steam after it has been used in the first cylinder. This is done to some extent at the present day, and we believe with good results.—(Ed. Locomotive.)

A California Snake-Story.—A man engaged near Hurleton lately in filling up an old mining-shaft, found that thousands of swallows had built their nests and made their homes in the shaft, and they flew out in great numbers as he shoveled. After working a time he went home, but returned the following morning. No sooner had he begun his work than out the swallows flew in clouds. Soon he was startled by a cold, slimy, wriggling snake falling upon his back. He supposed it came from a bush near by, but on looking up beheld a cloud of birds holding snakes in their claws, which they were trying to let fall on their enemy. It is needless to say he gathered up his pick and fled.

Condition of Carbon in Steel.

A report of a committee to the English Institution of Mechanical Engineers states that the results of many experiments made appear to warrant the following conclusions in regard to characteristics, recognizable by chemical examination, that are exhibited by different portions of one and the same sample of steel presenting marked physical differences consequent upon their exposure to the hardening, annealing, or tempering processes.

1. In annealed steel, the carbon exists entirely, or nearly so, in the form of a carbide of iron, of uniform composition (Fe_3C or a multiple thereof), uniformly diffused through the mass of metallic iron.

2. The cold rolled samples of steel examined were closely similar in this respect to the annealed steel, doubtless because of their having been annealed between the rollings.

3. In hardened steel, the sudden lowering of the temperature from a high red heat appears to have the effect of preventing or arresting the separation of the carbon, as a definite carbide, from the mass of the iron in which it exists in combination; its condition in the metal being, at any rate mainly, the same as when the steel is in a fused state. The presence of a small and variable proportion of carbide of iron in hardened steel is probably due to the unavoidable or variable extent of imperfection or want of suddenness of the hardening operation; so that, in some slight and variable degree, the change due to annealing takes place prior to the fixing of the carbon by the hardening process.

4. In tempered steel, the condition of the carbon is intermediate between that of hardened and annealed steel. The maintenance of hardened steel in a moderately heated state causes a gradual separation (within the mass) of the carbide molecules, the extent of which is regulated by the degree of heating, so that the metal gradually approaches in character to the annealed condition; but even in the best result obtained with blue-tempered steel, that approach, as indicated by the proportion of separated carbide, is not more than about half-way toward the condition of annealed steel.

5. The carbide separated by chemical treatment from blue and straw tempered steel has the same composition as that obtained from annealed steel.

Pyrometers.

Mr. W. R. Browne, writing in *Nature*, gives an interesting historical sketch of the advances made in pyrometry:

The accurate measurement of very high temperatures, he observes, is a matter of great importance, especially with regard to metallurgical operations; but it is also one of great difficulty. Until recent years the only methods suggested were to measure the expansion of a given fluid of gas, as in the air pyrometer; or to measure the contraction of a cone of hard, burnt clay, as in the Wedgewood pyrometer. Neither of these systems were at all reliable or satisfactory. Lately, however, other principles have been introduced with considerable success, and the matter is of so much interest, not only to the practical manufacturer, but also to the physicist, that a sketch of the chief systems now in use will probably be acceptable. He will thus be entitled to select the instrument best suited for the particular purpose he may have in view.

The first real improvement in this direction, as in so many others, is due to the genius of Sir William Siemens. His first attempt was a calorimetric pyrometer, in which a mass of copper at the temperature required to be known is thrown into the water of a calorimeter, and the heat it has absorbed thus determined. This method, however, is not very reliable, and was superseded by his well-known electric pyrometer. This rests on the principle that the electric resistance of metal conductors increases with the temperature. In the case of platinum, the metal chosen for the purpose, this increases up to 1500° C. is very nearly in the exact proportion of the rise of temperature. The principle is applied in the following manner: A cylinder of fire-clay slides in a metal tube, and has two platinum wires $\frac{1}{100}$ inch in diameter wound round it in separate grooves. Their ends are connected at the top to two conductors, which pass down inside the tube, and end in a fire-clay plug at the bottom. The other ends of the wires are connected with a small platinum coil, which is kept at a constant resistance. A third conductor starting from the top of the tube passes down through it and comes out at the face of the metal plug. The tube is inserted in the medium whose temperature is to be found, and the electric resistance of the coil is measured by a differential voltameter. From this it is easy to deduce the temperature to which the platinum has been raised. This pyrometer is probably the most widely used at the present time.

Tremeschini's pyrometer is based on a different principle, viz., on the expansion of a thin plate of platinum, which is heated by a mass of metal previously raised to the temperature of the medium. The exact arrangements are difficult to describe without the aid of drawings, but the result is to measure the difference of temperature between the medium to be tested and the atmosphere at the position of the instrument. The whole apparatus is simple, compact, and easy to manage, and its indications appear to be correct, at least up to 800° C.

The Trampler pyrometer is based upon the difference in the coefficients of dilatation for iron and graphite, that of the latter being about two thirds that of the former. There is an iron tube containing a stick of hard graphite. This is placed in the medium to be examined, and both lengthen under the heat, but the iron the most of the two. At the top of the stick of graphite is a metal cap carrying a knife-edge, on which rests a bent lever pressed down upon it by a light spring. A fine chain attached to the long arm of this lever is wound upon a small pulley; a larger pulley upon the same axis has wound upon it a second chain, which actuates a third pulley on the axis of the indicating needle. In this way the relative dilatation of the graphite is sufficiently magnified to be easily visible.

A somewhat similar instrument is the Gauntlett pyrometer, which is largely used in the north of England. Here the instrument is partly of iron, partly of fire clay, and the difference in the expansion of the two materials is caused to act by a system of springs upon a needle revolving upon a dial. The Ducomet pyrometer is on a very different principle, and only applicable to rough determination. It consists of a series of rings made of alloys which have slightly different melting points. These are strung upon a rod, which is pushed into the medium to be measured, and are pressed together by a spiral spring. As soon as any one of the rings begins to soften under the heat, it is squeezed together by the pressure, and as it melts, it is completely squeezed out and disappears. The rod is then made to rise by the thickness of the melted ring, and a simple apparatus shows at any moment the number of rings which have melted, and therefore the temperature which has been attained. The instrument cannot be used to follow variations of temperature, but indicates clearly the moment when a particular temperature is attained. It is, of course, entirely dependent on the accuracy with which the melting points of the various alloys have been fixed.

Yet another principle is involved in the instrument called the "thalpotasimeter," which may be used either with ether, water, or mercury. It is based on the principle that the pressure of any saturated vapor corresponds to its temperature. The instrument consists of a tube of metal partly filled with liquid, which is exposed to the medium which is to be measured. A metallic pressure gauge is connected with the tube and indicates the pressure existing within it at any moment. By graduating the face of the gauge when the instrument is at known temperatures, the temperature can be read off directly from the position of the needle. From 100° to 220° F., ether is the liquid used, from thence to 680° it is water, and above the latter temperature mercury is employed.

Another class of pyrometers having great promise in the future is based on what may be called the "water-current" principle. Here the temperature is determined by noting the amount of heat communicated to a known current of water circulating in the medium to be observed. The idea, which was due to M. de Saintignon, has been carried out in its most improved form by M. Boulier. Here the pyrometer itself consists of a set of tubes, one inside the other, and all inclosed for safety in a large tube of fire-clay. The central tube or pipe brings in the water from the tank above, where it is maintained at a constant level. The water descends to the bottom of the instrument, and opens into the end of another small tube called the explorer (*explorateur*). This tube projects from the fire clay casing into the medium to be examined, and can be pushed in or out as required. After circulating through this tube the water rises again in the annular space between the central pipe and the second pipe.

The similar space between the second pipe and the third pipe is always filled by another and much larger current of water, which keeps the interior cool. The result is that no loss of heat is possible in the instrument, and the water in the central tube merely takes up just so much heat as is conducted into it through the metal of the explorer. This heat it brings back through a short india-rubber pipe to a casing containing a thermometer. This thermometer is immersed in the returning current of water and records its temperature. It is graduated by immersing the instrument in known and constant temperatures, and thus the graduations on the thermometer give at once the temperature, not of the current of water but of the medium from which it has received its heat. In order to render the instrument perfectly reliable, all that is necessary is that the current of water should be always perfectly uniform, and this is easily attained by fixing the size of the outlet once for all, and also the level of water in the tank. So arranged the pyrometer works with great regularity, indicating the least variation of temperature, requiring no sort of attention, and never suffering injury under the most intense heat; in fact, the tube, when withdrawn from the furnace, is found to be merely warm. If there is any risk of the instrument getting broken from fall of materials or other causes it may be fitted with an ingenious self-acting apparatus shutting off the supply. For this purpose the water which has passed the thermometer is made to fall into a funnel hung on the longer arm of a balanced lever. With an ordinary flow the water stands at a certain height in the funnel, and while this is so, the lever remains balanced; but if from any accident the flow is diminished, the level of the water in the funnel descends, the other arm of the lever falls, and in doing so releases two springs, one of which in flying up rings a bell, and the other, by detaching a counterweight, closes a cock and stops the supply of water altogether.

It will be seen that these are not adapted for shifting about from place to place in order to observe different temperatures, but rather for following the variations of temperature at one and the same place. For many purposes this is of great importance. They have been used with great success in porcelain furnaces, both at the famous manufactories at Sèvres, and at another porcelain works in Limoges. From both these establishments very favorable reports as to their working have been received.—*Mechanics.*

What will Burst a Gun.

In bravado a young man placed the muzzle of his fowling-piece under the water and fired the charge. The result was the bursting of the barrel near the breech, and the mutilation of his hand. Another placed and held the muzzle of his gun square against a piece of plate window-glass, and fired the charge—powder and bullet. The glass was shattered, so was the gun-barrel. Another instance was that of an experimenter who had heard that a candle could be fired from the barrel of a gun through an inch-board. He drove a candle into the muzzle of the gun, fired, and the explosion split the barrel almost its entire length, and did not even drive the candle from the muzzle. Still another burst of a gun-barrel was caused by the use of wet grass for a wad, well rammed down over a charge of shot. But perhaps one of the most singular exhibitions in this line was a Colt's navy revolver, which some years ago was sent to the factory in Hartford, Ct. This was before the adaptation of these pistols to the metallic cartridges, and it is probable that in loading with open powder and ball only a small amount of powder got into the chambers, and the bullet was not propelled with sufficient force to drive it from the muzzle; at least the bullet did not go out, but lodged. As the shooter did not know whether the bullet escaped or not, but kept on firing until the barrel burst or bulged, and when it was sawed in two longitudinally there were found fourteen bullets wedged one into the other, and so much "upset" by the hammering of the successive explosions of the powder-charges that some of them were not less than one inch diameter, flattened discs instead of conical bullets.—*Manufacturer and Builder.*

Cocoaine Hydro-Chlorate and Electricity in Surgery.

A delicate and highly successful operation was recently performed in this city by a specialist in throat diseases, which demonstrated the wonderful advance that surgery has made in the last few years, and the peculiar adaptation of the new anæsthetic, hydrochlorate of cocoaine, to cases of minor surgery.

The patient, a middle-aged man, has been for many years a teacher in the public schools of Newark. For the last two years he has been troubled with a difficulty in the throat which has been variously diagnosed by physicians, one prominent in the profession having pronounced it a case of hay-fever, and treated it as such, without, of course, effecting a cure, as the real difficulty was of an entirely different character. Medicines failed to give any relief, and the patient gradually lost flesh and strength until he became alarmed at his condition, and came to this city for advice. Being seated in a reclining chair in the surgeon's office, a powerful light was reflected from a mirror, which was perforated through the center, into the patient's throat. By the aid of a larynogoscope (which is a small mirror attached to a handle at nearly a right angle) placed in the rear of the mouth, the light was thrown into the rear nasal passage, and a large tumor was discovered. Its base was attached to the mucous membrane at the top of the nasal passage, just to the rear of the two openings leading into the nose. The tumor had also grown forward into the left nostril, and covered the opening into the right, so no breath could be taken through the nose, and the mouth hung wide open nearly all the time. An operation was advised, and a week later appointed as the time.

The removal of a tumor of this sort was formerly a most serious affair and usually ended in death. The patient at first had to be etherized. As a preliminary step, the windpipe was opened externally and a tracheotomy tube inserted therein, so that the patient could breathe through it, after the mouth and throat had been packed firmly with cotton, to prevent the blood from running into the lungs. Then an incision was made from a point near the inner corner of the eye along the side of the nose, through the upper lip, and the cheek was dissected up and laid back from the bone. The upper jaw-bone was cut through and a section removed sufficiently large to permit the tumor to be handled. A knife was applied to the root of the tumor, and it was cut off or forcibly torn out with forceps. The great danger was from hemorrhage, on account of the large number of blood vessels located in this region, and great difficulty was experienced in binding and tying lacerated arteries in the small space exposed to view. Surgical science has advanced to such an extent that now, that in the treatment of these cases, at least, the surgeon's knife, the etherizing cone, and the dread that affected both patient and surgeon alike are happily laid aside forever.

The school teacher came again to the surgeon's office, and was placed in an operating chair, and his head was pressed as far backward as ease and comfort would permit. The mucous membrane of the mouth, throat, tongue, nostrils, and rear nasal passage was painted with a small camel's hair brush, that had been saturated in a 4 per cent. solution of the hydro chlorate of cocoaine. This was kept up for about ten minutes, and the parts were found to be in a state of perfect anæsthesia. An elastic probe, to the end of which was fastened a piece of whip cord, was gently forced through the left nostril until it appeared in the throat. The cord was then seized with a pair of forceps, and drawn through the mouth, one end being left suspended from the nose. To this end a fine piece of platinum-wire bent in the form of a loop was attached, and slowly drawn through the nostril until it was seen glistening in the patient's throat. The tumor was then drawn as far into the mouth as possible and the platinum loop was forced upward around it, being pulled through the nostril at the same time, until it reached the point where the tumor was suspended. That portion of the wire which ran from the tumor through the nose was insulated with two small tubes that had been heavily wound with silk thread, so that the only portion of it that was exposed was that which touched the tumor. The two ends of the wire, which hung about six inches from the nostril, were then attached to a galvano-cautery battery. By turning the wheel and ratchet attachment the platinum loop was drawn tightly around the neck of the tumor.

Everything being in readiness, an electric current was sent through the wire. In an instant the insulated section became white hot, and smoke from the burning flesh poured out of the mouth. The current was shut off in five seconds, and after waiting until the wire cooled a little, the wheel and ratchet were worked and the loop was drawn through the baked flesh, until the patient indicated pain by contracting the forehead. The process of heating, cooling, and tightening the loop was repeated and continued, until finally, by pulling gently upon a pair of forceps, which as a precaution had been fastened to the tumor through the mouth, to prevent it from falling into the windpipe, the neck of the tumor was severed close to the point of union. It was pear-shaped, two inches long, and one and a half inches in diameter. Five minutes had elapsed from the time the electric current was turned on, to the end of the operation. Not a drop of blood escaped.

The relief of the patient was immediate. His mouth closed naturally and for the first time in many months he was able to breathe through the nose. There was little exhaustion from shock, and in two hours the patient was on his way home. Three days afterward he was attending to his duties, a well man.

The removal of naso-pharyngeal tumors by the galvano-cautery has been done but a few times, and this case is the first in which cocoaine was used instead of ether as an anæsthetic. It did its work as well as the ether could possibly have done, and without the distressing after effects.—*N. Y. Tribune.*

The way to get credit is to be punctual in your payments. The way to preserve it is not to use it too much. Settle often. "Short reckonings make long friends."

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

NEW SERIES—VOL. VI. HARTFORD, CONN., APRIL, 1885. No. 4.

Peculiar Cases of Corrosion.

The boiler-head shown in the cut below illustrates a peculiar case of corrosion which is very interesting in many respects.

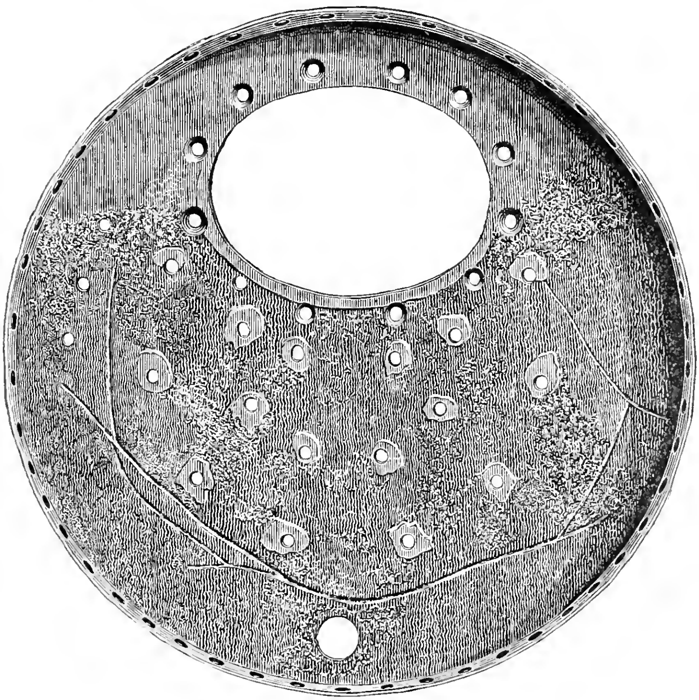


FIG. 1.

The boiler from which the head illustrated was taken, was one of a battery used for furnishing the necessary power at a coal mine in the western part of the country. They were, contrary to our advice, fed with water impregnated with the products of the mine. This contained much sulphur, and we attribute the severe corrosive action of the water to the presence of this substance. The appearance of the head is well shown in the illustration, which is from a photograph taken by us, while the actual amount of the corrosion, or depth to which it had penetrated, is better shown in Fig. 2, which is a vertical section through the center of the head. In Fig. 2 the proportion of vertical to horizontal scale is as 1 to 4, in order to more clearly show the extent of the corrosive action.

In some extended patches the corrosion is deeper than is shown in Fig. 2, being, in fact, $\frac{2}{5}$ of the entire thickness of the head. The original thickness was $\frac{5}{16}$ of an inch. In several places but $\frac{1}{8}$ of an inch of the metal is left. But eight months elapsed from the time the boiler was put in new until it had to be taken out dangerously corroded, as shown.

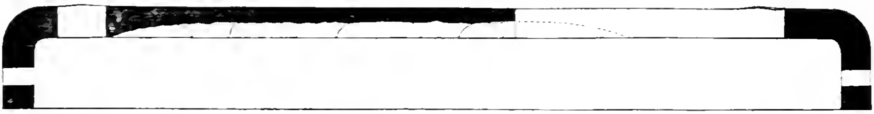


Fig. 2.

The bosses shown in Fig. 1 are where the braces were attached, and where, of course, there was no corrosion. The lines shown are small, rounded grooves or channels, about $\frac{1}{4}$ of an inch wide, and $\frac{1}{16}$ of an inch deep. The appearance is very peculiar. They are as smooth as though planed out and finished with a round file. Their cause has not been, as yet, satisfactorily explained. The only suggestion that we can offer is that the lines show the boundaries of the different heats taken in flanging the head, and that some molecular change took place at the junction of the hot and cold portions which rendered that portion more susceptible to corrosive action. Still, we do not attempt to *explain* the phenomenon in this manner.

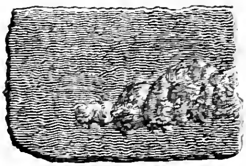


Fig. 3.

Fig 3 shows another form of corrosion which is peculiar in some respects. The origin of its peculiarity is in the water. This water makes some scale,—not an excessive amount. When tannin is used as a solvent for this scale, no trouble whatever is experienced: the boiler may be, with very little effort, kept in an almost polished condition internally. But when left to itself, or when certain patented compounds have been tried, the effect is most disastrous. Scale is formed in patches only, beneath which corrosion goes on with surprising rapidity. A few months only are necessary to make a hole through a plate, as shown in our illustration.

Inspectors' Reports.

February, 1885.

The number of inspection trips made during the month of February last was 2,898, the total number of boilers examined being 5,366. The number of boilers inspected internally was 1,356; 237 others were tested hydrostatic pressure, while 42 were found unsafe for further use, and were condemned. 3,627 defects were reported, of which 520 were considered dangerous. The usual tabulated statement of defects is given below.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	369	31
Cases of incrustation and scale,	358	29
Cases of internal grooving,	21	2
Cases of internal corrosion,	128	9
Cases of external corrosion,	265	39
Broken and loose braces and stays,	51	22
Settings defective,	199	29
Furnaces out of shape,	79	18
Fractured plates,	102	48
Burned plates,	82	31
Blistered plates,	215	6

Nature of defects.	Whole number.	Dangerous.
Cases of defective riveting,	606	54
Defective heads,	19	7
Serious leakage around tube ends,	506	95
Serious leakage at seams,	233	32
Defective water-gauges,	105	8
Defective blow-offs,	35	11
Defective feeding apparatus,	1	0
Cases of deficiency of water,	15	4
Safety-valves overloaded,	34	9
Safety-valves defective in construction,	53	18
Pressure-gauges defective,	146	18
Boilers without pressure-gauges,	6	0
Total,	3,627	520

The feeding apparatus for boilers should always receive the closest attention, in order that it may not become inoperative, for, if this happens, it is evident that the boiler *must* be stopped until it can be put into working condition again.

Fortunately, there are, at the present time, almost any number of perfectly reliable boiler-feeders, both pumps and injectors, which are offered for sale at such reasonable prices that no excuse can be made for running a boiler with any sort of a makeshift apparatus. Of course, the representative of every pump or injector thinks, and will stoutly maintain, that his article is the very best that ever was or can be designed for the purpose; but, leaving off, which we may safely do, all extravagant claims, there still remains sufficient merit in any of the well-known pumps or injectors for all practical purposes. They will *all* feed boilers well if properly handled and cared for.

It is always well, and almost a necessity in establishments of any considerable size, to have duplicate and independent feeding-apparatus for the boilers, so that either may be used if the other fails, or it becomes necessary to make repairs. This will save many hours of night, or Sunday work, which is always expensive.

A satisfactory arrangement of pipes is always possible at a small expense; in fact, a good arrangement is nearly always cheaper in first cost than some of the very complex Chinese puzzles which are sometimes found, and are called systems of piping. Lack of systems would better describe some of them.

Boiler Explosions.

FEBRUARY, 1885.

Brewery (15).—A boiler in the Snider Brewery exploded Feb.—th, and John Bush, an employee, was struck and fatally injured by a piece of iron. Three children playing in an adjacent yard were also seriously hurt.

Colliery (16).—A terrific explosion occurred in the boiler-house at the colliery of Linderman & Skeer at Humboldt, Pa., Feb. 7th. The building was completely demolished. The debris was thrown hundreds of feet away, and one of the eight boilers was hurled a distance of 200 feet, striking a dwelling-house, and partly demolishing it. The occupants were asleep at the time, and barely escaped being crushed to death. The loss will reach several thousand dollars.

Flouring-Mill (17).—The large flouring-mill of J. C. Harris at Montgomery, Ind., was blown up at noon Feb. 7th, scalding the engineer, John Mattingly, to death. The ·oss caused by the explosion is large.

Starch Mill (18).—Three of the boilers in the Firmenich Starch Works, situated in the lower end of Peoria, Ill., exploded Feb. 8th with terrific force, portions of the boilers being carried 300 yards away, and the building in which they were situated being almost entirely wrecked. Two men were in the building at the time: Joseph Doolittle, fireman, and John Byers, watchman, and both men were killed. Shortly after the explosion the ruins took fire, but the flames were soon extinguished. The works were erected something over a year ago, and employed 100 men.

Rolling-Mill (19).—A boiler explosion occurred Feb. 10th, at the Central Iron and Steel Works, Brazil, Ind. Four men were killed, eight were dangerously wounded, and a large number of others received slight injuries. The names of the dead are: Mallon Baker, watchman; Robert Davis, roller; —— Brock, puddler, and James Billiter. They all belonged in Brazil. It is supposed that the bodies of five or six tramps were buried under the tremendous pile of brick and debris. The injured are: Charles Sage, John Burnes, Joseph Dailey, Thomas Kennedy, Francis Posey, Lewis Miller, James Rogers, and George Miller. The explosion is said to be due to the carelessness of the engineer. The damage to property is $15,000.

Heating-Boiler (20).—An explosion occurred in the cigar store of Alles & Fisher, on Cambridge street, Boston, Feb. 11th. The hot-water boiler in the cellar blew up, and the concussion shattered all the windows, tore away the wall, and started the floor. Fragments of the windows were blown clear across the street, and one person was badly cut about the face. The inside of the store looked as though it had passed through an extended siege. Window-glass and plastering covered the floors and the counters, and hundreds of cigars were thrown in all directions. Several persons were in the room at the time, and the concussion was nearly enough to knock them down. Three workmen were in the back room, and their escape from injury was almost miraculous, as the boiler was directly beneath them. Their faces were blackened with soot, but they were not hurt. The furniture was piled up on the opposite side from where the boiler was, and two or three barrels of cigars were added to the wreck.

Stone-Quarry (21).—A boiler explosion in a quarry three miles east of Harrisburg, Pa., Feb. 11th, caused the death of Christian Horn, John Spencer, and Peter Browne, while taking out stone. Horn and Spencer were instantly killed, one of them having the back of his head carried away. Browne had one of his arms torn off, and was otherwise injured. He died soon after. The boiler-house was blown to atoms, and fragments of it were thrown three hundred yards. The accident is said to have resulted from the supply to the boiler becoming frozen, thus cutting off the necessary amount of water.

Flouring Mill (22).—The boiler in McDaniel & Wright's flour-mill, Franklin, Ind., exploded Feb. 12th, killing James High, engineer, and wrecking the building. The employees had a narrow escape. The damage is about $6,000.

Locomotive (23).—The engine of a passenger train on the Wabash, St. Louis & Pacific R. R. exploded the dome of its boiler Feb. 12th, at Forrest, Ill. No one injured.

Colliery (24).—A boiler at the North Mahoney Colliery, of the Philadelphia & Reading Coal and Iron Company, near Mahoney City, exploded Feb. 14th with terrible force. Eleven other boilers were displaced, and the engine-house was completely wrecked. John Swank was terribly mutilated and killed, and Joseph Lloyd, the fireman, died in a few hours. The pecuniary damage is heavy, and 150 men and boys are thrown out of employment.

Colliery (25).—The engine-boiler at the east shaft of the coal mine at Springfield, Ill., exploded Feb. 16th, instantly killing the engineer and fireman, and wrecking the building.

Flouring-Mill (26).—The boiler in David Ellis & Sons' flouring-mill, Indiana, Pa., exploded Feb. 18th, wrecking the boiler house. A team of horses were badly scalded, and two men were burned. The loss is about $4,000.

Fire-Engine (27).—The bottom tube-sheet of the only fire-engine available blew out at a fire in Westerly, R. I., Feb. 19th, and four buildings were destroyed before aid could be summoned from elsewhere. Total loss, $40,000.

Locomotive (28).—Several flues in the boiler of a passenger-train engine collapsed Feb. 20th, at Fairport, N. Y.

Locomotive (29).—The locomotive of a passenger train on the St. Louis, Iron Mountain & Southern railroad exploded its boiler Feb. 20th, near Poplar Bluff, Mo. The engine was completely wrecked, and engineer and fireman both killed.

Mine (30).—A little before 8 o'clock, while twelve men were in the cage being lowered to the 900-foot level in a mine in New Almaden, Cal., Feb. 24th, the boiler exploded. Although in the midst of a cloud of scalding steam, the engineer, Tonkin, stood at his post until the signal "All right" came, knowing that if he left his place the cage would drop 1,800 feet to the bottom of the mine. He was severely but not dangerously burned.

Saw-Mill (31).—A boiler exploded Feb. 24th, at Carroll & Co.'s lumber-mills, three miles south of Keuntz, Tex., instantly killing Mr. J. A. Carroll's son, aged six years; Mr. Kirby, a white laborer, and badly injuring Mr. Joseph Carroll, Mr. Gregory, Mr. Crow, and twelve of Carroll & Co.'s employees working around the mill. It is thought that Mr. Gregory, Mr. Crow, and four of the colored employees will not survive.

Saw-Mill (32).—The boiler in the saw-mill of Hein & Mertons, at Finksburg, Md., exploded Feb. 24th, killing Samuel Rice and Edward Twigg, both of Flintstone, Md., and badly injuring Owen Gallia of Williamsport. Rice was the fireman of the establishment, and his body was found fully three hundred feet from the scene of the explosion. The mill, which was operated by John G. Cole, of Somerset, Pa., was entirely demolished.

Machine-Shop (33).—The boiler at the Dayton Screw Works, Dayton, O., exploded Feb. 25th, demolishing the walls of the boiler-house, and wrecking the engine. The engineer had just gone to the main building.

Locomotive (34).—A freight-line train from the Philadelphia and Reading railroad, bound north, was disabled by a parting coupling at Lothrop's, near Lawrenceville. N. Y., on the Fall Brook road, on Saturday evening, Feb. 28th. The train parted near the engine. Next to the caboose was a car containing over 20,000 pounds of gunpowder. A flagman was sent back to warn a coal train which was approaching at full speed. The engineer saw the flag too late to prevent a collision. He reversed the lever and jumped. His example was followed by the fireman. Both lay flat as the engine plunged through the caboose into the powder car. The car ignited and blew up, and the boiler burst. The caboose was dispersed in minute fragments. The engine and boiler were hurled 1,500 feet across the Tioga river. A piece of iron, weighing over fifty pounds, was carried two-thirds of a mile. Cylinders, bent rails, and fragments of machinery and cars were thrown hundreds of feet. Five cars of merchandise were destroyed, and eleven blown into splinters. Twenty-five cars were wrecked in all. The explosion made a hole in the road-bed ten feet deep, and thirty feet broad. Branches of trees in the neighborhood were strewn with garments, neckties, and other merchandise. The track was destroyed for a considerable distance. No one was killed. The train men who had left the caboose and gone ahead were thrown prostrate by the shock. Driving-wheels, and other heavy pieces of wreck passed over the heads of the engineer and firemen, but they escaped without injury. The explosion was felt and heard in Corning and Elmira, twenty miles from the scene of the accident. Windows were shattered in houses over a mile distant. The track was cleared for traffic by noon, March 2d. The loss is estimated at over $50,000.

Foreign.—The boiler on the sugar estate Altamira, Cuba, exploded Feb. 15th, causing the death of twelve persons, and the wounding of twenty more. The building containing the machinery was totally destroyed.

Local Variations in Thermometers.

Mr. H. A. Paul has called attention to discrepancies in the observations of temperatures which can not be covered by the ordinary precautions in the exposure and reading of thermometers, nor even by those more carefully devised ones recommended by Mr. H. A. Hazen, of the Signal Service Office, in his recent paper on "Thermometer Exposure." According to Professor T. C. Mendenhall, of the Ohio State Weather Service, "the means of the thermometrical readings of the twenty State Service stations on the nights of the 21st and 25th of January, 1884, differed by respectively 12.4° and 14.7° Fahr. from those of the four Signal-Service stations. At Columbus a difference of 27° appeared between the reading of a thermometer on the north side of a stone building, and that of the State Service instrument in an open lot three miles distant. This circumstance indicates that the true minimum cannot be got in a city or to the leeward of it when a moderate breeze is blowing. It may be questioned also whether exposure near the ground, where the conditions must vary with the local character of the surface, can be relied upon as a measure of the average state of the atmosphere for a few hundred or a few thousand feet overhead. Hence a plan of exposure on high, open scaffoldings would be highly desirable. At any rate, meteorological stations, especially those of the Signal Service, which is engaged in predicting the weather conditions for large areas, will have to be moved into the country, and probably to moderately elevated points, before the best results can be obtained."

Keely Surpassed.

At one of the fairs of the Massachusetts Charitable Mechanics' Association in Boston, the management forbade any fires in the building; and, as a consequence, exhibitors of portable engines considered that they were deprived of opportunities of showing the operation of their class of engines. One exhibitor showed resources equal to the occasion, for he connected the exhaust pipe of one engine in his exhibit to the boiler of another of his engines, removed the safety-valve, and connected the flywheel by belting to the shaft which was kept in motion by the main engine of the Exhibition. This method of driving an engine furnished a supply of compressed air in the second boiler, whence it was used for motive purposes. Soon the manager learned that those portable engines were in operation, and assuming that the regulations concerning fire were necessarily violated, sent a worthy colored messenger to examine and report the facts to him. After looking these engines over very carefully, he reported that they were running the engines in question with the "northwest wind or something or other." A group of laborers were examining the engine, and one of them gave his opinion that "cold steam and no fire was the greatest invention yet."

The Locomotive.

HARTFORD, APRIL, 1885.

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

Assets and Amount at Risk.

We have been favored with a circular in which the assets and amount at risk of three companies doing the boiler insurance business are given. The moral of this circular is, as we understand it, "*Place your insurance in the company that does the least business.*" July 3, 1884, a circular emanating from the same company showed the following statement of its financial condition:

Assets,	$197,724.41
Total liability,	1,806.52
	$195,917.89
Amount at risk,	$221,100.00
Assets to amount at risk,	89.44

This remarkable result came from the fact that it had very little business, and at the time it had no surplus over and above its liabilities, but on the contrary a deficiency of $3,000 and upwards. In the circular issued March 11, 1885, in which is a comparison of the assets and amount at risk of three companies, it gives its assets as $243,694, amount at risk, $5,666,237. If we apply the same rule by which it estimated its assets to amount at risk eight months ago, we shall find that it now has assets to amount at risk, $4.30. This is a considerable falling off from the $89.44 of eight months ago, and further, after doing a year's business, with fortunately no losses, and paying no dividends, it shows a surplus over all liabilities of $545.00. The balance of its earnings being exhausted in expenses and unearned premiums, supposing it had been called upon to pay a loss on one of its $25,000 or $40,000 policies, where would it have stood?

We have made these comments to show the speciousness of the arguments contained in such circulars. Men conversant with the insurance business understand such reasoning. It is often resorted to by weak life insurance companies in order to show how much stronger they are than the Mutual Life Insurance Company, or the Equitable of New York, or some other large and well-managed company. If we apply this principle to the large fire insurance companies of the country, we shall find that they stand nowhere when compared with some small company with $300,000 or $400,000 assets and a small business. These facts are too well understood by business men to mislead them.

THE TRUE BASIS OF STRENGTH.

In making up the statement of an insurance company, its assets should be given at their true value. Experienced persons can very readily detect irregularities in a statement if they exist. The liability items should show all outstanding claims against the company of every nature—unsettled losses, bills, and the re-insurance liability or unearned premium. What is this reserve or unearned premium liability? It is a sum required by all insurance commissioners to be set apart as sufficient to carry existing risks to maturity. If every insured boiler exploded, it will be readily seen that the sum required would be the same as the amount at risk, and the premiums would be correspondingly high. But experience shows that only a certain percentage of boilers explode, hence the sum required must be sufficient for such possible or probable contingencies. The rule adopted by insurance commissioners as applicable to fire insurance companies is, that fifty per cent. of the premiums on risks in force shall be entered as a liability, and they have ruled that this shall apply to boiler insurance companies also. We think the rate too high for a boiler insurance company, because a large percentage of its receipts are paid out in the inspection department for mechanical work. But the commissioners' ruling provides for periodical inspections during the life of the policy, and regards these inspections as a part of the contract.

From the foregoing it will be seen that if we deduct the liabilities from the assets of a company, we shall have the true surplus as regards policy-holders, and if from that amount we deduct the cash capital, we shall have the net surplus over and above all liabilities. To apply this to the financial condition of the *Hartford Steam Boiler Inspection and Insurance Company.* Its statement is as follows:

Total assets, ...	$505,273.81
Tot. liability, including prem. reserve, legal standard,	168,369.23
Surplus as regards policy-holders, . . .	$336,904 58
Deduct cash capital, ...	250,000.00
Net surplus over and above all liabilities, . .	$86,904.58

It is well known that the shrinkage in the assets of insurance companies was quite large during the past year. This arose from the fluctuation in the market value of stocks and other securities. The shrinkage in the assets of the Hartford Steam Boiler Inspection and Insurance Company was less than one-half of one per cent. It has not been the custom of this company to make a parade of its financial condition. But it has always had money enough to pay its losses promptly on receipt of satisfactory proofs, and all bills on presentation. Our attention is largely given to the mechanical department, which requires careful and well-directed study, and our patrons get the benefit of it. We issue no circulars. The report that we had issued or sent out a large number of anonymous circulars from this office is false. If nine hundred such circulars, more or less, have been mailed from Hartford, we are ready to believe that they were sent here to be re-mailed for the purpose of involving us in some way. When we issue any circulars there will be no difficulty in knowing at once where they come from.

Waste.

During these dull times, it behooves manufacturers to look sharply to every avenue of waste, in order that losses from this source may be reduced to a minimum.

In the matter of waste, as in most other things, there may be sins of omission as as well as sins of commission, and we believe this is fully as apt to be the case in the management of boilers as in any other department of a manufacturing establishment.

Boilers should have the *very best* of care, for although they may be black, dirty-looking, and generally uninviting in appearance, the principles underlying their construction and management are vastly deeper, and require for their proper elucidation a higher order of intelligent and well-directed effort, than many other manufacturing processes which are, on their face, of greater complexity and importance. This being the case, it will readily be seen that in boiler management there is an excellent chance for sins of omission to "put in their very best licks."

In the design and construction of boilers the greatest care should be exercised. In designing, safety, simplicity and efficiency should be considered. Safety, so far as it can be assured by the design, can be obtained by intelligently considering the strength of each essential part, and making due allowance for ordinary wear and tear, and using good material. This can only be attained by employing some competent disinterested person to make plans and specifications for the whole plant, and seeing that they are conscientiously carried out.

The matter of setting should also receive fully as much attention as the construction of the boiler itself, for upon it depends very greatly the possible efficiency and durability of the entire system. Boilers badly set *cannot* be made to do their best work, and many patented settings which to the inexperienced appear to be all that can be desired, in practice prove to be very wastefui and injurious to the boiler. We have in mind now, a plant consisting of two new boilers set on a highly-recommended plan, where it was absolutely impossible to make steam, and one of the boilers was badly burned in a few weeks. Upon making repairs, it was decided to reset one of the boilers with the ordinary setting; when this was done it was found ample to do the work, and the second one has never been required since.

The draught is also an important feature in the economy of a steam plant. Without good draught, perfect combustion of fuel is impossible, and without good combustion economy *cannot* be attained.

In many cases where the draught is poor, and the fault has been attributed to the chimney, we have found that cracks in the setting or flue leading to chimney, when of brick, has been the real cause of the trouble, and when these were repaired, the draught has been good. The influence of air-leaks in settings and flues upon the draught is greater than is generally supposed.

A heavy coating of incrustation upon the heating surface of a boiler greatly impairs its evaporative efficiency. Many cases have occurred in our experience where boilers had to be driven to perform their work, and were found to be heavily incrusted; after the incrustation was removed (and it always can be if proper measures are taken), they performed the work easily, and with a very noticeable diminution in the consumption of fuel. Besides impairing the heating surface by the interposition of a thick layer of non-conducting material, a heavy coating of scale also, in some types of boilers, interferes greatly with the circulation of the water, and this is of very great disadvantage, besides rendering the boiler liable to burning.

But about the most important element entering into the economy of a boiler, is the manner in which it is run. The matter of proper coal-burning is of vastly more difficulty than the mere stopping, starting, and oiling of an engine, and calls for some one of judgment and superior intelligence to do it properly, or at least to see that it is done properly. Many suppose that the one thing necessary is to heave the coal on to the grates, but this is a very great error. Some men appear to be born firemen, others never can learn to fire properly. And it is not always that the best men get their deserts, which is unfortunate and discouraging. We have in mind now a man who fired, unaided, a battery of thirteen boilers, and the peculiar thing about it was the fact that he never seemed to be doing anything at all. He did this for several years, and his employers became accustomed to it, and took it as a matter of course. Finally he said to the superintendent of the concern that he could burn half-screenings if he would hire another man, a laborer, to wheel them into the fire-room. This was done, and resulted in a large saving in the cost of fuel; but the treasurer of the establisment happened around one day and found the extra man at work and immediately raised a row about the expense of the extra man, and insisted that they couldn't stand it! Very naturally the fireman couldn't stand that, and he put on his coat and went home. Not long afterward we visited the place and found four men were then required to do the work. This was a clear case of *waste.*

In the foregoing we have pointed to but a few of the avenues of waste, and those leading from the boiler-room only. Every other department should be subjected to the same scrutiny. In many cases enough waste might be prevented to pay handsome dividends.

THE buckling of plates sometimes occurs in a manner at first sight difficult to explain. Overheating, in consequence of a deposit of oil, sediment, or scale, is most frequently the direct cause, but sometimes it occurs in boilers that are quite clean, and show no signs of having been overheated. In such cases it is of interest to trace the cause. It may generally be found in the plates themselves.

If boiler-plates are not homogeneous, bulging may occur from unequal expansion. We have in mind now, a battery of boilers, the plates of every one of which are corrugated somewhat over the grates. The boilers have always had the best of care, have been kept quite clean, and show no signs of overheating, the seams never having leaked a drop since the day they were put in. This is good evidence that they have not been unduly overheated. The buckling seems to have been gradually brought about simply through unequal expansion of the different laminæ of the shell-plates themselves in the course of ordinary usage.

Time Required to Digest Different Foods.

The Monitor de la Salud contains in a recent number the results of some experiments lately made by E. Jessen on the time required for the digestion of certain kinds of food. The stomach of the person on whom the experiments were made was emptied by means of a pump: 100 grammes, equal to 1,544 grains, or about 2⅔ ounces, of meat, finely chopped and mixed with three times the quantity of water, were introduced. The experiment was considered ended when the matter, on removal by the pump, was found to contain no muscular fibre.

It will be remembered that the gramme weighs nearly 15½ grains, and the cubic centigramme is equal to 1 gramme. The 2⅔ ounces of meat were therefore mixed with nearly eight ounces of water, before being introduced into the stomach.

The results were as follows:

Beef, raw, and finely chopped,	2 hours.
" half cooked,	2½ "
" well cooked,	3 "
" slightly roasted,	3 "
" well roasted,	4 "
Mutton, raw,	2 "
Veal,	2½ "
Pork,	3 "

The digestibility of milk was examined in the same way. The quantity used was regulated so that the nitrogen should be the same as in the 100 grammes of beef.

602 cubic centimeters, nearly sixteen ounces, of cow's milk, not boiled, required,	3½ hours.
602 cubic centimeters, boiled,	4 "
602 " " sour,	3½ "
675 " " skimmed,	3½ "
656 " " goat's milk, not boiled,	3½ "

Hardened and Tempered Glass.

In a paper read before the British Society of Arts a short time ago, Mr. F. Siemens spoke in an interesting manner of the above subject. Having satisfied himself by a series of experiments of the true cause of the spontaneous fracture of glass, Mr. Siemens invented processes of manufacture by means of which glass may be thoroughly toughened, or, as he prefers to call it, hardened. The principle upon which the processes depend consists in cooling the glass, not in proportion to its surface, but to its volume or capacity for heat. The method employed will be readily understood by considering a sheet of uniform thickness, which, after having been heated uniformly to a sufficient degree, must be cooled on the surfaces of its two parallel sides only, leaving the edges uncooled. This is done by placing the heated sheet of glass between two cold slabs of suitable material, prepared in a peculiar manner. Uniform cooling of the whole sheet is thus secured, no matter what its shape, because the edges are not subject to the cooling influence caused by the surfaces between which the glass is placed. The plan adopted for various articles varies with their shapes, but it is on the principle of uniform heating and cooling that the author's processes of manufacturing hard glass are based. Of these the two principal are known as press-hardening and casting, but, besides these, there is a third, theoretically less perfect than the others, viz., semi-hardening or hard tempering; this, though less important, may be advantageously employed where presses would be unsuitable and casting impossible or difficult, as in the case of bottles, lamp chimneys, &c.

Press-hardened glass has now been made, with constantly-increasing success, for six years. The articles are mainly of plate and sheet glass, either flat or bent into a variety of shapes. Besides plain work, decorated sheets, such as sign-boards with enameled inscriptions, figures and other ornaments, form an important part of the goods produced; the process, as already stated, is, therefore, one of manufacture (the goods receiving through it their definite shape and decoration), and not simply one of hardening or toughening. The glass is so hard that the diamond will not touch it, and it cannot, therefore, be cut or bent after manufacture; it may, however, be polished, etched, and slightly ground; its strength is at least eight times that of ordinary glass.

The process of manufacture is as follows: The glass is first cut in the ordinary way to the requisite shape and dimensions, and is then exposed to the radiant heat of a peculiarly-constructed furnace until quite soft; as soon as it has attained the necessary temperature it is placed between cold metal plates, to be cooled down with a rapidity which varies with the thickness of the glass, but is in any case very great. The heating and cooling of sheet glass of ordinary thickness last altogether a minute and a half, a minute being the length of the heating and half a minute that of the cooling operation. It is a remarkable circumstance that glass may be thus heated and cooled in so short a space of time without either cracking or breaking; this is altogether due in the case of the operation of heating to the uniform temperature of the furnace, and to the heat being produced entirely by radiation; should these conditions not be fulfilled, the glass would break to a certainty. As regards the success of the cooling operation, this depends upon the uniform temperature of the glass before it is cooled, and upon that of the metal plates between which it is placed while being cooled. This uniformity of temperature and the total absence of draft, which would cause irregular cooling, are the conditions under which the whole operation can be carried on with assured success.

The surface of the metal plates or molds used for the presses may be so prepared as to produce more or less cooling effect on the glass as required. If the glass is to be hardened to a very high degree, the metallic surfaces must be of very high heat-conducting power, such as copper, and must be left quite bare; the glass must also be raised to a very high temperature, as it would otherwise crack during cooling. If it is proposed to harden the glass to a lower degree, surfaces of iron are used, this metal not being so.

good a conductor of heat as copper, while the temperature of the glass is also kept lower. By covering the surfaces of the iron presses with wire gauze, their cooling effect may be reduced to any required extent. so that a certain amount of hardening may be produced without rendering it necessary to heat the glass to such a temperature as to make it difficult to handle. or to cause it to stick to the furnace-bed. If a still lower degree of hardening is proposed, the faces of the presses may be covered with asbestos paper. or even clay slabs may be employed.

Semi-hardened glass is made in the same large radiation furnaces as press-hardened. by means of the hard-tempering process, of which the following is a description: Finished articles, which are of a shape to which presses cannot be easily applied, such as bottles, are heated up to a temperature short of softening: each one is then placed in a casing of sheet iron, which is so arranged that the heated article shall not touch the inner sides of the casing. In order to effect this, the casing is provided with internal projecting ribs which retain the glass in position, touching it only at a very few points. The casing, with the heated article of glass within it, is allowed to cool in the open air. Whenever it is a difficult matter to handle the heated glass, instead of placing it hot into the casing, the casing with the glass inside it is inserted in the heating furnace for the requisite time and then allowed to cool, as before described.

The third and last process to be described, which Mr. Siemens considers the most valuable of the three, is a peculiar mode of casting hard glass. This has not yet been introduced on a manufacturing scale, but the experimental castings produced have turned out to be quite satisfactory in every way. They consist of floor plates, grindstones, pulleys, tramway sleepers, and various ornamental work.

Hard-cast glass is manufactured in the following manner: Glass, melted in a tank furnace, is tapped into molds, as with iron castings. The process thus far resembles that carried on in an iron foundry, but differs from it, inasmuch as a special material is used in place of sand, and that the mold and the glass inside it are heated and cooled together. The material or mixture to be used in place of sand must be selected so as to have, as nearly as possible, the same conductivity and capacity for heat as glass; in such a case the glass and mold forming, as it were, one homogeneous body, the glass will cool without cracking, even if the cooling process is comparatively quick, which is quite necessary if hard glass is to be produced. Glass cast in this way may have almost any variety of form and inequality of thickness. In the last respect this process differs entirely from those previously described, in which only glass of uniform thickness can be dealt with. If care be taken that the surface of the glass does not approach the outer casing of the mold, it does not much matter how the cooling is effected. The great point is that the mold and glass should be brought to a uniformly high temperature, which should be rather above that at which press-hardened glass is made. When fully heated the mold is taken from the furnace and allowed to cool in the open air, which generally acts quickly enough to produce a good hardening effect upon the glass within. When cold the mold is opened and the glass removed.

It will be readily understood, from the descriptions given, that the three processes differ so materially from one another that hardly any resemblance remains to show that they are merely different ways of treating differently-shaped articles in carrying out the principle of keeping the whole body of the glass at a uniform temperature during the operations of heating and cooling.

The De la Bastie process, as well as the ordinary tempering processes employed, fail in not being founded on the principle set forth; glass toughened by the De la Bastie process being cooled in a fluid bath, and ordinary glass in kilns, the cooling action is most active on the portions offering the largest surfaces to the cooling influence, and hence in the one case there is a strong tension or strain in the molecules, which causes them to break up spontaneously: and in the other case, to counteract that tendency, it is necessary that the glass should be cooled very slowly.—*Mechanics.*

Durability of Building Stones.

Dr. Alexis A. Julien has made examinations of buildings of various ages, and of tombstones in some of the older grave-yards around New York city, to assist in determining the durability of the various stones used in building. The coarse brown-stone which is largely employed, appears to be one of the most perishable materials in use, so that many builders are returning to brick, although the finer varieties of brown stone are better and compare favorably with other materials. Among the causes for the decay of this stone are mentioned, erection on the edge of lamination, the heat of the sun on exposed sides, and imperfect pointing, with poor mortar, which falls away and leaves the joints exposed to the weather. The presence of sea-salt in the atmosphere has exerted no appreciable effect, and lichens growing on the stone do not appear to have occasioned any decay or corrosion. The light-colored Nova Scotia sandstones have been too recently introduced to show marked defect, but evidences of exfoliation and of slight moldering in damp spots have begun to appear. Buildings constructed of the Amherst (Ohio) sand-stone show little decay, only discoloration; and that is regarded as a favorable sign rather than otherwise, for it indicates durability, while a stone that cleans itself does so by disintegration of its surface, the grains dropping out and carrying away the dirt. The coarse fossiliferous limestone from Lockport has disintegrated rapidly within the last ten years, chiefly on account of careless arrangement in masonry. The oölitic stone from Ellettsville, Indiana, shows an almost immediate and irregular discoloration, said to be produced by the exudation of oil. The oölite from Caen, France, has shown decay in several instances where it was not protected by paint. The dolomitic marble of Westchester County has decayed considerably after sixty years of use, but much of this is owing to the stone having been improperly laid. Often marbles, of various kinds, in tombstones, are in fairly good condition. Horizontal slabs show a tendency to bend. The frequent obliteration of inscriptions, the general and often rapid granulation of the surface, and the occasional fissuring of slabs, show that the decay of marble—in the varieties hitherto long used in New York city—is steady, inevitable, and but a question of time; and, if unprotected, this material is likely to prove utterly unsuitable for out-of-door use, at least for decorative purposes or cemetery records, within the atmosphere of a city. A blue stone, or graywacke, is yearly coming into more general use, and though somewhat somber in tone and difficult to dress, seems likely to prove a material of remarkable durability. The bluish Quincy granite has been used in many buildings, and rarely shows as yet many signs of decay. A fine-grained granite from Concord, New Hampshire, also promises to be durable. The light-colored and fine-grained granite of Hallowell, Maine, in which the white feldspar predominates, has shown some exfoliation, but in the single building in which this is remarked the stones appear to have been set on edge, and, as their structure is laminated, that is an important matter. "The weathering of granite does not proceed by a merely superficial wear, which can be measured or limited by fractions of an inch, but by a deep insinuation along the lines of weakness, between grains, through cleavage-planes, and into latent fissures. Thus, long before the surface has become much corroded or removed, a deep disintegration has taken place by which large fragments are ready for separation by frost, from the edges and angles of a block. When directly exposed to the heat of the sun, an additional agency of destruction is involved, and the stone is suddenly found ready to exfoliate, layer after layer, concentrically." The following is an approximative estimate of the "life" of different kinds of stone, signifying by the term life, without regard to discoloration or other objectionable qualities, merely the period after which the incipient decay of the variety becomes sufficiently offensive to the eye to demand repair or renewal: coarse brown-stone, five to fifteen years; laminated fine brown stone, twenty to fifty years; compact fine brown-stone, one hundred to two hundred years; blue-stone, untried, probably centuries; Nova Scotia stone, untried, perhaps fifty to two hundred years; Ohio sandstone (best silicious variety), perhaps from one to many centuries; coarse fossiliferous limestone, twenty to forty years; fine oölitic (French) limestone, thirty to forty years; fine oölitic (American) limestone, untried here; coarse dolomite marble, forty years; fine dolomite marble, sixty to eighty years; fine marble, fifty to two hundred years; granite, seventy-five to two hundred years; gneiss, fifty years to many centuries. Many of the best building-stones in the country have never yet been brought to the city.—*Popular Science Monthly.*

The Telephone Girl Again.

The girl had been asleep a long time when somebody called. Looking at the switch-board she observed that 1,111 was down, and leisurely raising the phone to her ear, she softly replied: "Hello! What do want?"

"Dr. Highflyer. No. 2,222."

"Hello, Highflyer! My wife is not very well to-night. She has as evere pain in the back.of her neck, and complains of a sort of goneness in the abdomen."

"Got malaria colic, I guess."

"I think so. What shall I do for her?"

Here the wicked telephone girl switched on a machinist who was telling the owner of a saw-mill what he thought ailed his boiler, and the answer to Doldoodle's question was as follows:

"I think she's covered with scales inside about an inch thick. Let her cool down during the night, and before she fires up in the morning take a hammer and pound her thoroughly all over, and then take a hose and hitch it on the fire-plug and wash her out. I wouldn't be surprised if she is full of mud, besides the scale. When you get through, fill her up with cold water and build a good fire under her, and if she don't get hot enough to steam well in half an hour, I'll eat her."

The result is that No. 1,111 does not now speak to No. 2,222, and Dr. Highflyer has had the telephone taken out of his house.—*Oil City Blizzard.*

The Engineer's Story of a Brakeman.

"Several years ago I was running a fast express. One night we were three hours behind time, and if there is anything in the world I hate it's to finish a run behind schedule. Those grade-crossings of one-horse roads are nuisances to the trunk-lines, and we had a habit of failing to stop, merely slacking up for 'em. At one crossing I had never seen a train at that time of night, and so I rounded the curve out of the cut at full tilt. I was astonished to see that a freight-train was standing right over the crossing evidently intending to put a few cars on our switch. I gave the danger whistle and tried to stop my train, but I had seven heavy sleepers on, and we just slid down that grade spite of everything I could do. Quicker than I can tell you, the brakeman on that freight-train uncoupled a car just back of our crossing and signaled his engineer to go ahead, which he did sharply, but barely in time to let us through, in fact the pilot of my engine took the buffer off the rear car. Through that little hole we slipped, and lives and property were saved. Now, that brakeman was only a common railroader, yet he saw that situation at a glance. There wasn't time to run his whole train off the crossing, nor even half of it—barely time to pull up one car-length by prompt, quick work. He kept his wits about him as, I venture to say, not one man in a thousand would have done, and saved my reputation, if not my life. He is now a division-superintendent on one of the best roads in this country."

Psalm of the Postman.

The righteous man ariseth early in the morning after the snow-storm and cleareth his walk of snow; yea, he covereth the icy places with ashes and scattereth sand upon his sidewalk.

But the unrighteous man doeth not so. He lieth in bed and letteth the snow remain upon his walk; yea, he scattereth no sand upon the icy places, and when the postman walketh thereon he slippeth up and bangeth himself against the earth, so that his spine sticketh up through the top of his hat, and his sky is brightened by many a brilliant star.

The righteous man hath a letter-box affixed to his door, wherein the postman droppeth the mail and departheth, with thanksgiving in his heart.

But the ungodly man doeth not so. He hath no bell upon his door, and his latch-string is broken; and when the postman bringeth the mail he knocketh at the door till his knuckles are raw. And when the ungodly man comes to the door he growleth at the postman, and kicketh the dog, and forgetteth to say "Thank you."

The godly man hath a charming daughter, and smileth graciously at the postman; and he chaineth the dog in the stable, that the postman's heart be not affrighted, and the postman carries the mail even unto the kitchen door; and the godly man laugheth to himself and recalleth the days of his youth.

When the ungodly man writeth a letter he sticketh upon one corner the legend, "In haste," thinking to deceive the unwary. But the postman smileth a happy smile and tucketh it down to the bottom of his bag; yea, he layeth it over several trips, and his heart is full of joy.—*Law. Telegram.*

Growth in the West.

The following story of an engineer on a Western railway shows how fast the country is growing. We do not hold ourselves responsible for the truth of the story, but we do not hesitate to say that it is "not much of a story," compared with that told by the Western man who makes an effort:

One day I was driving my engine over the prairie at the rate of 40 miles an hour, without a house in sight, and supposing the nearest town to be 30 miles distant. But as I glanced ahead I was astonished to see that I was approaching a large city. I rubbed my eyes, thinking it was a mirage.

"Jim," says I to the fireman, "what's this place?"

"Blamed if I know!" says Jim, staring out of the cab. "I declare if there ain't a new town growed up here since we went over the line yesterday!"

"I believe you are right, Jim. Ring the bell or we shall run over somebody!"

So I slowed up and we pulled into a large depot, where more'n 500 people were waiting to see the first train come into the place. The conductor learned the name of the town, put it down on the schedule, and we went on.

"Jim," says I, as we pulled out, "keep your eyes open for new towns. First thing you know we'll be runnin' by some strange place."

"That's so!" says Jim. "An' hadn't we better git one of the brakemen to watch out on the rear platform for towns that spring up after the engine gets by?"—*Providence News.*

An Irishman went to the theatre for the first time. Just as the curtain descended on the first act a boiler in the basement exploded, and he was blown through the roof, coming down in the next street. After coming to his senses he asked, "An' what piece do yez play next?"

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

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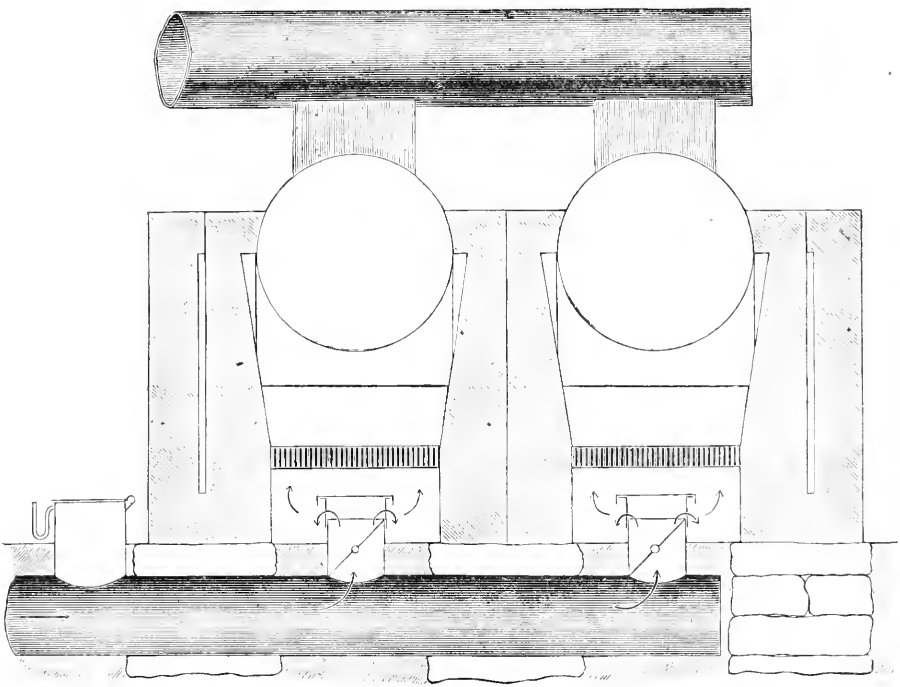
Forced Draught for Boilers.

The question frequently arises, Is the use of a blower for producing draught for a boiler-furnace to be recommended? And is it in any way injurious to the boiler? The answer to this latter question may be, Yes, or it may be, No. It depends almost wholly on whether the blowing apparatus is properly or improperly arranged and managed. The proper use of a blower is not injurious to a boiler; its abuse most certainly is.



The force of a good natural draught will balance a column of water, measured in a siphon gauge, or such an apparatus as that figured and described in the Locomotive, May, 1884, from $\frac{3}{4}$ inch to 1 inch in height. This is equal to a pressure of from one-thirty-seventh to one twenty-eighth of a pound per square inch; or say from seven-sixteenths to nine-sixteenths of an ounce. If the pressure of air from a blower does not exceed this, the fires will not be any more intense than with natural draught; and if precautions are taken to admit it properly to the ash-pit, no more damage can be done.

Much of the damage done by blowers may be traced to the fact that, in most cases, the current of air is allowed to blow directly against some *portion* of the grate. This causes unequal combustion of the layer of fuel, holes are burned through, and currents of air pass through and strike the boiler shell. This is apt to injure the boiler, and also diminishes the efficiency of the system.

The air should be discharged into the ash pit in a downward direction, and so diffused that an equal air pressure is established beneath the whole grate surface. Uniform combustion of the layer of fuel is thus easily attained, and the best possible results realized.

The pipes for conveying the air from the blower should be of good size, one-half the area through flues of boiler will be found about right. This enables more perfect control over the pressure, and better equalization of the supply to each boiler, when there are several boilers running together, to be obtained.

The main conduit, or supply-pipe, should be provided with a relief-valve, near or attached to which should be a siphon, or other gauge, to enable the pressure to be accurately adjusted to suit the requirements of different fuels. A pressure sufficient to balance one inch of water will be found to give sufficient air to burn the most difficult fuels, such as slack or screenings.

The individual supply-pipe to each boiler should be provided with a valve, to enable the blast to be shut off when the fires are to be cleaned, or fresh supplies of fuel added. When the supply to one or more of the boilers is thus shut off, the relief valve in main pipe (which should be weighted to the exact pressure required to furnish proper draught) will open and discharge the excess, and thus no harm can be done to the other fires.

Our illustration shows a very simple arrangement. Two boilers are shown. The supply-pipe is shown as coming in at the left-hand side. Just outside the setting wall may be seen the relief-valve, with water-gauge attached. Passing under the boilers, a riser, furnished with a butterfly throttle, delivers air into each ash pit. The top of each riser has a metal cover, which answers the double purpose of distributing the air supply and keeping the risers, or supply-pipes, free from ashes. Further explanation of the cut is unnecessary.

The following short table shows the pressure of air for different heights of water in the siphon gauge:

TABLE SHOWING PRESSURE PER SQUARE INCH OF AIR FOR DIFFERENT HEIGHTS OF WATER IN SIPHON GAUGE.

Height of Water in Gauge.	Pressure in Pounds per square inch.	Height of Water in Gauge.	Pressure in Pounds per square inch.	Height of Water in Gauge.	Pressure in Pounds per square inch.	Height of Water in Gauge.	Pressure in Pounds per square inch.	Height of Water in Gauge.	Pressure in Pounds per square inch.
.25″	.009	.41″	.0148	.56″	.0202	.71″	.0256	.86″	.031
.26	.0094	.42	.0151	.57	.0206	.72	.026	.87	.0314
.27	.0097	.43	.0155	.58	.0209	.73	.0263	.88	.0317
.28	.0101	.44	.0159	.59	.0213	.74	.0267	.89	.0321
.29	.0105	.45	.0162	.60	.0216	.75	.0270	.90	.0325
.30	.0108	.46	.0166	.61	.022	.76	.0274	.91	.0328
.31	.0112	.47	.0169	.62	.0224	.77	.0278	.92	.0332
.32	.0115	.48	.0173	.63	.0227	.78	.0281	.93	.0335
.33	.0119	.49	.0177	.64	.0231	.79	.0285	.94	.0339
.34	.0123	.50	.018	.65	.0234	.80	.0288	.95	.0343
.35	.0126	.51	.0184	.66	.0238	.81	.0292	.96	.0346
.36	.013	.52	.0188	.67	.0242	.82	.0296	.97	.035
.37	.0133	.53	.0191	.68	.0245	.83	.0299	.98	.0353
.38	.0137	.54	.0195	.69	.0249	.84	.0303	.99	.0357
.39	.0141	.55	.0198	.70	.0252	.85	.0307	1.00	.0361
.40	.0144								

This Table enables comparison of Draught Pressure and pressure per square inch to be easily made by using it in connection with that found on page 68 of our last volume.

Boiler Explosions.

MARCH, 1885.

GRAIN ELEVATOR (35).—The boiler of the elevator of the R. T. Davis Milling Company, St. Joseph, Mo , exploded at half-past ten this morning. The elevator was wrecked and the engineer severely injured. John Link, who was working in the gas-works a quarter of a mile away, was struck by a piece of pipe and fatally injured.

COLLIERY (36).—A terrific boiler explosion occurred at Coleraine, Carbon county, Pa., March 4th. The exploding boiler was one of a nest of four large ones at the colliery of W. T. Carter & Co. Only two persons were near at the time, the fireman, George Krapf, and a boy. Krapf had just entered the boiler-house and was fixing the fires when the explosion took place. He was instantly killed, and had his body hurled 120 yards. The boy, who was in the engine-house near by, was slightly hurt by flying débris. The boiler-house was entirely demolished. One end of the boiler, weighing over two tons, was blown through a stable belonging to Michael Whalen, 100 yards away, and two horses and six goats were instantly killed. Another portion of the boiler was hurled against the breaker, 300 yards away, and the ground for a long distance around was covered with débris. Two of the other boilers were displaced and burst. The loss to the company, including stoppage of their works, is estimated at $20,000.

STEAMER (37).—The boiler of the steamer *Ware*, a stern-wheel boat plying between Wilmington, N. C., and Fayetteville, exploded March 5th, while she was taking in a cargo at a wharf opposite Wilmington, and she immediately sank. Neill Jessup, James Stedman, and Kitty Harvey, all colored, were blown into the river and drowned. Perry Cotton, the colored pilot, and Dave McPherson were badly scalded. Several other persons employed on the boat received slight injuries. The were no passengers on board. The boat was valued at $10,000, and is a complete wreck.

CAR HEATER (38).—The steam-heater in the Wagner drawing-room car "China," on the New York Central road, exploded at Syracuse, N. Y., March 9th. Half the roof was blown off and on to a mail car on the side track. Every window was smashed, and the interior of the car disarranged generally. The report was heard for a long distance. All of the passengers were dining and escaped injury. Two employés were scratched and bruised some. It was a narrow escape.

IRON WORKS (39).—A boiler in the blacksmith department of the American Tube and Iron Company's works, at Middletown, Pa., exploded March 12th, injuring eleven persons, two of them seriously. O. P. Melborn, an old man, was dug out of the débris badly scalded and having a hole in his head. Alonzo Sohn was wedged among joists. His right leg was broken and he was slightly scalded. Elmer Groff, John S. Kendig, John Eveler, Charles W. Frantz, Henry J. Miller, Charles Mattis, John S. Cole, Elijah Keener, and James Keener received injuries more or less severe, which required their removal to their homes. The building was entirely destroyed.

COLLIERY (40).—A boiler explosion occurred at Lawrence Brown's colliery, at Mahonoy Plane, Pa., March 16th. The boiler of the hoisting engine at the shops exploded with terrific force, one half being projected fully one hundred yards. Amos Grinder, the fireman, and a boy named Smith were fatally scalded, and another named Crawford seriously injured. The cause of the explosion is unknown. Besides the boiler demolished twenty-two other boilers were displaced. Loss $5,000.

SAW-MILL (41).—The boiler in Chambers' mill, Newtown, Miss., exploded, killing Sam Gloss, fireman, and badly injuring R. H. Wilson and Marion Chambers, the former fatally.

Penitentiary (42).—A terrible explosion occurred at the State Penitentiary of South Carolina, March 21st. The boiler of the engine which supplies the shoe factory and the hoisery mill with power burst, partially wrecking the building, tearing two convicts limb from limb and causing thousands of dollars damage. The cause of the explosion is not known. Those killed were Henry Knight, the engineer, and a lifelong convict of Marion county, and William Grate, who was sentenced for two years from Georgetown county.

Saw-Mill (43).—On March 21st, the boiler in a mill, five miles from Pine Bluff, Ark., owned by Edward Montgomery, exploded, fatally wounding Montgomery, killing the engineer, S. C. Morriss, breaking the leg of Amos Ewing, and severely scalding several mill hands.

Grocery (44).—The boiler in Ruffner Bros. wholesale grocery, Charleston, W. Va., exploded March 23d, setting the building on fire. The fire communicated to the Hale House adjoining, destroying that building also. George Welcher, a porter employed by the Ruffners, was killed by the explosion and his body burned. The flames spread so rapidly that the building was a wreck in a quarter of an hour. Joel Ruffner, a clerk, was seriously injured by the explosion. The Ruffners' loss will reach $30,000, and the loss of Fritz & Woodward, proprietors of the Hale House, will be fully $50,000.

Saw-Mill (45).—A twenty horse-power boiler burst March 26th, in the Pineville, Pa., saw-mill, blowing a man, working near, a distance of thirty feet, his body passing through a two-inch oak board ceiling, mangling him in a terrible manner.

Saw Mill (46).—A disastrous boiler explosion occurred March 26th, at the mills of G. S. Potter at Groton Pond, Vt. The mill was shut down at six o'clock and ten minutes later one of the three boilers exploded, tearing out one side of the building and killing John McLeod, the night watchman. William Fowler, another employé, had a shoulder broken and was otherwise injured. The pecuniary damage is about $5,000.

Steamer (47).—The boilers of the steamer *Mark Twain*, running as a ferryboat between Memphis and Mound City, Ark., exploded March 27th, while lying at Mound City, killing Wm. T. Tiestie and A. J. Demerich, the fireman, a deck hand, and an unknown negro. Captain Fagelman had a leg broken, as did also Captain Malone, the pilot. The barkeeper was badly scalded, and Mary W. Jones, a colored passenger, had an arm broken. There were twenty persons aboard the boat when the explosion occurred.

Lead Works (48).—The boiler of the Cincinnati Lead Works exploded in March. Little damage was done. The flues, which were fifteen inches in diameter by twenty-six feet long, collapsed.

APRIL, 1885.

Saw-Mill (49).—A boiler in the saw-mill of David Hulz, near Columbus, Ind., exploded April 2d, wrecking the place. Eugene Clever was instantly killed; Albert Hulz, aged twenty-eight, had his skull crushed and leg broken, and died at midnight; Martin Hulz had his head crushed and died two days afterward; David Hulz, aged sixty-eight, was scalded and had his left leg and right hip broken and cannot live.

Fertilizer Works (50).—The boiler in ex-Senator Coe's fish factory on Barren Island, N. Y., exploded April 2d, and five men were scalded.

Shoe Shop (51).—A hot-water boiler in the shoe factory of G. H. Burke at Randolph, Mass., blew up April 4th. The total damage is about $400. No one was injured.

Colliery (52).—One of the set of eighteen boilers at No. 5 colliery, Hazelton, Pa. exploded April 10th, instantly killing the fireman, Edward Geatons, and fatally scalding the assistant fireman, James Boyle. The latter was blown into a reservoir forty feet from the scene.

Oil Well (53).—By the explosion of the boiler of a forty-five horse power engine on the Angel Oil Company's property at Knapp's Creek, N. Y., April 24th, George Cripps, a married man, was killed, two other men seriously injured, and a span of horses killed. The accident was caused by pumping cold water into the hot boiler.

Saw-Mill (54).—The boiler in the saw-mill of Samuel Beauchamp, situated on the Straight Line railroad, three miles north of Oakland City, Ind., exploded at eleven o'clock April 29th, instantly killing the engineer, John Canthorn, and seriously injuring two fellow-workmen. The latter were Jesse Wester, whose skull was crushed and one leg broken, and Jep Collins, who suffered a broken foot and other injuries.

Saw-Mill (55).—A terrific boiler explosion occurred at the Chicago Lumbering Company's artesian well, at Manistique, Mich., April. The cause was unknown. The fireman, named Fuller, was fatally injured. The boiler was thrown 100 feet.

Foreign.—The boiler on the Mena estate, situated at Calimete, Cuba, exploded April 27th, instantly killing eight persons and injuring fifteen. The building and machinery were badly damaged.

Cast Iron Cutlery.

This title may appear anomalous, but cast iron cutlery of certain forms is far more common than its purchasers generally imagine. And it is not necessarily of a poor quality, although made of nothing but cast iron. In the writer's family is a pair of scissors of cast iron that has been used for three years, and has been several times sharpened. The writer has shaved with a cast iron razor, which did excellent work for months. There are in Connecticut two quite extensive establishments which reckon cast iron cutlery as among the important products of their work. This allusion to cast iron shears and scissors does not refer to the combined cast iron and steel articles which are usually considered superior to the forged ones. These have a steel inner plate cemented on each blade by the fused iron when it is poured into the mould; but the cast iron shears and scissors are wholly and entirely of cast iron, and they are finished for the market precisely as they come from the moulds. The quality of the iron used is the same or similar to that used in casting for malleable iron, and for cutlery it is cast in chills. When broken, the crystallization is very similar to that of hardened cast steel, and, except for lack of elasticity, it serves the same general purpose. But although this cast iron is not adapted to tools which work by blows, it is sometimes made into ice picks and axes, hatchets and steak choppers. The manufacturers of cast iron shears and scissors make no secret of the material, and sell their goods for just what they are. Of course they are sold cheaper than forged work of steel can be sold. Retailers, also, know that this cheap cutlery is not steel, and usually—unless dishonest—they will truthfully answer questions on the subject. But, really, a pair of cast iron shears or scissors for ordinary household work is just as good as one of forged cast steel. There is only one difficulty in the way of superseding cast steel forgings by cast iron castings in these implements, which is that the chill that makes the iron hard does not always extend to a depth that will allow of repeated grindings and resharpenings, the material crumbling before it can be brought to an edge. But when first ground and edged, the shears are as keen as those of tempered cast steel, and the blades retain their edges longer.

Van Nostrand's.

The other day a very recent mother said to her accomplice: "O William, nurse says that the baby weighs only six pounds. I'm so glad!" "Why are you glad?" growled the husband, disgusted at having received so little for his money. "Because the fashion papers say that light kids are all the rage again."

The Locomotive.

HARTFORD, MAY, 1885.

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

The following letter explains itself, and confirms the opinion, expressed by us in the January Locomotive, that "if suffocation by carbonic acid gas was the cause of the man's death, it seems to us that he was probably in some flue leading to the chimney, and not in the boiler itself as was reported."

To the Editor of the Locomotive:

Sir,—Having seen several statements in various papers and journals in regard to the death of the engineer at the Laflin & Rand Powder Works, and none of them being correct, I beg leave to give you an accurate account of the accident, which was probably due to the forgetfulness of the man.

It was not in the boiler proper, but in the flue leading from the boilers to the stack, that he was overcome by carbonic acid gas. At the time of the accident one of the boilers was out of use, and the other one had a banked fire under it. When he entered the stack and crawled into the flue, he was overcome by the gas.

Whether he forgot about the banked fire or not I cannot say.

Respectfully yours,

EDWARD HAMILTON,

Engineer at Laflin & Rand Powder Works.

Mountain View, N. J., April 20, 1885.

Mr. Sylvester Marsh, the projector and designer of the Mount Washington Railway, died recently at the ripe age of 81 years, and his death recalls the part he took in that unique engineering enterprise.

The charter for the building this road was granted, we believe, in 1867 or about that time. The work was in progress during the summer of 1868. At that time the writer of this was a young lad, and living in sight of Mt. Washington, and could watch the progress of the work. The date of the opening of the road for travel we do not exactly remember, but we believe it was in 1869. When application was made by Mr. Marsh to the New Hampshire Legislature for a charter, one of the members offered an amendment authorizing him to build a railroad to the moon. In spite of ridicule, however, Mr. Marsh triumphed, and the road was built, and during the time it has been in operation, not a passenger has been injured or an accident occurred.

The length of the road from the station at the base to the summit, or "Tip top House," is about three miles. It seems a much longer distance than this to *walk up*, and a much shorter one to *slide down* on a board placed on the central rail, as the writer can bear witness by experience. The average grade is 1,300 feet per mile, but in some places it is much steeper. "Jacob's Ladder," for instance, rises about three feet in eight, at the same time being built on trestle work upwards of a hundred feet from the ground in its highest part. The cars are pushed up by the locomotive, which gets its grip by means of gears working in a wrought-iron rack in the center of the track. This rack is formed by riveting bars between two angle irons which are about five inches apart. The speed of the trains is slow, about as fast as an ordinary walk, and frequent stops are made to allow the magnificent scenery to be viewed by the passengers.

The brake system is very efficient, the one on the cars consisting of a strong gear, exactly like the driving gear on the engine, which engages with the rack, and is connected by means of a train of gearing with a drum around which a spiral steel ribbon is wound. When the brake is off, this train of gearing revolves freely, being driven by the motion of the car, which operates the rack pinion. The operation of setting up on the brake wheel tightens this ribbon around the drum, and the friction thus produced is very great, so that the car may be instantly stopped. The engine is provided with a similar brake, in addition to other precautions.

According to the *Railroad Gazette*, Mr. F. M. Wilder has in use on the N. Y., L. E. & Western Railroad a simple and very effective test for stay-bolt iron. Instead of testing the iron for ultimate tensile strength in a testing machine, Mr. Wilder puts a piece from 30 to 36 inches long into a vise and bends it back and forth about 90° each way, and notes the number of such bends which the iron will stand before breaking. His requirement is that a sample of iron shall stand 12 such bends before fracture. Different brands $\frac{7}{8}''$ in diameter stand from 4 to 16 bends.

This test had its origin in the fact that the fractures, coming as they do on the inner edge of the outside firebox sheet, indicated that they were caused by a bending or transverse strain concentrating at that point. It was at first attempted with success to imitate the effect of these strains by vibrating the upper end of a stay bolt in a shaper, giving it a throw of $\frac{1}{8}$ of an inch, which was assumed to be the maximum to which they were exposed in practice by the expansion of the fire box. It was found that from 2,000 to 9,000 such vibrations produced such fractures as were found to result from ordinary use.

The above is a very simple, inexpensive, and rational way of testing material for such purposes. When *all* tests are made under the conditions of actual use, as nearly as can be done, we shall hear of fewer accidents by failure of engineering structures.

Somebody out in St. Louis, who is troubled with an anti-steel craze, says of boiler plates, "refined iron is not 'too brittle,' and it will not 'bulge.'"

Whew! We learn something every day. If that brilliant mind ever flashes upon the Eastern horizon we hope it will give us a call, when we shall take a great deal of pleasure in showing it some "refined" iron plates which have bulged, yea, verily, and cracked too!

Wonder if that fellow knows just what is meant by the brand "refined" iron.

Thos. Pray, Jr., has just issued Vol. II of *Twenty Years with the Indicator*. Vol. I was issued in 1883, and had a large sale. Mr. Pray has had a wide and varied experience with the Indicator, and is regarded as authority on that subject. The volume just issued treats upon many and peculiar cards, the features of which are fully explained and their peculiarities accounted for. The book is gotten up in attractive form, and will be found valuable to all persons interested in the subject. It can be obtained of Thos. Pray, Jr., Managing Editor of *The Manufacturer's Gazette*, No. 77 Astor House, New York, or of John Wiley & Sons, 15 Astor Place, New York. Price $2.00.

J. J. G.—The strain per inch in length on the shell of a 54-inch boiler working at a pressure of 160 pounds per square inch will be 4,320 lbs. To safely withstand this the thickness of the metal should be $\frac{1}{2}$ inch, and it should have a tensile strength of not less than 55,000 to 60,000 pounds per square inch, with good ductility.

Wade's *Fiber and Fabric* for April 11th has a very interesting illustrated article on the "Philosophy of Twist." It will pay a careful reading.

THE *Electrician and Electrical Engineer* perpetrates the following:—

An eminent Italian scientist who has been engaged in a new determination of the ohm by absolute measurement, gives in his official report the following harrowing details of the difficulties he has labored under. Some of the discordant results attained by various observers are possibly traceable to causes of this kind hitherto suppressed.

"An other circumstance for me very distressing, is come to influence the rigor of long series of experiences. My laboratory finds itself on the ground floor, in a vast room, very stable and situated at the north: but alongside finds itself the laboratory of chemistry, so that I have the misfortune to have for neighbor, the Prof. Ugo Schiff, who (thing unbelivable) himself is amused to carry from right and from left long pieces of iron, though he me had promised formally of it to refrain himself.

"Now that I have inflicted to M. Schiff the blame that he merits, in him denouncing publicly, I me propose to explain briefly the manner of which one makes the observations."

CONSIDERABLE comment is being made at the present time regarding the rupture of some steel boilers while under hydrostatic test in England recently. The facts of the case seem to be simply this: Some one tried to use a very fair article of *tool steel* for a boiler and quite naturally failed. *Just* as naturally, in fact, as they would if they had tried to make a razor of low moor iron. Had specimens of the plate been properly tested, by some one who knew the qualities required of boiler steel, it is quite likely the plates would have been rejected.

THE *Bolt* for 1885, published by the students of the *Stevens Institute*, has been received. It contains a history of each class, lists of the members of the various fraternities, etc., besides much amusing general reading. It is very tastily illustrated, and the work of the printer has been done in the best possible manner.

THE *Eccentric*, 1885, has been received. Published by the students of the Stevens Institute of Technology. It has a history of each class, names of members of the faculty, different classes, societies, clubs, etc., and contains besides much interesting and amusing matter. It is very neatly gotten up.

How Rails are Pounded.

If we stand at a moderate distance from a railroad track and watch an express train as it rushes past, everything seems perfectly adapted to its purpose, and the engine and train seem to glide over the rails with perfect smoothness. This smoothness of action, however true it may be with respect to the cars, is, in the case of the engine itself, only apparent. The ordinary locomotive, owing to peculiarities in its construction, so far from being in reality the perfect machine which poets rave about, is quite a different affair. This is, however, in a great measure due to difficulties, which are, owing to the peculiar condition under which they arise, practically very hard to overcome.

The locomotive, as generally constructed, is subject to very severe internal disturbing forces, some of which are of such a nature that they not only (at high speeds), seriously strain parts of the engine itself, but become an actual element of danger on account of their tendency to cause breakage of wheels, rails, and even bridges, unless great care is exercised.

Probably the most serious of these internal disturbing forces is due to the fact that it is simply impossible to perfectly balance the reciprocating parts of the engine in the ordinary form of construction. In consequence of this lack of balance, an engine, in motion, delivers, through its driving wheels, a series of blows upon the rails at every revolution, which in the case of an ordinary express engine running at a speed of fifty miles per hour has been calculated to be equal to a load of over six tons, suddenly applied. This is repeated at the above-mentioned speed, over four times every second.

The effect of this tremendous blow so often repeated, is seen in the breakage of rails in frosty weather, and unless due care is exercised, it is the prime factor in the destruction of bridges.

The cause of this "hammer blow," is this: To prevent injurious irregularities of motion in a horizontal, or fore-and-aft direction, and which would be seriously felt in the train, it is necessary to put sufficient weight on the driving wheels to counterbalance the crank-pin hub, crank-pin, parallel-rods, connecting-rods, piston, piston-rod, and crosshead.

Now the only vertically moving parts which have to be counterbalanced are the crank-pin hub, crank-pin parallel rods, and one end of the connecting rods.

Thus we see that there is necessarily an excess of counterbalancing weight in a vertical direction, and it is this excess which strikes the severe blow above referred to.

The effect of this blow on the driving wheels themselves is to flatten tires after a comparatively short season of running, this flattened spot may easily be seen by examining the wheels of an engine after it has run a few months. A good idea of the magnitude of this hammering-action may be obtained by examining this flattened spot.

With the high speeds which will be demanded of our railroads in a few years, it seems to us that it will be a measure of very great economy, if not absolute necessity, for railroads to adopt some modified form of construction which shall enable more perfect balance of the reciprocating parts to be attained, as the saving of fuel, and wear and tear of rolling-stock and road-bed to be gained thereby would be very considerable. To tell the truth the locomotive to-day does not seem to be much of an improvement over that built fifty years ago.

The Great Bore of the Amazon.

Mr. John C. Branner, formerly of the Imperial Geological Commission of Brazil, has published a paper on the pororóca, or bore, of the Amazon, a manifestation of force peculiar to the northern division of the mouth of the great river, of which the inhabitants of the adjacent country stand in extreme terror. It was not his privilege to witness an exhibition of the phenomenon, although he much wished to do so, while the people with whom he was staying desired that he or anyone else should not, but he observed some of its effects and had the scene described to him. The most impressive manifestations of the force of the wave are near the mouth of the Araguary River. An eye-witness of one of the appearances of the pororóca, at that place, one of a party of soldiers, related that "shortly after the tide had stopped running out they saw something coming toward them from the ocean in a long white line, which grew bigger and whiter as it approached. Then there was a sound like the rumbling of distant thunder, which grew louder and louder as the white line came nearer, until it seemed as if the whole ocean had risen up, and was coming charging and thundering down on them, boiling over the edge of this pile of water like an endless cataract, from four to seven metres high, that spread across the whole eastern horizon. This was the pororóca! When they saw it coming, the crew became utterly demoralized, and fell to crying and praying in the bottom of the boat, expecting that it would certainly be dashed to pieces, and they themselves be drowned. The pilot, however, had the presence of mind to heave anchor before the wall of waters struck them: and, when it did strike, they were first pitched violently forward, and then lifted, and left rolling and tossing like a cork on the foaming sea it left behind, the boat nearly filled with water. But their trouble was not yet ended: for, before they had emptied the boat, two other such seas came down on them at short intervals, tossing them in the same manner, and finally leaving them within a stone's throw of the river-bank, when another such wave would have dashed them on the shore. They had been anchored near the middle of the stream before the waves struck them, and the stream at this place is several miles wide." The signs of the devastation wrought upon the land by this gigantic wave are very impressive. Great trees, dense tropical forests, "uprooted, torn, and swept away like chaff"—for the most powerful roots of the largest trees cannot withstand its rush: the destruction of the banks for some distance inland: and the formation of new land in places, are among the signs of its ravages. The pororóca is an accompaniment of the spring tides, and is due to the resistance offered to the tidal waves by the sand bars and narrow channels which they have to meet. Its effects are most marked in the northern channels of the mouth of the Amazon, while little is known of it in the southern channels.

Table Showing the Comparative Density and Volume of Air and Saturated Steam.

The following table, from D. K. Clark's Manual of Rules, Tables, and Data, will be found interesting as showing the relative density and volume of air and dry saturated steam at various temperatures and pressures:

Total Pressure per Square Inch in Pounds.	Temperature in Degrees Fahrenheit.	Density or Weight of one Cubic Foot, in Pounds.		Volume of one Pound, in Cubic Feet.		Specific Density of Saturated Steam.
		Air.	Steam.	Air.	Steam.	Air = 1.
1	162.1	.0048	.0030	208.01	330.36	.622
5	162.3	.0217	.0138	46.04	72.66	.635
10	193.3	.0414	.0264	24.17	37.84	.638
14.7	212.0	.0591	.0380	16.91	26.36	.643
20	228.0	.0786	.0507	12.72	19.72	.645
30	250.4	.1142	.0743	8.76	13.46	.651
40	267.3	.1487	.0974	6.73	10.27	.655
50	281.0	.1824	.1202	5.48	8.31	.659
60	292.7	.2155	1425	4.64	7.01	.661
70	302.9	.2481	.1648	4.03	6.07	.664
80	312.0	.2802	.1869	3.57	5.35	.667
90	320 2	.3119	.2089	3.21	4.79	.670
100	327.9	.3432	.2307	2.91	4.33	.672
110	334 6	.3743	.2521	2.67	3.97	.673
120	341.1	.4051	.2738	2.17	3.65	.676
130	347.2	.4355	.2955	2.30	3.38	.678
140	352 9	.4657	.3162	2.15	3.16	.679
150	358 3	.4957	.3377	2.02	2:96	.681
160	363.4	.5255	.3590	1.90	2.79	.683
170	368.2	.5551	.3798	1.80	2.63	.684
180	372.9	.5844	.4009	1 71	2.49	.686
190	377.5	.6135	.4222	1.63	2.37	.688
200	381.7	.6425	.4431	1.56	2.26	.690
220	389.9	.7000	.4842	1.43	2.06	.692
240	397.5	.7569	.5248	1.32	1.90	.694
260	404.5	.8133	.5669	1.23	1.76	.697
280	411.2	.8691	.6081	1.15	1.64	.700
300	417.5	.9246	.6486	1.08	1.54	.702

Cause of Decay of Wood.

Professor P. H. Dudley, well known to railway and scientific men in connection with his discoveries made by the aid of the dynagraph car of his own invention, has been for some time investigating the cause of the rapid decay of wood. His methods of investigations have been microscopic and chemical. Some time ago he discovered the fungi that caused the permanent decay of most of the woods used in railroad structures, and followed their operations on the secular structure of the wood. By use of the photomicrograph views, he kept a graphic record of the appearance of decaying wood tissue. After patient search Mr. Dudley has discovered the spore that acts as the seed of fungus, and he expects soon to find a means of destroying this seed before it produces growth. Some of the wood-preserving processes in use do not destroy the fungus spores, and they go on germinating their ruin-making fruit. Any sure means of arresting the premature decay of wood will prove exceedingly valuable to railroad companies, since bridges and ties often fail with half their natural age, and in failing often bring about disastrous consequences.—*Boston Journal of Commerce.*

The Cellular Structure of Steel.

Experiments continued for several years past in the laboratories of the Creusót Works by MM. Osmond and Werth, have led to some new observations on the internal structure of cast steel, which have been communicated recently to the French Academy of Sciences. If thin plates of cast steel, .02 to .03 of a millimetre ($\frac{1}{1250}$ to $\frac{1}{825}$ of an inch) thick, are fixed on glass by means of Canada balsam, and attached cold by dilute nitric acid, the acid dissolves the iron and leaves as a residue the derived nitrate of a hydrate of carbon. The skeleton thus obtained reveals *in situ* the distribution of the carbon in the steel. Microscopic examination shows that this distribution is not uniform, and that cast steel is formed by little granules of soft iron in general separated from each other by small pieces of a different substance which contains carbon, and is in fact a carbide of iron. In other words, cast steel possesses a kind of "cellular tissue," iron constituting the cores, and the carbide the envelopes of the cells. These elementary or simple cells are agglomerated into compound cells, the agglomerations being separated in the thin transparent plate, by empty lines, which indicate closed polygons in run steel, but which become smaller and more confused in proportion as the metal has been perfectly worked. These void lines in the corroded plates imply that the faces of the polygons are composed of soft iron, without interposition of carbide; and MM. Osmond and Werth infer that the compound cells are deprived of envelopes. These compound cells are easily identified with what is termed the "grain" of the steel; their faces are regions of least cohesion, and thus the fracture of a bar of steel follows the surface which contains least carbon.

Trials were also made by the method of Weyl, which consists in attaching a bar of steel by dilute hydrochloric acid at the positive pole of a Bunsen cell; the carbonaceous residue preserves the form, appearance, and dimensions of the original bar. The residue is formed of continuous meshes, in which were lodged the free iron. These meshes consist of carbide of iron. Surfaces of polished steel were also treated with nitric acid; crystalitic organization of the globulites of iron well shown.

With regard to tempering, MM. Osmond and Werth remark that (in the case of cast steel cooled slowly) after quick tempering the compound cells completely disappear, and the simple cell remains the constituent element, but the carbide of iron interposed has become much rarer than in the same annealed steel. The surplus carbide seems to have dissolved in the metallic mass. From the anatomical point of view, hammer hardening has nothing in common with tempering, although its effects are similar. It is shown by a permanent deformation of the cells, with elongations of the cores in the direction of local movement, a correlative dislocation more or less complete of the slightly malleable envelope.—*Engineering.*

Superheated Water and Boiler Explosions.

In our December 1884 number we briefly referred to the results of an investigation on the superheated water-theory of boiler explosions conducted by a French committee under the supervision of M. Hirsch. As the manner in which the experiments were conducted may prove interesting to some of our readers, we extract the following from the report submitted at the time:

The first series of experiments were made in ordinary clear glass flasks (carboys and other "balloons," as the French term them), in order to study the phenomena of ebullition in pure water and in dilute aqueous solutions of such matters as are found in the feed water of boilers. The heat was obtained from a Bunsen, with a gauze top to spread the flame. The temperature was read by a thermometer dipping into the liquid. With pure water, and with saline and alkaline solutions, no movement of any significance was observed; but with slightly acid water a superheating of 2° or 3° was obtained with violent movements of the vessel, and when vaporization was encouraged there was at times violent ebullition, accompanied by projections. It will be understood that the superheating of the acidulous water amounted to 2° or 3° above the temperature of the steam at the pressure.

A second series of experiments was carried out in the shops of the Orleans Railway, in order to test the truth of the statements that prolonged stagnation of water in a steam boiler favors superheating by expelling air, and when energetic action is again set up, a large quantity of steam is rapidly given off. The boiler used was of the locomotive type, having a heating surface of 704 square feet, a water capacity of about 700 gallons, and a steam space of 250 gallons. The result of the experiments, repeated for many days, was absolutely negative, showing nothing abnormal in the movements of the gauge. If the fire was quick at starting the engine, the pressure continued to rise; on the contrary, if the fire was covered, the pressure slowly declined. In the normal condition of a steam boiler the water and steam are practically at the same temperature; but if there is any truth in the hypothesis of superheated water, there would be times when the water, having ceased to vaporize, would acquire a temperature higher than that of the steam. Accordingly, the committee made a series of experiments in which the temperature of the water and the steam in the boiler, at the Conservatoire des Arts at Métiers, were made to register themselves for a considerable period. A thermo-electric pile was constructed for suspension in the boiler in such a way that a series of solderings should dip into the water, while others of equal number should remain in thes team. This pile, which was 45 cm. in length, consisted of 15 iron and 15 German-silver wires, 1.5 mm. in diameter, soldered successively by their extremities. These wires were arranged according to the generatrices of a box wood cylinder, 40 mm. in diameter, having an aperture running through it lengthwise for the passage of the copper wire, by which the pile was suspended vertically from the self-closing cover of the man-hole of the boiler. The ends of contrary polarity, which remained free, were connected with a galvanometer-needle whose deflections were registered every quarter of an hour, upon a sheet of paper, by means of a puncture made by a vertical point fixed to the needle's extremity.

This registering apparatus, with clock-work movement, was the same as had been successfully employed by General Morin for measuring, at the different points of a ventilating chimney, the excess of internal temperature over that of the surrounding air. Each positive experiment including the registering, every 24 hours, of the position of the galvanometer needle, before firing up and until the boiler was under pressure, at the time the engine was set running, and while the latter was operating under nearly a constant pressure, and finally during the period of cooling, up to the next day or day after. Then the paper was changed, in order to obtain a new diagram corresponding to the firing up again, before or after a new feed, until the pressure had risen to the normal one of five atmospheres, and had permitted the engine to run regularly. No notable deviation in the position of the galvanometer-needle was observed during all these alterations, nor during the whole course of experiments, which were greatly prolonged, with the exception of one night, when the galvanometer-needle, as shown by the tracings, became strongly disturbed. The cause of that is unknown; but as it occurred during the time of cooling, while, moreover, the deflections of the needle took place suddenly and disappeared slowly, it seems clear that superheating of the water could have nothing to do with the phenomenon. The whole series of diagrams showed that the difference in temperature was always less than 2° C., the temperature of the steam pole being the lower, which is explained by its proximity to the sides of the boiler, which were naturally lower in temperature, owing to radiation. The experiments were again continued in another series in which the water was completely deprived of air. The water was continuously boiled for many days, and arrangements were adopted to secure the effects of hard firing and slow firing, with rapid rise of temperature or a gradual increase of pressure, but in all no abnormal movement of the pressure gauge was seen or recorded. The committee, therefore, as we remarked in an earlier issue, concluded that superheating is responsible for explosions only in exceptional circumstances.—*Mechanics.*

Things worth Remembering.

That a bag of hot sand relieves neuralgia.

That warm borax-water will remove dandruff.

That salt should be eaten with nuts, to aid digestion.

That milk which stands too long makes bitter butter.

That a hot, strong lemonade taken at bed-time will break up a cold.

That rusty flat-irons should be rubbed over with beeswax and lard.

That fried onions should be boiled first in milk, to be mild and odorless.

That a little soda-water will relieve sick-headache caused by indigestion.

That a cup of strong coffee will remove the odor of onions from the breath.

That boiled cabbage is much sweeter when the water is changed in boiling.

That tough meat may be made tender by lying a few minutes in vinegar-water.

That well-ventilated bed-rooms will prevent morning-headaches and lassitude.

That a cup of hot-water drank before meals will relieve nausea and dyspepsia.

That a fever-patient is cooled and comforted by frequent sponging with soda water.

That mustard-water is excellent for cleansing the hands after handling odorous substances.

That consumptive night-sweats may be arrested by sponging the body nightly in salt-water.

That one in a faint should be laid flat on his back; then loosen his clothes and let him alone.

That cold tea should be saved for your vinegar-barrel. It sours easily and gives color and flavor.

An old lady read a paragraph in one of the papers the other day, describing how a grindstone burst in a saw-mill, and killed four men. She happened to remember that there was a small grindstone down in her cellar, leaning against the wall; so she went out and got an accident insurance policy, and then, summoning her servant, and holding a pie-board in front of her, so that if the thing exploded her face would not be injured, had the stone taken out into the road, where twenty-four pails of water were thrown, over it, and a stick was struck in the hole bearing a placard marked, "Dangerous." She says it is a mercy the whole house was not blown to pieces by the thing before this.

A Drove of Wild Hogs Fight a Locomotive.

I had gone down to take a job on a Texas railroad, like a good many other sap-headed railroaders from the North. I didn't know any more about Texas than—well, than you do; but I went down there to run a train, and I thought I could do it. I got a passenger train, and had a fireman who was from the North. I had got the hang of the road fairly, and was b'iling along one day through a piece of woods, when all of a sudden my fireman hollers:

"Jewhilikins! yonder 's a drove of hogs on the track!"

Sure enough, about three train lengths ahead was a big drove of the ugliest-looking hogs I ever saw. They were taking their time in walking across the track. At first I thought I'd sock on the brakes and try to stop; but on second thought I made up my mind that it would be safer to cut through the drove with full head on. I pulled her wide open and let the whistle sing. Of course I thought the sound of the whistle would scare the hogs, and likely cause 'em to scatter and make an opening for me. But the minute they heard the sound they all stopped dead, and the ones that had got off the track came crowding to get on again. Every hog bristled up and showed fight, and when I struck 'em they were standing there like a wall to receive me. Of course the engine knocked 'em right and left, and cut a swath through the drove like a red-hot iron through a piece of butter, but the ones that were left flew fiercely at the wheels of the cars as they passed, and were crushed to death by the dozen. Looking back after the train had passed the spot, we saw one solitary peccary left alive out of the drove. I told the native at the end of the run about the persistent pluck of the peccaries, and about killing them all but one.

"I don't s'pose we'll see him again," said I.

"Oh, he 'll be thar," said the native. "Ye kin bet a bucket o' liquor he 'll be thar! Pec'ries don't know such a thing as backin' out of a fight. He 'll be thar."

And he was there. We could see him for a mile ahead of us when we went back next day, standing plumb in the middle of the track, or rather, squatting on his haunches, waiting for us. It seemed a pity to run him down. He rose to his feet as we drew near him and rushed forward to meet us. The engine struck him and hurled him fifty feet out into the woods. We had finished the drove.

"Why," said the native, "ef ye had a stawped, them pec'ries 'd a bounced inter yer cab quicker'n a t'rantuly kin kill a mouse, an' thud a chawed ye up thrum yer cow-lick down to yer last bunion. Then thud a s'rounded them cars, an' the fust galoot that opened a door thud a chawed him up. Arter a day or so the comp'ny 'd a missed the train an' 'd a sent another ingine out to look it up, an' when the engineer found it an' stawped his ingine to hook on to it, them pec'ries 'd bounced on his ingine an' chawed him up, an' so it 'd a gone on, an' the business o' the road 'd a suffered."—*N. Y. Sun.*

THE wickedest boy lives in Washington. He visited the observatory a few days ago with a large fire-fly he had caught, and with the aid of some mucilage stuck it in the center of the largest lens of the telescope. That night, when the astronomer went to work, he perceived a blaze of light apparently in the heavens, and what amazed him the more was that it would give a couple of spurts and then die out, only to burst forth again in a second or two. He examined it carefully for a few minutes and then began to do sums to find out where in the heavens that extraordinary star was placed. He thought he found the locality, and next morning he telegraphed all over the universe that he had discovered a new and remarkable star of the third magnitude in Orion. In a day or two all the astronomers of Europe and America were studying Orion; they gazed at it for hours until they were mad, and then they began to telegraph to the man in Washington to know what he meant. The discoverer took another look, and found that the new star had moved eighteen billion miles in twenty four hours, and, upon examining it closely, he was alarmed to perceive that it had legs. When he went on the dome next morning to polish up the glass he found the lightning-bug. The bill for telegraphing dispatches amounted to $2,600, and now the astronomer wants to find that boy. This story is related by an exchange, and of course is true.

Rubber Stamp Ink.—The following proportions are said to give an excellent ink, which, while not drying up on the pad, yet will not readily smear when impressed upon the paper: Aniline red (violet), 90 grains; boiling distilled water, 1 oz.; glycerine, ½ teaspoonful; molasses, half as much as glycerine. The crystals of the violet dye to be powdered and rubbed up with the boiling water, and the other ingredients stirred in. Another indorsing ink, which does not dry quickly on the pad, and is quickly taken by the paper, can be obtained, according to the *Papier Zeitung*, by the following recipe: Aniline color in solid form (blue, red, etc.), 16 parts; 80 parts boiling distilled water, 7 parts glycerine, and 3 parts syrup. The color is dissolved in hot water, and the other ingredients are added while agitating. This indorsing ink is said to obtain its good quality by the addition of the syrup.—*Ex.*

Gray Hair.

Many persons begin to show gray hairs while they are yet in their twenties, and some while in their teens. This does not by any means argue a premature decay of the constitution. It is a purely local phenomenon, and may co-exist with unusual bodily vigor. The celebrated author and traveler George Borrow turned quite gray before he was thirty, but was an extraordinary swimmer and athelete at sixty-five.

Many feeble persons, and others who have suffered extremely both mentally and physically, do not blanche a hair until past middle life; while others, without assignable cause, lose their capillary coloring matter rapidly when about forty years of age.

Race has a marked influence. The traveler Dr. Orbigny says that in the many years he spent in South America he never saw a bald Indian, and scarcely ever a gray haired one. The negroes turn more slowly than the whites. Yet we know a negress of pure blood, about thirty-five years old, who is quite gray.

In this country, sex appears to make little difference. Men and women grow gray about the same period of life.

In men the hair and beard rarely change equally. The one is usually darker than the other for several years, but there seems to be no general rule as to which whitens first.

The spot where grayness begins differs with the individual. The philosopher Schopenhauer began to turn gray on the temples, and complacently framed a theory that this is an indication of vigorous mental activity.

The correlation of gray hair, as well as its causes, deserves more attentive study than they have received. Such a change is undoubtedly indicative of some deep physiological process, but what this is we can only ascertain by a much wider series of observations than have yet been submitted to scientific analysis.—*Med. and Surg. Reporter.*

The Locomotive.

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Proportions for Rivets and Rivet-Heads.

In the course of our examinations we sometimes find rivets very badly proportioned. The heads will be too small, in hand-riveting they are quite apt to be much too flat, which makes them thin at the edges, so thin that they are liable to burn off and leave a very bad looking and insecure piece of work indeed. In button-set riveting, unless the work is done with care and intelligence, a bad job will be the result. This is particularly apt to be the case if the rivet is badly proportioned.

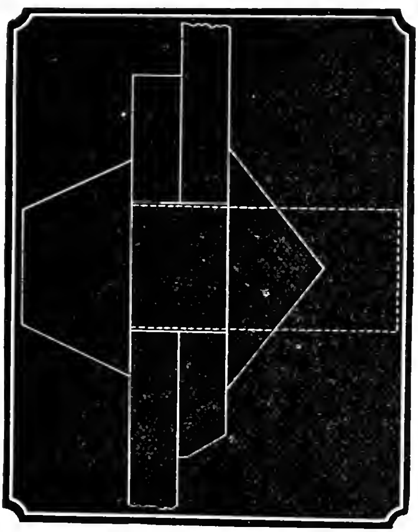

FIG. 1.

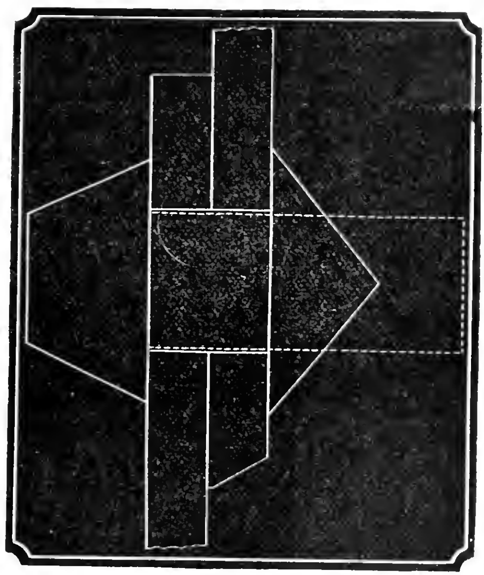

FIG. 2.

Our illustrations this month show what we have found by experience to be good proportions for hand-driven rivets for boiler shells. In all the cuts, the full lines show the plates, and the outlines of the finished rivets; the dotted lines show the outlines of the same before driving.

Figure 1 shows the proportions for plates $\frac{1}{4}''$ thick. The size of rivet used should be $\frac{5}{8}$ of an inch in diameter by $1\frac{3}{8}$ inches long. The rivet-holes will be from $\frac{21}{32}$ to $\frac{11}{16}$ of an inch in diameter. The diameter of the base of the conical head where it comes in contact with the plate, should be $1\frac{1}{4}''$ in diameter. The height of head, from base to apex of cone, should be $\frac{1}{2}$ of an inch. To form this head, as well also as to furnish metal enough to properly fill the rivet hole, the rivet must project $\frac{7}{8}$ of an inch before driving, beyond the plate. This is secured by using rivets $1\frac{3}{8}''$ long as before stated.

Figure 2 shows proportions for $\frac{5}{16}$ inch plates. The rivet used should be $\frac{11}{16}$ of an inch in diameter. The diameter of head should be $1\frac{3}{8}$ inches, its height $\frac{9}{16}$ of an inch. The rivet-hole will be from $\frac{1}{32}$ to $\frac{1}{16}$ larger than the original diameter of the rivet-shank,

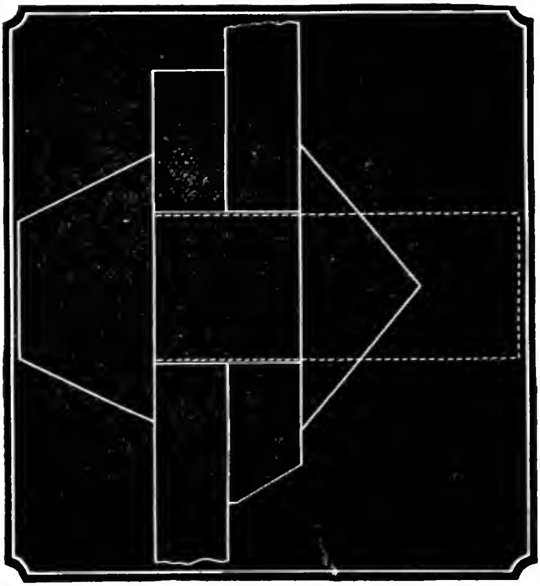

FIG. 3.

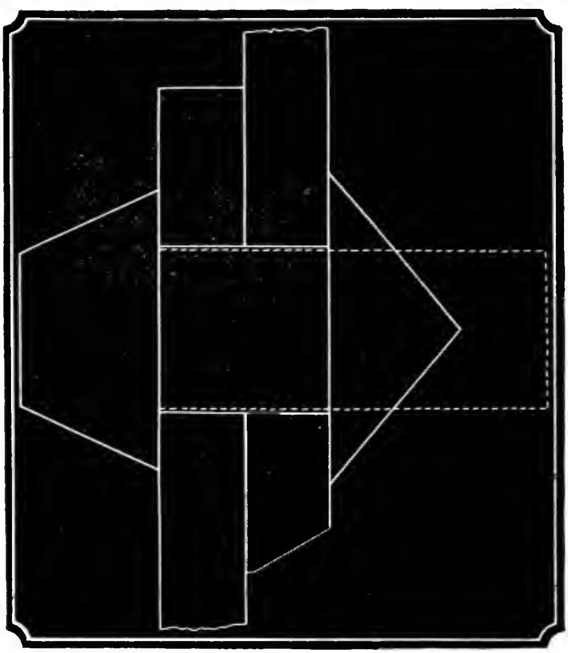

FIG. 4.

or from $\frac{23}{32}$ to $\frac{3}{4}$ of an inch. To form this head and furnish metal enough to properly fill the rivet-hole it will be necessary to use a rivet $1\frac{5}{8}$ inches in length.

Figure 3 shows a good proportion of rivets in $\frac{3}{8}$ plates. The holes as punched will

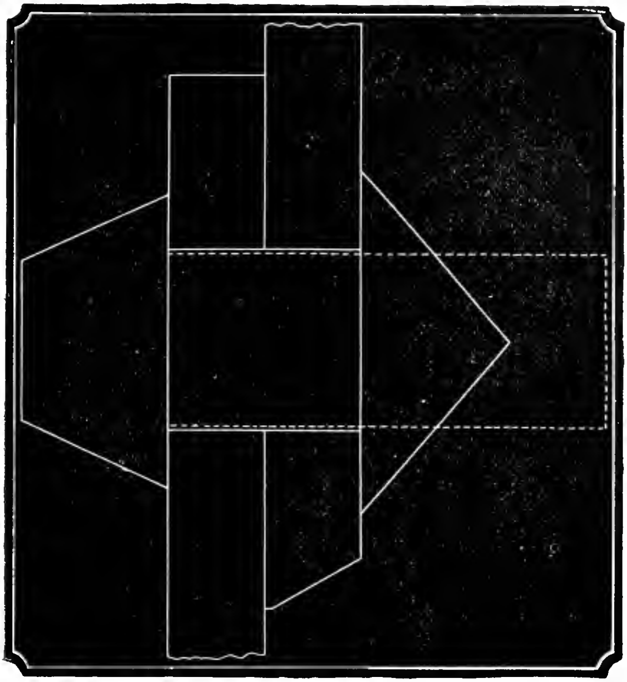

Fig. 5.

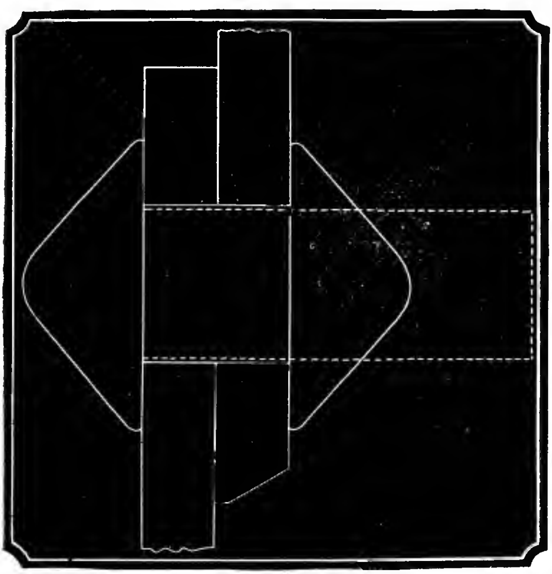

Fig. 6.

vary from $\frac{25}{32}$ to $\frac{13}{16}$ of an inch in diameter. The diameter of the base of the hand-driven head should be not less than $1\frac{1}{2}$ inches, and its height $\frac{5}{8}$ of an inch. To fill this hole and properly form the head it will be necessary to use a $\frac{3}{4}$ inch rivet $1\frac{7}{8}$ inches in length.

Figure 4 shows a good proportion for $\frac{7}{16}$ inch plates. A $\frac{13}{16}$ inch rivet should be used, the hole as punched being from $\frac{27}{32}$ to $\frac{7}{8}$ of an inch in diameter. Diameter of head at base $1\frac{5}{8}$ inches, height, $\frac{11}{16}$ inch. The length of rivet required will be two inches.

Figure 5 shows a rivet for half-inch plates, which is the thickest that should ever be used for tubular boiler shells. A $\frac{7}{8}$ inch rivet, $2\frac{1}{4}''$ long, will be found necessary, to prop-

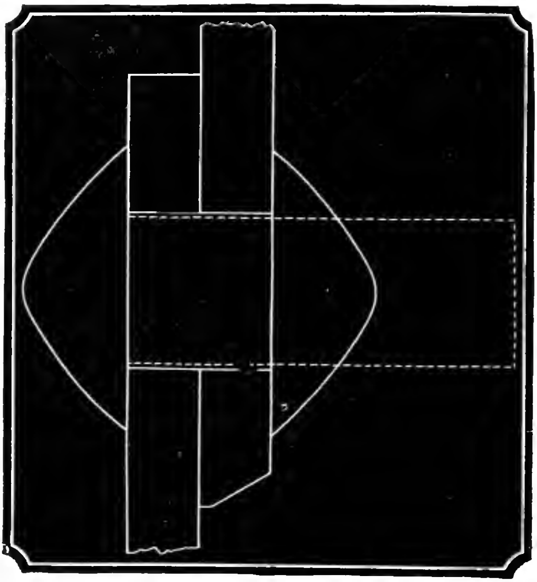

FIG. 7.

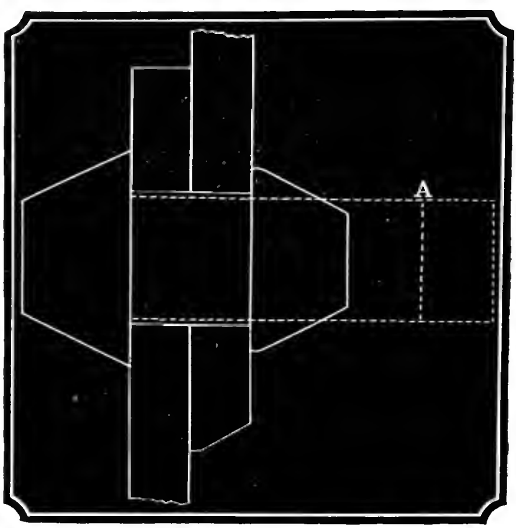

FIG. 8.

erly fill the hole, which will be generally $\frac{15}{16}$ of an inch in diameter, and form the head which should be $1\frac{3}{4}$ inches in diameter, and $\frac{3}{4}$ of an inch high.

The foregoing are the minimum lengths of rivets and sizes of heads which should be used for hand-riveting.

Figures 6 and 7 show two excellent specimens of machine-driven rivets. The thickness of plate used in each case is $\frac{3}{8}$ of an inch. In each the spread of the rivet, or diamater of the head is $1\frac{1}{2}$ inches, and the height in Fig. 6 is $\frac{5}{8}$ inch and in Fig. 7 $\frac{9}{16}$ inch. To make these heads as shown, each rivet would necessarily be two inches in length by $\frac{3}{4}$ inches original diameter.

Figure 6 was received from the Baldwin Locomotive Works, of Philadelphia, and Fig. 7 from the Cunningham Iron Works, of Boston.

Figure 8 shows a specimen of button-sett riveting which is *not* right. The thickness of plates shown is $\frac{5}{16}$ inch. The diameter of rivet used was $\frac{5}{8}$ of an inch. The diameter of the head at base, as finished, was one inch, which does not give sufficient bearing surface under the head to make a secure joint. The length of rivet required to form this head would be $1\frac{1}{2}$ inches, whereas to form a head of the proper size a length of $1\frac{7}{8}$ inches would be required.

Inspectors' Reports.

March and April, 1885.

Below we give the usual summary of the reports of the inspectors for the month of April, and also for the month of March, which latter were not all received in time to go into the May issue of the Locomotive, although its publication was delayed a month on that account solely. It is much to be hoped that inspectors will be prompt in sending in their reports. If the chiefs of some of the larger offices cannot find time to make up the summaries, let the men send in their daily records and we will make it up here and return them. Such long delays in matters involving such a trifling amount of work are entirely inexcusable.

During the month of March there were made 2,911 visits of inspection, in the course of which 6,060 boilers were visited. The complete internal inspections foot up 2,138, the hydrostatic test was applied in 297 cases, and 28 boilers were condemned.

The whole number of defects reported foots up 4,063, of which 680 were considered dangerous, as per the following detailed statement.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	372	33
Cases of incrustation and scale,	526	43
Cases of internal grooving,	17	4
Cases of internal corrosion,	147	11
Cases of external corrosion,	283	23
Broken braces and stays,	45	14
Defective settings,	141	17
Furnaces out of shape,	181	14
Fractured plates,	111	58
Burned plates,	95	21
Blistered plates,	292	24
Cases of defective riveting,	354	51
Defective heads,	37	12
Leakage at tube ends,	840	224
Leakage at seams,	205	46

Nature of defects.	Whole number.	Dangerous.
Defective water-gauges,	142	10
Defective blow-offs,	41	9
Cases of deficiency of water,	11	4
Safety-valves overloaded,	31	20
Safety-valves defective in construction,	25	14
Pressure-gauges defective,	160	25
Boilers without pressure-guages,	7	3
Total,	4,063	680

APRIL, 1885.

In April last, 2,814 inspection trips were made, 5,458 boilers were examined, 2,447 were examined internally, 361 were tested by hydrostatic pressure, 49 were condemned, and 4,058 defects were found, of which 621 were dangerous.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	456	31
Cases of incrustation and scale,	677	61
Cases of internal grooving,	16	9
Cases of internal corrosion,	141	23
Cases of external corrosion,	268	45
Broken braces and stays,	71	28
Defective settings,	108	15
Furnaces out of shape,	176	23
Fractured plates,	191	59
Burned plates,	102	29
Blistered plates,	287	29
Cases of defective riveting,	380	56
Defective heads,	37	12
Leaky tubes,	599	72
Leaky seams,	194	33
Defective water-gauges,	72	12
Defective blow-offs,	38	8
Deficiency of water,	15	6
Safety-valves overloaded,	30	14
Safety-valves defective,	29	13
Pressure-gauges defective,	169	42
Boilers without pressure-guages,	2	1
Total,	4,058	621

Several correspondents take exception to our explanation of the cause of the bulge on the plate illustrated in our article entitled "The Effect of Oil in Boilers," in the March issue of the LOCOMOTIVE, and seem to regard the explanation given as a novel one. We can assure them that such is not the case. Such cases happen very frequently in our experience, and there is nothing new about it. Of course the usual explanation of low water is given, but in this case there was not the *slightest* indication of low water. One correspondent says that the water got out of this boiler and the steam-pressure from the adjacent boilers caused the bulge. He strains several points to explain *how* the water *may* have gotten out of this boiler, but completely ignores the fact that the boiler actually *was* full of water.

No, we can assure all our friends that the same thing happens *very frequently* to a greater or less extent, and the fact that a mass of black, dirty sludge is sold as *pure mineral oil*, is *no guarantee* that the *injudicious* use of it will not ruin any steam-boiler.

The only noteworthy feature of the case was the fact that the plate stretched so much without fracture. That simply shows the superlative excellence of the steel used in the construction of the boiler. Many brands of iron or steel would have ruptured in such a case, and then our correspondents *might* have had another mysterious (?) explosion to explain.

Boiler Explosions.

MAY, 1885.

SAW MILL (56).—The boiler in John Bishop's mill, at Bowman Creek, Pa., exploded May 2d, totally wrecking the frame structure inclosing the machinery, and throwing the debris a distance of 500 yards. Carey Bader, the fireman, was instantly killed, while William May was so seriously injured that his recovery is not expected.

TANNERY (57). — The boiler in H. Poor & Sons' tannery at Winn, Maine, blew up May 2d, badly damaging the surrounding building; nobody injured.

HOTEL HEATING BOILER (58). — One of the boilers at the Tremont hotel, Galveston, Texas, exploded May 3d, instantly killing four persons, wounding several others and doing great damage to the hotel and neighboring property. The killed were: Thomas Cross, engineer, leaves a wife and several children; Laurence Carr, fireman, leaves a family; Clara Miller, a white woman, and Anderson Jones, colored. The following are the wounded: Jose Aguillo, body bruised and injured internally; John Axman, shoulder broken and otherwise injured; Maurice Sullivan, collar bone broken and badly cut about the head; R. Walton, arm broken and badly bruised; Mrs. Burns, slightly bruised about the head.

RENDERING TANK (59).— A large tank containing 4,000 pounds of grease exploded May 8th, in the grease factory of Charles O'Neal, in Somerville, Mass., terribly scalding two employes, Barney Carney and Michael Maguire. Their injuries will probably prove fatal. There was a steam pressure of sixty pounds upon the tank, the bottom being blown out. There were only two men in the building at the time of the explosion.

AGRICULTURAL (60).— A boiler owned by Mr. S. M. Wells, Wethersfield, Conn., exploded May 8th, and considerable damage was caused. The report of the explosion was heard a considerable distance, and the boiler was thrown about twenty-five feet, landing in a hay mow. Mr. Wells' oldest son, Dudley, who was running the engine, was badly scalded in the face and on his limbs by the hot water and escaped steam. Mr. Wells had just stepped into an adjoining room when the explosion occurred. He was slightly scalded about the wrists and legs. Thomas Griffin, a hired man, who was at work in the cellar adjoining, was somewhat bruised and scalded. The escape from death in Dudley Wells' case was almost marvelous.

COLLIERY (61).— At the Luke Fidler Colliery, Shamokin, Pa., May 9th, a car broke loose and ran down the inclined plane into the boiler causing an explosion. Enoch Sandusky was killed, Martin Malony fatally scalded, and William Katighan, John Marose, and John Thomas severely injured.

SAW-MILL (62).— A boiler in the Dunkort Stave Company's mill, Grayson. Ky., exploded May 12th, killing George James and Theodore Bautz, and badly injuring George and Robert Gee.

COTTON MILL (63).— While starting up the engine at the cotton mill of the Bibb Manufacturing Company, Macon, Ga., May 18th, one of the five boilers exploded, killing

Frank Gibson, engineer; fracturing the skull of Wesley Johnson, who will die, and injuring three others. The brick engine-house was wrecked, but the main building escaped injury. The damage to the machinery and engine-house is estimated at $10,000. One hundred and fifty persons are thrown out of employment.

RENDERING TANK (64).—May 23d. Lard tank exploded in the packing establishment of Karcher and Paul, Brooklyn, N. Y., Herbert Weisser and John Kraemer killed.

STEAMER (65).—The boiler of the steamer *John Greenway*, a small boat running on Lake Onondaga, near Syracuse, N. Y., exploded May 24th. Two persons were killed and four others injured.

RENDERING TANK (66).—A terrible explosion occurred at Bayley's California Tripe House on Fifth Avenue, in South San Francisco, May —. Seven men were badly injured, one of whom, John Serot, the engineer, will probably die.

SAW-MILL (67).—A boiler explosion in Foley & Flood's saw mill, Gregory's Landing, Mo., May 27th, injured five men, one of whom is not expected to live.

The Wire Nuisance.

From the address of Dr. Percy, President of the British Iron and Steel Institute, we abstract the following timely words concerning the dangerous feature of what has for some time past been an unsightly nuisance in most of our cities and towns of any considerable size.

"I trust that a word or two on a question which is now exciting considerable attention, and causing alarm in the public mind, may not be deemed irrelevant. I allude to the daily increasing danger from the possible fracture of overhead telegraph wires, and especially cables. So long ago as 1866, I addressed a letter to the editor of the *Times* on the subject, in which this new source of danger to the inhabitants of London was pointed out; and to show that it was not imaginary, an instance of a fatal accident having occurred from this cause a short time previously, was adduced. It was that of an unfortunate man who, while seated on the top of a vehicle, was killed, and nearly decaptiated by the sudden breakage of an overhead telegraph wire. My friend, Sir John Hawkshaw, who, it will be admitted by all who have the pleasure of his personal acquaintance, is no alarmist, has so lately as last month (April, 1885) addressed emphatic words warning to the public, through the medium of the *Times*, concerning this new danger. Life is said to hang upon a thread, and now the life of a Londoner may be said to hang upon a wire, which is but a metallic thread, and with much greater reason to depend upon a heavy telegraph cable. Should any great diminution in the tensile strength of these wires, from physical or other causes, take place in the course of time, it is difficult to conceive how mischief in consequence could be prevented, inasmuch as it would, to say the least, be exceedingly difficult to make a proper inspection of them; and, moreover, even if such inspection were easily practicable, it would probably be neglected until a political dignitary like the Home Secretary or the Postmaster-General should happen to be strangled, or, it may be, decapitated, by a broken wire, or crushed by a broken cable. In the event of such an unhappy accident, this unsightly and dangerous nuisance might possibly be suppressed."

The words of Dr. Percy are to the point. "An unsightly and dangerous nuisance," describes the case exactly, and it is growing daily. So long as we had nothing to contend with but the telegraph wires, we could get along very well, for they, from the nature of their business, could in a measure be limited to certain localities, but since the introduction of the telephone, and the electric light, the nuisance has rapidly become almost unendurable. Every street is crossed, and re-crossed, and filled up with these ubiquitous wires, and every severe storm "floors" them by the hundred. At every fire in the business parts of a city, the efforts of the firemen are greatly impeded by them, and yet the managers of all these concerns look on with unruffled serenity, and apply the earnings from extortionate charges, to the absorption of rival companies instead of spending a portion of them in proper construction. Every telegraph, telephone, and electric light company should be compelled to lay their wires underground within the corporate limits of every city. If the business will not justify this expense, then,—it is pretty good evidence that it is not necessary to the public welfare, or the transaction of legitimate business.

The Locomotive.

HARTFORD, JUNE, 1885.

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

Mechanics' Societies.

Under the above caption, *The American Machinist* of recent date discusses editorially the question, and advances some ideas and suggestions which are of the greatest value, and with which we most heartily concur. It advocates the formation of clubs in the different trades, which shall meet for the purpose of discussing the various matters pertaining to their avocations.

The object accomplished by discussion at such meetings is two-fold. Ideas of much value are thus not only mutually interchanged, but the individual members of the clubs are set to *thinking*, and this is, perhaps, a result of more value than anything else. A machinist or other mechanic who *thinks* is worth twice as much every way as one who does not, but is content to plod along day in and day out, doing things as he has always done them, or as he has seen some one else do them, without stopping to inquire if there is not a better way of doing them. The way to set men thinking is to get them together, and discuss some matter with which each one *thinks* he is perfectly familiar. Some or all of them then generally *learn something*, or if not they *hear* of something which they didn't know before. If they receive this information in a proper spirit, they have obtained much benefit.

One of the greatest obstacles to the formation and perpetuation of these societies, is the fact that in every community there are always some selfish spirits who enter into such matters, and strive to make them subserve their own purposes, instead of working for the greatest good of all. The continued predominance of such men generally results in the disorganization of the society through internal dissensions. But this should not discourage the wiser and more unselfish ones who have the welfare of all in view. It is only by the continuance of such an organization, *as* an organization, that it acquires the knowledge and experience necessary to deal with such elements and properly eliminate them. This is also, perhaps, another very important benefit which results from such associations, as the records of the existence of various engineers', artisans', and literary associations will show.

CONCERNING the explosion of a certain rendering tank which occurred last month causing several deaths, the cause of which was a great mystery, one of our inspectors writes us:—"The digester was made of $\frac{3}{8}''$ iron and was 74 inches in diameter. The iron was reduced by corrosion so that in several places it was but $\frac{1}{16}$ to $\frac{3}{64}$ of an inch in thickness. There was no safety valve on the digester, and after the explosion occurred the steam gauge on the boiler showed 125 lbs. per square inch with the connections broken and steam escaping into the atmosphere, so that *before* the explosion occurred there must have been *over* 125 lbs. pressure per square inch on the digester, as there was no reducing valve between it and the boiler. The safety valve should have blown off at 60 lbs., but it had been overloaded by the engineer so that it would not blow off at 150 lbs."

Is it any wonder that under these circumstances the digester went to pieces, and took the building along with it? The only wonder is that it didn't go before it did, and further than it did.

THE spring meeting of the American Association of Mechanical Engineers was held at Atlantic City, N. J., last month, and was a very successful gathering. Many interesting papers were read and discussed. We shall endeavor to reproduce some of the most interesting ones, or abstracts from them, in following numbers.

THE *American Engineer*, the editor of which for some reason or other condemns the use of the compound engine, has been having a little tilt on the question with Mr. Geo. H. Barrus, the well-known expert of Boston, on the relative economy of simple and compound engines. In our opinion Mr. Barrus comes out most decidedly on top of the heap. Facts are hard things to butt against anyhow.

The current number of *Van Nostrand's* is a very interesting and valuable one. Among the more interesting articles, may be mentioned *The Pyramid Builders*, by Cope Whitehouse; *The General Theory of Thermodynamics*, by Prof. Osborne Reynolds; *Cushioning in Engines*, by George L. Morton, M. E.; *The Distribution of Electrical Energy by Secondary Generators*, by J. Dixon Gibbs; and *Hydraulic Tables based on the Formula of D'Arcy and Kutter*, by J. P. Flynn. All of which will repay a careful perusal.

The following clipping from a Staten Island paper, for which we are indebted to Chief Inspector R. K. McMurray of the New York office, is interesting. Such long periods of service are very rare, in this country at least:

"About the oldest business corporation on Staten Island is the 'New York Dyeing and Printing Establishment,' at West New Brighton, which was chartered in 1819, and it speaks well for its management, as well as for the healthfulness of the North Shore, that so many of its employees have been in their service over a third of a century — some for half a century and upwards. The following is a list of the older employees now in their service, with the number of years they have been connected with the corporation: Smith B. Freeman, 57 years; John Jones, 56; Richard Ditton, 53; Jacob B. Merrill, 53; John DeGroot, 52; Abraham Houseman, 52; James McCrum, 50; Thomas Ditton, 50; Stephen Hooker, 49; Henry Spendiff, 48; John J. Kennisson, 48; George Fritz, 48; Michael Boylan, 48; Charles Fish, 45; Augustus Frary, 43; Edward Steers, 40; Freeman Corsen, 39; James Corsen, 36; Jeannett Thompson, 36; Patrick Daily, 36; Michael Kirkman, 42. Mr. John S. Clarke, the superintendent and secretary, might be added to the list, as his thirty-four years of service is entitled to some recognition."

Strength and Proportion of Riveted Joints.

A Committee of the British Institution of Mechanical Engineers has been making experiments on the strength of riveted joints, and the results have been embodied in a report recently made to that body by Prof. A. B. W. Kennedy. The following is a résumé of the report, for which we are indebted to the *Iron Age*. 290 experiments were made: 64 on punched and drilled plates, 97 on actual joints, 44 on the tenacity of the plates used in the joints, 33 on the tenacity and shearing resistance of the steel used in the joints, and the remainder on various other matters connected with them.

"The whole of the experiments were made upon soft steel supplied by the Landore Siemens Steel Works, which was found to have a tenacity of from 28 to 30 tons per square inch [we suppose the ton here referred is 2240 lbs.—ED. *Locomotive*] with an extension of 23 to 25 per cent. in a length of 10 inches. The limit of elasticity of the metal was generally about 60 per cent. of its ultimate resistance, and the percentage of carbon in the plates was given as about .18. The main conclusions drawn from these experiments are the following:

"The metal between the rivet holes had a considerably greater tensile resistance per square inch than the same metal unperforated; the excess tenacity varying from 20 to about 8 per cent.

"The shearing resistance of rivet steel is a much more variable quantity than the tenacity of steel plate or that of the rivet steel itself, a result due, Prof. Kennedy thinks, in some manner to the want of attention directed to this point, or of experiments made specially upon it.

"The size of the rivet heads and ends plays a most important part in the strength of the joints; an increase of about one-third of weight of metal in the heads and ends increased the resistance of the joint $8\frac{1}{2}$ per cent., the additional strength being no doubt due to the prevention of so great tensile stress in the rivets through distortion of the plates.

"The strength of a joint made across a plate is equal to that of one made in the usual direction.

"The intensity of bearing pressure on the rivets exercises, with joints proportioned in the usual way, a very important influence on their strength.

"The value of machine as compared with hand riveting, in the case where sound hand-riveting is possible, lies in the increased security and stiffness it gives at ordinary working loads, rather than in any actual raising of the breaking load.

"The experiments point to very simple rules for proportioning joints of maximum strength. Assuming a bearing pressure on the rivets of 43 tons per square inch, and an excess tenacity of the plate of 10 per cent. of its original strength, the diameter of the rivet hole should be $2\frac{1}{3}$ times the thickness of the plate, and the pitch of the rivets $2\frac{3}{8}$ times the diameter of the holes, for single riveted joints, while for double riveted lap-joints, with the same ratio of diameter of rivet-hole to thickness of plate, the ratio of pitch to diameter of rivet-hole should be from 3.64 to 3.82.

"If a smaller rivet be used than that here specified, the joint will not be of uniform, and therefore not of maximum, strength; but with any other size of rivet the best result will be obtained by using a pitch calculated from the following formula:

$$p = a\frac{d^2}{t} + d,$$

where p is the pitch, d the diameter of the rivet-hole, and t the thickness of the plate, while the mean value of the constant a is .56. By the use of this formula for double-riveted lap-joints, it is likely that the prescribed size of the rivet may be inconveniently large in practice. In this case the diameter of the rivet should be taken as large as possible, and the above formula will give the pitch by making the constant $a = 1.15$ in the mean.

"For double-riveted butt joints of maximum strength the diameter of the rivet-hole should be 1.8 times the thickness of the plate, and the pitch should be 4.1 times the diameter of the hole.

"In a boiler the plate is much more affected by time than the rivets, and it is therefore not unreasonable to estimate the percentage by which the plates might be weakened by corrosion before the boiler would be unfit for use at its proper steam pressure, and to add correspondingly to the plate area; in this case the joint should be proportioned not for the actual thickness of the plate, but for a nominal thickness less than the actual by the assumed percentage. The joint will thus be approximately one of uniform strength by the time it has reached its final workable condition, up to which time the joint, as a whole, will not really have been weakened, the corrosion only gradually bringing the strength of the plates down to that of the rivets."

It is interesting to note in connection with the above the size and pitch of which the formula calls for in the case of lap joints. Take $\frac{3}{8}''$ plate, for instance. The diameter of the rivet hole would be $.375'' \times 2\frac{1}{3} = .875''$, and the pitch, $.875'' \times 2.375 = 2\frac{1}{12}''$ for single riveting, and $.875'' \times 3.64 = 3\frac{1}{6}''$ for double riveting. This agrees very closely with the table given in the LOCOMOTIVE in July, 1882, our figures for $\frac{3}{8}''$ plate being $\frac{3}{4}''$ rivet,

$\frac{13}{16}''$ hole, $2\frac{1}{8}''$ pitch for single, and $3\frac{1}{4}''$ for double riveted joints. These figures are perfectly reliable and practical, as every good boiler-maker who has tried them conscientiously will admit. The objection urged against such wide pitches has been: It is impossible to make a tight joint with such wide pitches. Our answer to this is: If a boiler-maker cannot make a staunch joint using the above proportions, he does not understand his business, and had better try his hand at something else. The foreman of the boiler department in our largest locomotive shop told the writer that he had adopted wide pitches, and he found that he could make a stauncher joint than he could with a narrow one, for, in driving each rivet, there was less disturbance of the preceding one, owing to its greater distance from it, and consequently less caulking was required to make a tight joint for 160 lbs. pressure than in the other case, and the joint remained in better condition. Several well-known makers of stationary boilers have also adopted the same proportions, and their testimony is uniformly the same,—a better joint with less work. We certainly have seen no trouble from leakage at seams where wide pitches are used.

Concerning the statement about the increase of strength in plates with holes over the same plate without holes, we would say that it is probably due to the fact that the strain is more equally distributed in the former case than in the latter. It is well known, and has been for a long time, that the larger the specimen under test the less tensile strength it shows. This is due to the fact that in the larger specimen in testing the strains must of necessity be somewhat localized. A large piece of plate, tested after the holes are drilled, would probably show about the same tensile strength as a single piece of the same plate having a width equal to the distance between rivet holes in the wider piece.

"Mitis" Wrought Iron Castings.

The following paper, for which we are indebted to *Engineering*, was recently read before the British Iron and Steel Institute by Mr. T. Nordenfeld of London. It will be found interesting:

I have the honor to draw your attention to the samples of wrought-iron castings which I have been allowed to exhibit to this meeting. They represent what I believe to be an entirely new method of producing iron or steel, especially mild steel, in forms and for objects which have not up to the present been attained so cheaply and perfectly as I believe this method will enable a manufacturer to do it. It will be seen that the castings are flexible and weldable to a degree which has hitherto only been produced by the very highest class of wrought-iron forgings. The main point is that we have succeeded in making a commercial success of melting wrought iron, or rather iron with a low percentage of carbon, and casting it into the shapes required by the trade. I am aware that Sir Henry Bessemer, Mr. Crampton, and others have melted wrought iron in even larger quantities than what might be called laboratory experiments, but I would like to claim that before these "mitis" castings were perfected, as they now are, no manufacturer has succeeded in melting wrought-iron under conditions which have enabled the manufacture to be carried out commercially, although upon this point I am in the hands of the meeting, and I would be glad to hear whether we have a right to claim this for our system or not. I have called our produce "wrought-iron castings," because they are made of wrought iron alone, without any other additions than such chemicals (physics) as we have found most suitable for our purposes, and I have called these castings "mitis" castings, in order to give them a name which specifically applies to their qualities, and which name can be easily remembered, even if not understood, by every workman who may have to use them—the Latin word "mitis" meaning, of course, mild, flexible, or ductile.

The origin of this invention, as I must call it (although during the last twenty years so many powerful minds have given their intelligence and energy to develop the manufacture of iron and steel, that there seemed to be but little room for anything new; is as follows:—We had at Carlsvik, in Stockholm, a malleable iron foundry, which fairly succeeded in producing good malleable castings, but we did not succeed in making these castings so absolutely free from faults that I could use them in my gun manufacture. The trade for malleable castings in a small country like Sweden being of course limited, we adopted the method originated by Mr. Wittenstroem, assisted by the experience of Mr. Ludwig Noble, of dynamite and petroleum reputation, and the results of a couple of years' experiments by Messrs. Faustman and Oestberg and myself, with the guidance of Mr. Wittenstroem, are what you now see before you. We, then, last year pulled down our malleable foundry, and put up a comparatively large foundry for making "mitis" wrought-iron castings, the first brick of the foundry being laid in September last year; the first castings in this new foundry were produced in January of this year, and we have already found, not only that we can make much better articles than before, but that, whereas our trade in malleable castings was very limited, we have already for these "mitis" wrought-iron castings much larger orders for consumption in Sweden than we can see our way to execute. The raw material we first used was Swedish wrought-iron scrap, such as horse-shoes, rivets, etc., and the castings we obtained from this raw material were found to have about 20 per cent. higher tensile strength than the wrought iron used—the tensile strength being 24 tons per square inch and upwards—and this percentage of gain in strength has been maintained for other raw materials. We could not at first see that our castings were in any way less pliable or ductile than the Swedish wrought-iron used as raw material, and you will observe from the samples, all of which are bent cold, that the castings show as good a quality in this respect as can possibly be expected from wrought iron forgings. When, however, we tested the material for elongation, we found that the elongation of the castings was slightly less (from 5 to 10 per cent. less) than that of the Swedish wrought iron. This is also natural enough when you consider what had been done by melting the wrought iron. We got rid of all slag, and at the same time we were free from all risk of the delamination and imperfect welding occurring in wrought iron forgings. Our castings are, therefore, more dense than wrought iron, and have practically no fiber; they have the same tensile strength in all directions, this advantage being obtained at the cost of the slight loss of elongation caused by the absence of slag, and by the virtual absence of fiber. But, although there is theoretically some slight loss in elongation, I think you will admit that the samples before you prove that practically the elongation and ductility are fully sufficient for even the most severe requirements.

We do not alter to any considerable extent the chemical properties of the material we use, and I need hardly say that I do not claim that we improve (more than already stated) the actual raw material used. What we put into the pot we get out of it, with such alterations only as are caused by the treatment to which we subject it; therefore, if we use iron free from all impurities, we obtain exceedingly good castings, and if we use iron with a very large percentage of phosphorus we naturally obtain proportionately brittle and unsatisfactory castings. In order to ascertain how much impurity we can deal with, I sent over to Sweden last January a number of different qualities of English iron, and I found that whereas the most impure scrap gave castings too brittle for practical use, a purer iron, such as refined iron from Middlesborough, gave us castings to all intents and purposes as good as the best English forgings, while such perfect raw material as hematite puddle bars gave us castings which were equally as good as, if not better, in every respect, than those produced from Swedish wrought-iron scrap. We found that raw material containing $\frac{1}{4}$ per cent. of phosphorus was too impure to prevent brittleness in the castings; but when we mixed two-thirds of scrap containing $\frac{1}{4}$ per cent. of phosphorus with one-third of refined iron, hematite, or Swedish iron, we obtained castings quite satisfactory for general purposes; when we mixed half and half we obtained castings quite as ductile as, and much stronger than ordinary forgings; while using refined Yorkshire iron, hematite, or Swedish iron alone, we obtained castings which I may be allowed to call "extra" quality, that is, their ductility (as shown by the samples) probably exceeds what can be produced by forgings, while their strength is fully 20 per cent. greater in all directions than the best wrought-iron forgings.

All the above-named mixtures, with less than $\frac{1}{4}$ per cent. of phosphorus, give us castings which can be welded and mended like wrought iron without the slightest trouble. It seems to me that what we do might be said to be that we make exceedingly mild steel by melting the wrought iron almost free from carbon, instead of making mild steel by decarbonizing pig iron which contains about 3 per cent. of carbon. Good pure cast iron would probably not be a much cheaper raw material than the above-named mixtures of wrought-iron scrap, while, on the other hand, we do not require the costly apparatus of the Bessemer and Siemens manufacture, and the very inconsiderable cost of our furnaces would enable our castings to be made on a much smaller scale than those made by the Bessemer and Siemens methods; while, on the other hand, those methods may produce very heavy castings more cheaply than we can. This will also probably be found a more economical way of using up scrap than any other. The manner in which we make the "mitis" wrought-iron castings is as follows: You will see that the samples show an unusually clean surface, and the iron runs, perhaps, more perfectly than in the best cast-iron castings. This, of course, means that we use a very great heat; in order to obtain this heat we melt the wrought iron in crucibles placed in furnaces, each containing six crucibles. Each furnace has one fire, and we work two crucibles together; the pair farthest away from the fire is warmed to a certain degree by the waste heat, the second pair is heated also by the waste heat to a point where the scrap approaches its melting temperature, and in the pair nearest to the fire the wrought iron is completely melted. As this last pair is lifted out, the second pair is moved forward into their place, the third pair is moved forward into the place of the second, and a fresh pair of filled crucibles is placed in the compartment furthest away from the fire. In order to obtain quickly the great heat required, we employ as fuel the residuum of petroleum, called naphtha, which is easily obtainable in unlimited quantities, and which is not in any way dangerous. We have tried this residuum from American petroleum, from Glasgow, and from Baku, and they all work equally satisfactorily; and we have tried other forms of volatile oil, which also works well with slight modification in the furnaces, but which in most places would be found more expensive than the naphtha. From these furnaces we can draw eight to ten pairs of crucibles per day of twelve hours, and when we, as we intend to do, commence working day and night shifts, we can cast fifteen to twenty times every twenty-four hours. This is a considerable gain, as I believe that in Sheffield the crucibles are taken out only about three times in twelve hours; and we have the further advantage that we refill each crucible every time by its full charge of about 60 lbs. of scrap, whereas in Sheffield a full charge of 60 lbs. is only put into a new crucible, their second charge being about 50 lbs., their third about 45 lbs., and so on. Our next step is to deal with this exceedingly hot iron. We have carried out a method of moulding and facing sand which works to our entire satisfaction, as shown by the samples, and we have made use of water moulds of a special construction when a great number of castings have to be made to the same pattern. In order to do this expeditiously and cheaply we use a ladle, in which we keep the iron at its full heat by means of a surface blast of very hot gases, and we fix a number of moulds around the circumference of a turntable in such a manner that one mould can be filled after the other as quickly as it is brought under the lip of the ladle, and the castings are immediately taken out of the moulds, so that each mould is ready for refilling as soon as it comes round again under the lip of the ladle.

The raw material being wrought iron only the castings do not require to be in any way annealed, but are simply cleaned up by emery-wheels, or otherwise, and delivered to the purchaser. As the iron runs so exceedingly free without large heads, and as it falls out of the moulds so easily, this method of "Mitis" wrought-iron castings must tend to save labor to a very important extent, and we have already found that it enables us to considerably lighten and greatly vary designs—such as designs of machinery, etc. —as we can, without extra cost, shape our moulds, so that we give the strength of metal where wanted, but only where wanted, whereas in forgings it would often not pay to complicate the shape. This method also enables a constructor to make much bolder designs, and of more difficult forms, knowing that such designs can be easily and cheaply carried out. Here again we find great advantage in being able to weld the castings as we can cast the parts, which would otherwise be difficult to forge, or which would require much machining, and weld them on to a bar or rod as required. Some of the samples show links, bearings, and clutches used in this way.

I can hardly imagine any form of forging which it would not be more advantageous to cast by this method. You see before you the most difficult forms, such as pulleys, smoke-consumers, wheels, knees and bends of piping, etc., which give the tensible strength of mild steel forgings without any greater expense than for castings of ordinary shapes, except what may be caused by the greater trouble in making the mould. Our work at present is principally limited to such castings as would compete with malleable castings, because that was our trade previously, and because we were lucky enough to find that the malleable patterns came in exactly without any alteration for our "Mitis" castings, the contraction in both cases happening to be the same. The cost of our "Mitis" castings being practically the same or perhaps slightly lower than that of our malleable castings, all our customers are, of course, very glad to have the "Mitis" castings instead of the others, as they are so much more strong and ductile, and as the decarbonization in malleable castings is apt to destroy the iron in very thin pieces, whereas in castings of comparatively larger dimensions the decarbonizing of course only acts near the surface, while the main portion of the malleable casting remains brittle cast iron. As a matter of fact we are not only paid much higher prices for our "Mitis" castings than we were paid for the same castings made of malleable iron, but we cover a much larger field of work, because of our "Mitis" castings being used for a great many purposes for which malleable castings could not even be thought of.

As we have more to do than we can provide for in these smaller castings, I have as yet had hardly any experience in castings of larger dimensions, but I have no doubt that we shall ultimately arrive at larger castings, and that we shall be able successfully to deal with the contraction in articles even exceeding two or three inches in thickness; but at present I see such an extensive field for smaller castings, where this method has no competition other than drop-hammer forgings, because our steel-makers are not prepared to cast very thin or intricate articles, that it seems to me of no use as yet to compete in the sphere of such larger castings as can be easily produced from a Bessemer or Siemens furnance, or from the ordinary crucible. We have also lately made some very successful steel castings with a higher percentage of carbon, some samples of which, unpolished as well as burnished, I have brought here. These promise well for the future, the surface being exceedingly clean and taking a very high polish, and we have tried them successfully for ordinary edged tools; for instance, we cast at present some of our tools for the gun factory in Stockholm, and we cast them ready to shape, after which we have only to harden and grind in order to make them ready to put into use. These steel castings we also make out of wrought-iron scrap as raw material, adding the quantity of pure pig iron required to bring up the percentage of carbon to the point required for each different purpose. I do not mean to say that tools can be made better by this method than by the ordinary methods, but it is certainly a more direct way than to make wrought iron bars into blister steel and then smelt this blister steel in a crucible, and my method is certainly cheaper, seeing that pure scrap can be obtained at a very much lower figure than the bars, and that my tools are cast ready to shape. There can be no risk of sufficient wrought iron scrap not being procurable to enlarge the "Mitis" casting business to any extent; but, if scrap were to become scarce, the difference of 25s. per ton between scrap and puddle bars would only represent half a farthing per pound in the cost of the castings. I cannot help thinking that this, like other means of saving manual labor, while it may be opposed at starting, is certain in the long run to extend the use of iron and steel so much further that quite as many workmen and blacksmiths will be employed in the future as at present, though their labor will be more profitably employed in this work than in making forgings by the old process.

The Locomotive.

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The Proper Connection of Steam Pipes.

After boilers are properly arranged and set up, the next important point to be considered is the arrangement of the main steam pipes and their connections, for unless these are properly designed and put up, much trouble is apt to ensue. The points to be considered, but which are very often neglected, is to provide for the effects of expansion.

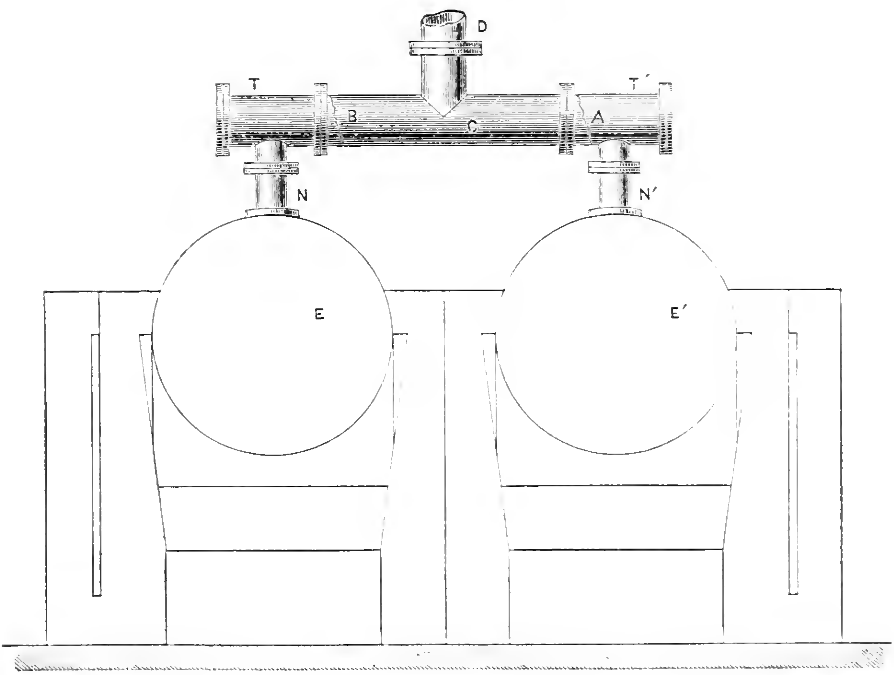

FIG. 1.

and also to make allowance for any settling of the boilers which may, and generally does, occur after they have been run a short time.

Fig. 1 shows a case where two boilers were improperly connected. Cast-iron tees were bolted to the nozzles, and connected by means of a cast-iron pipe, which had an outlet on top, as shown from which the steam pipe was led. It will be seen at once that the boilers were rigidly bound together, by this arrangement. After a short time the tee on No. 2 cracked off as shown at A; this was replaced with a new one and soon afterward the pipe connecting the two boilers broke off at B. Both these breaks occurred while the boilers were in use, and of course resulted in their stoppage until the broken pieces could be renewed. The only strange thing in connection with the affair was the fact that the breaks did not occur the first time steam was gotten up.

Cast-iron pipe should be used with caution for such purposes, as from its brittle nature, accidents are liable to occur at any time. Wrought-iron pipe is better every way. and should always be used. But in no case can the use of such connections as that shown in Fig. 1 be justified. Only a very inexperienced engineer would design such a connection, and no steam-fitter should put it up without entering a strong protest against it. No provision whatever is made for the motion of the boilers due to expansion, or settling of the foundations, or walls.

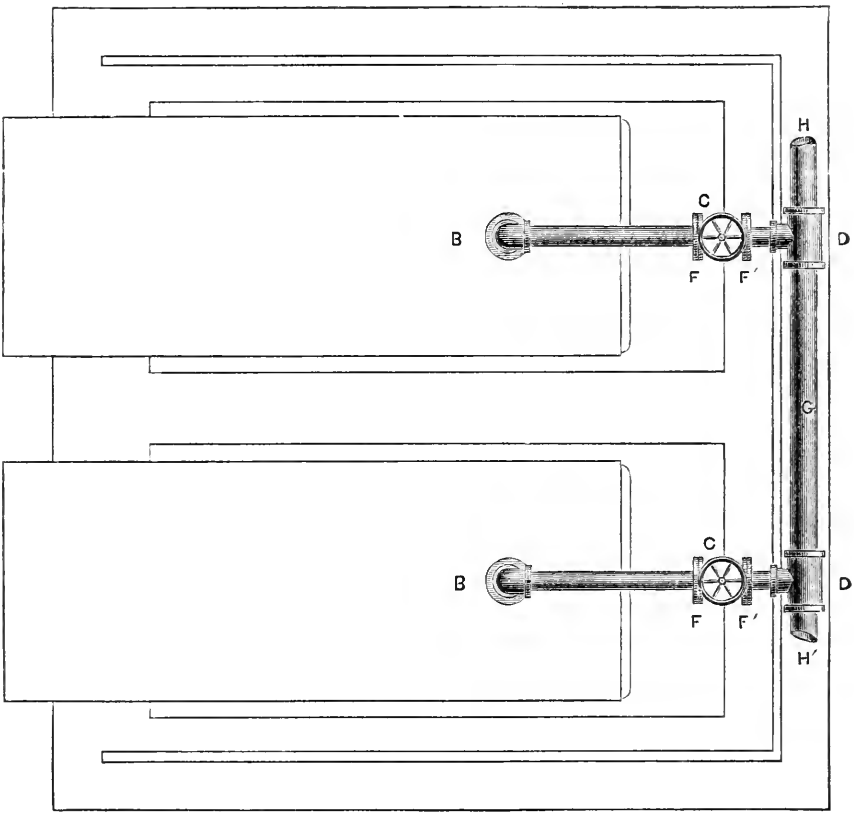

FIG. 2. PLAN.

Figures 2 and 3 show what we consider a properly-designed arrangement of steam connections for a battery of boilers. Wrought-iron pipe is used. To the nozzles risers are attached by means of flanges, and from the upper ends of these risers pipes are led horizontally backwards into the main steam-pipe. In this horizontal pipe, the stop-valves, one to each boiler, are placed. These valves should have flanged ends as shown, so that they may be easily removed, if repairs become necessary, without disturbing any other portion of the piping. The main steam-pipe may be supported by means of long hangers from the roof of the boiler-house, when practicable, or if this cannot be done, it may be held up by posts which rest on the back wall of the boiler-setting, or any other convenient place.

By this arrangement it will be seen that the movements of the boilers, and the piping itself are compensated for by the spring of the pipes, and no trouble will ever occur. The height of the risers should never be less than three feet, and when there are

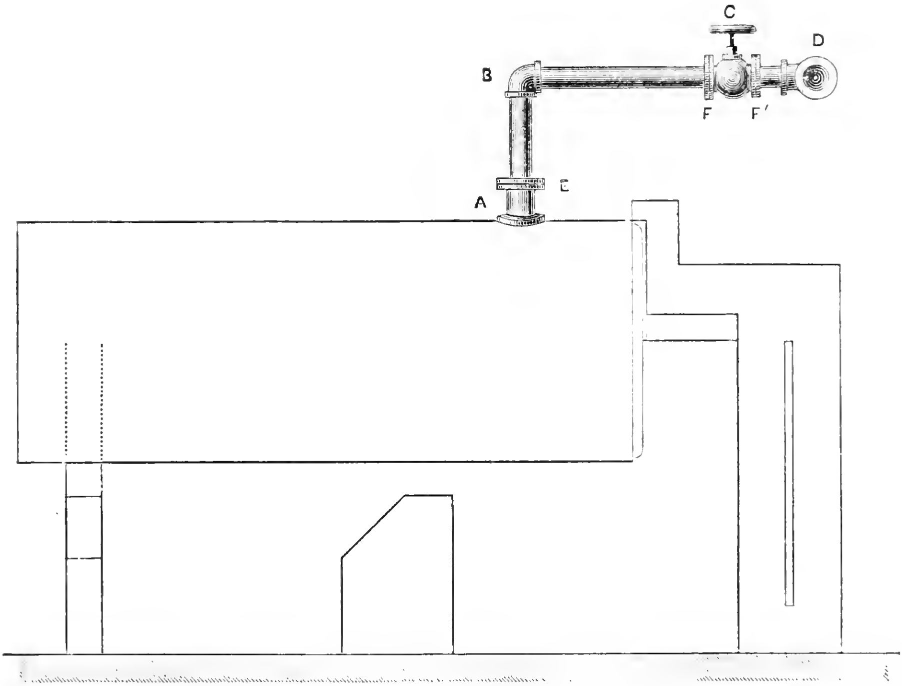

Fig. 3. Side Elevation.

eight or ten boilers in one battery, they should be, if room permits, six to eight feet high, and the horizontal pipes leading to main steam-pipe should be ten to twelve feet or more.

Inspectors' Reports.

MAY, 1885.

The number of inspection trips made during the month of May last foots up 3,001 the total number of boilers visited 5,708, boilers inspected internally 2,235. The hydrostatic test was applied to 383 boilers, and 33 were considered unfit for further use, 3,638 defects were reported, of which 505 or 14 per cent. were considered of such a serious character as to impair the safety of the boilers unless immediately attended to and remedied. Our usual tabular statement of defects is appended.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	394	34
Cases of incrustation and scale,	657	37
Cases of internal grooving,	21	8
Cases of internal corrosion,	135	16
Cases of external corrosion,	280	35
Broken and loose braces and stays,	54	23

Nature of defects.	Whole number.	Dangerous.
Settings defective,	146	21
Furnaces out of shape,	177	27
Fractured plates,	99	43
Burned plates,	108	20
Blistered plates,	198	21
Defective rivets,	348	35
Defective heads,	37	11
Leakage around tubes,	427	70
Leakage at seams,	165	18
Water gauges defective,	84	12
Blow-out defective,	36	12
Cases of deficiency of water,	8	7
Safety-valves overloaded,	20	8
Safety-valves defective,	33	15
Pressure gauges defective,	203	32
Boilers without pressure-gauges,	8	0
Total,	3,638	505

Leakage at tubes ends is one of the most frequent and annoying defects to which the ordinary horizontal and upright tubular boilers are subject, and while it is not necessarily, on its first appearance dangerous, it indicates that something is wrong, either in the construction or management of the boiler, and it should be attended to at once, for if neglected, the resulting corrosion of the head and tube ends will speedily induce a dangerous condition. Many explosions of upright tubular boilers have resulted solely from this cause.

Faults of construction may consist of insufficient rolling, or too severe rolling or expanding of the tubes; by which the ends may be split, or cracked, so that it is impossible to keep them tight. The second defect is, perhaps, more frequent than the first. The feed-pipe is also very frequently wrongly located in the head close to the tubes, and when it is, and cold feed-water is used, the tubes in the immediate vicinity are almost sure to show a chronic leak.

A heavy coating of scale on the heads between the tubes is sure to set them leaking severely, as the water is thus kept away from the head and tube-ends, and they become overheated. In this case the only thing that will do any permanent good is to remove the cause, that is the scale: when generally if the defect has not existed for too long a time, the tubes may be rolled and made tight again. But a comparatively short time of severe leakage in this case is pretty sure to so severely corrode the ends that new tubes are required.

This collection of scale is also a fruitful source of burning and cracking of the back tube-sheet. The front end of the boiler is not so much subject to this action, as the heat to which it is subject is not so intense.

The removal of a heavy coating of incrustation from between the tubes of a boiler is sometimes a matter of some difficulty unless due intelligence is use. With "staggered" tubes, very bad water, and where the boiler is worked hard, the case is much complicated, and the almost sole reliance is a judicious use of solvents, coupled with proper cleaning, as often as the boiler can be spared for the purpose. With properly arranged tubes, much help can be obtained by the use of proper chisels and scraping tools. Still no rule of procedure can be given that will apply to all cases. A thorough examination of each case is always necessary to determine the best method of procedure, and it is always easier to keep a boiler clean, than it is to clean it after it is badly fouled.

The Locomotive.

HARTFORD, JULY, 1885.

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.

Crystallization of Iron.

The question of the crystallization or molecular change in the constitution of iron under strain in such structures as bridges, boilers, etc., has always received considerable attention, and been the cause of much discussion. It has recently been revived, so that a few words upon the question so far as it relates to boilers may not be out of place here.

In the first place, it is assumed by the advocates of the crystallization theory that a moderate amount of strain, well within the limit of what would be considered safe, will, if long continued or often repeated, ultimately cause a crystallization of the material, which renders it brittle and liable to break at a much lighter load than would be required if the material were new, or with a load which would be perfectly safe if the crystallization had not taken place. Many examples have been cited to prove the correctness of this theory, and it has many able and earnest defenders. But we do not think it is true, at least in the sense in which it is generally taken.

We have found that plates taken from boilers after a period of service of upward of twenty-six years were as good as new, and stood the test of flanging perfectly well. This they would not have done had they been deteriorated by the strains to which they were subjected during their long period of service.

It is a very frequent thing for boilers which have served a long term of useful life to be cut up, and the plates found to be in good condition.

One element which no doubt has furnished much of the material for argument in favor of crystallization, is the fact that in built up structures of all kinds, calculations of stress are made upon the assumption that the proportions and workmanship are so nearly perfect that the strains on the various parts are just what they are supposed to be. This may lead to serious error; for it is quite within the range of possibility, if not of probability, that proportions and workmanship may be so much in error that when the structure is put together, the strains, instead of being uniformly distributed as they may have been originally intended, are so much localized that some portion may give way in a comparatively short time, and this in turn is quite likely to bring undue strain upon some other part, which fails in its turn, and may eventually lead to the destruction of the entire structure, while the true modus operandi of its failure may be unsuspected, and the result very naturally be attributed to some form of deterioration of the material.

For instance, we once saw a boiler in process of construction, and the operation of riveting was a marvel indeed. The holes did n't seem to come fair somehow; so two men with a drift-pin and sledge-hammers *brought them fair.* But the seam, when finished, was a curious sight. "Not straight by two inches," was the expression of one disgusted mechanic, and it seemed about so. It would be interesting to learn just how uniformly the strains on this seam would be distributed when the boiler was under steam, and just what its real factor of safety would be, compared with the calculated margin. These examples show how possible it may be for engineering structures to fail when the factor of safety is *supposed* to be large enough to meet any contingencies, when in fact there is no margin of safety: the strength of the structure as a whole being no greater than that of the weakest point.

But in the case of those portions of a boiler exposed to the direct action of the fire the case *may* be different, so far as deterioration is concerned. Here we have that most powerful of all physical forces, *heat*, to deal with, and this force will produce structural changes in any known substance if the conditions are right.

On this point our experience teaches us that where a boiler is made of good material, well put together, and *properly cared for*, no portion of it will suffer materially from molecular changes during the ordinary life-time of a boiler. But on the other hand, if the boiler be made of bad material, or if the feed-water is of such a quality that much scale or sediment is formed, and it is not kept cleaned out properly, then the habitual overheating, which is possible, may so change the structure of the iron that it may be unfit for the purpose. But under these very unfavorable conditions we have known boiler iron to retain its good quality until actual overheating had occurred to such an extent that rupture occurred, simply because the plates were red-hot, and very weak in consequence. Good iron in such cases will generally rupture locally and no serious damage may be done, while if it is of a brittle character, the rupture may be so sudden and extensive that an explosion may occur.

On the whole it is safe to conclude that if a boiler is well made, of good material, and properly cared for, we need have no fear that it will become unsafe through molecular change in the plates.

THE *Mechanical Engineer* has published in late issues memoranda relating to amount and proportion of grate surface, heating surface, condensing surface, indicated horse power, etc., of the boilers and engines on various successful steamers. One column of such matter is worth more than volumes of speculative or dogmatic engineering literature.

THE Annual Report of Mr. Hiller, Chief Engineer of the National Boiler Insurance Company, Limited, Manchester, England, for the year 1884, has just been received. It contains a list of the explosions which occurred in England during the past year, with a discussion of their causes, hints on boiler-construction, setting, and management, and much valuable information of interest to steam-users. We give extracts from it on another page.

We learn that the clipping entitled "What will burst a gun," on page 45, and "Cast Iron Cutlery," on page 69, of our current volume, were originally published in the *Scientific American*, and should be credited to it. We make the correctian cheerfully, as we always intend to put the credit where it belongs. We missed them when first published and credited them to the papers in which we afterwards found them.

Boiler Explosions in England in 1884.

From the Report of Mr. Henry Hiller, Chief Engineer of the National Boiler Insurance Co., Limited, we learn that the number of explosions of steam boilers in the United Kingdom, in the year 1884, were 36, by which 24 persons were killed, and 49 others severely injured. Of these explosions, 10 arose from external corrosion, 8 from internal corrosion or grooving, and 3 from general deterioration, 4 from weakness of flues, 1 from overheating of vertical flue-tube, one from overheating through deficient circulation, 1 from defective material, 4 from deficiency of water, 4 from over-pressure, 1 boiler fractured at the seams, the cause given being that the boiler was externally fired, and 1, the cause of which was not assigned.

Some of Mr. Hiller's remarks on the causes of these explosions may be interesting, so we append extracts from them.

"No less than nine of the explosions reported arose from external corrosion. Five of these were 'Cornish' boilers, two vertical with internal fire-boxes, one "Rastrick" boiler, and one portable locomotive type. These explosions could have been prevented by due attention to the principles I have laid down in my various reports, and which are continually brought before the notice of boiler owners, viz., the importance of all parts of boilers being accessible for inspection, and the necessity for baring those which have been long hidden from view, or in contact with broad brick-work seatings.

"One of the 'Cornish' boilers was set on side seatings nine inches broad. There was a tank over one side, which had evidently leaked occasionally, and the flues were in a damp condition, and hence there had been extensive corrosion of the shell-plates. The boiler had been repaired in an objectionable manner, viz., by bolted patch. Rupture commenced thereat, and the boiler was torn into several pieces, the adjacent buildings were wrecked, and four persons, including one of the firm, were injured. Another of these boilers was set on similar seatings, the side flues being inaccessible. The plates were much thinned in contact with one seating, where the rent began, the shell being torn into several fragments, one of these being projected about 130 yards away. The chimney stack was knocked down. The owner had been pressed to prepare the boiler for complete inspection, but had neglected to do so, with the result described.

"Another was set on a broad mid-feather seating, one of the shell plates being much reduced in contact therewith, and this ruptured. The explosion caused the death of the attendant and injury to another man. The explosion of another of these was similar to the preceding one, but the boiler was of smaller dimensions. Fortunately no one was injured by its failure, although it was forced from its seating. In the fifth case, the boiler was of large dimensions and set upon side seatings, the side flues being inaccessible. The boiler had been repaired in an unreliable manner by bolted patches, the leakage therefrom and other dampness causing great thinning of the shell-plates, two rings of which were torn away and considerable damage resulted. The owners had been strongly urged to have the boiler completely examined, but deferred it too long.

"Two of the boilers which exploded from general deterioration were plain cylindrical, externally fired, and one was a vertical boiler with internal fire-box. All were second-hand. One of the cylindrical boilers was evidently very old. It had been bought from a broker several years ago, when it had probably been discarded by the previous owner as worn out. A large piece was blown out of the lower part, and the brick-work setting demolished, and other damage done. The explosion of the other cylindrical boiler was similar in character. It also was generally much deteriorated; in fact both these boilers, which were of small dimensions, were in disgraceful condition, and only fit for the scrap heap. Fortunately for the owners, no life was lost in either case. The other boiler was much weakened in the fire-box, the plates being thinned to less than half their original thickness, whilst it is probable that the safety-valve load had been excessive. The fire-box collapsed and was rent to pieces. The main portion of the boiler was projected through the upper portions of the building in which it was situate, and passing over a street, fell on and embedded itself in the roof of an adjacent granary, sixty or seventy yards away. This explosion was also fortunately unattended by loss of life.

"Four 'Cornish' boilers exploded through weakness of flue-tubes. In one of them the tube was about 25 ft. long, 3 ft. 2 in. diameter, $\frac{7}{16}$ in. plates originally, the stated pressure 35 lbs. per square inch, a moderate load, but the upper part of the tube was much corroded. It collapsed the whole length and ruptured in several places. The attendant lost his life. In another, the tube was 26 ft. long, about 4 ft. diameter, the plates originally $\frac{1}{2}$ inch, stated pressure 40 lbs. It also was weakened by corrosion, and was collapsed nearly the whole length. The owners had been advised to strengthen it, but had not done so. The third was a small boiler. The tube was of oval form, and hence originally very weak. The plates were also reduced by corrosion, but it was unsuited when new, for even a moderate pressure. Its collapse caused the death of a man, who was found buried in the debris and dreadfully scalded. The fourth occurred at a colliery, to one of several boilers which had been proposed for insurance with this company, but the proposal had not been accepted, owing to the unsatisfactory condition of the boilers. The tube was totally collapsed for about half its length, the collapse being evidently arrested by some cross tubes, which had been inserted. It was stated the boiler had been tested by hydraulic pressure, and it was believed that this had, by severely straining or flattening the tube, contributed to the explosion.

"One of the lower tubes of a water-tube, or so-called safety-boiler, was torn open through over-heating from deficient circulation, a matter which is not suitably provided for in some boilers of this class. A man was severely scalded by the contents, which were discharged through the large opening, and died shortly afterwards.

"Four explosions arose from deficiency of water. One boiler was 'Cornish,' one 'Galloway,' and one cylindrical 'Breeches'-flued, all internally fired. These three explosions were all similar and of slight character; a furnace crown becoming over-heated, collapsing, and rupturing in each case, through over-heating when the water became deficient. The 'Cornish' boiler, which was situated in the county from which this class of boiler takes its name, was altogether in most defective and dangerous condition, and it is wonderful that explosion had not occurred long before, as the boiler had evidently been unfit for work at any pressure for a long period. The accident was actually due, however, to deficiency of water, through mistake or neglect of the attendant, who was fatally scalded.

"In addition to the 36 explosions described in preceding pages, I have particulars of 19 accidents to boilers or other apparatus, particulars of which follow. These caused the deaths of 4 persons and injury to 27 others.

"Two men were scalded by incautiously removing the cover of a pipe of an economiser, or feed-water heater, whilst it was under pressure, one of the valves connected therewith having failed to act, it being fouled by a small stone. The top of a pitch cooler was blown off, owing to the gas it contained being ignited, and exploded. The lid of a bleaching 'kier,' which had become distorted by the pressure, escaped from the pinching screws or clamps which held it. The lid of the vessel was too weak for the usual pressure. The lid of another similar vessel was blown off, and nine persons were injured by the escaping hot liquor, etc. Some of the bolts and nuts, which secured the lid, had become much weakened through constant usage, until they failed at the usual pressure. These two cases exemplify the importance of ample margin of strength in such apparatus and their connections. Two men were scalded through one of them incautiously unscrewing the bolts of a man-hole cover of a revolving grass or rag boiler, even though the pressure-gauge still registered 15 pounds.

"A cylindrical grass or rag boiler exploded, and was blown to pieces, through over-pressure. It was fitted with a safety-valve, stated to be loaded to six pounds, but the out-let to the valve had evidently become choked with some of the grass or material in the vessel. Such valves should be placed on the pipe leading to, and close to the vessel, but not on the vessel itself. Several explosions have arisen through valves becoming choked when placed direct on the vessels. The vessels themselves should be of such a strength as will enable them to withstand, with safety, the full pressure of the boilers with which they may be connected. When this vessel exploded, a hole was knocked in an adjacent steam boiler by one of the fragments. This might have caused its explosion, and it is probable that in such case, the whole occurrence might have been erroneously attributed to the explosion of the steam boiler."

The Preservation of Timber.

Summary of Report of a Committee of the American Society of Civil Engineers.

After a brief statement of the labors of the committee, and of the evident necessity for the introduction of preserving processes on account of rapidly diminishing supplies of timber, a short history of the progress of the art is given, showing three principal methods of working, namely:

1. Steeping.
2. Vital suction or hydraulic pressure.
3. Treatment in close vessels by steaming, vacuum, pressure, etc.

The experience in the United States is given in five tables, comprising the results more or less conclusive of 142 authenticated trials or experiments. In each case, these are referred to at more or less length in the text, sufficiently to give the reasons for success or failure, and the lesson taught. The five heads corresponding to the tables are:

1. Kyanizing, or use of corrosive sublimate.
2. Burnettizing, or use of chloride of zinc.
3. Creosoting, or use of creosote oil.
4. Boucherie, or use of sulphate of copper.
5. Miscellaneous, or use of various substances.

Of the first, *Kyanizing*, it is stated that an absorption of four or five pounds of corrosive sublimate per thousand feet, board measure, is considered sufficient, and it would now cost about $6.00 per 1,000 feet, board measure. It is not recommended except in situations where the air can circulate freely about the wood, as in bridges and trestles, but in very damp locations (as for ties when in wet soil and pavements), its success is doubtful. Its cost when first used led to cheating, which for a time brought discredit upon it.

Burnettizing the committee do not consider the best adapted to use where the timber is exposed to the washing action of water (as this removes the preservative); but on account of its cheapness, it is probably to be preferred at the present time to any other process for the preservation of railroad ties. The Wellhouse, Thilmany, and other modifications of the process aim at making the chloride insoluble, but are yet on trial. This process has been largely and successfully introduced in Germany. Experience shows the life of soft wood ties to be doubled and trebled by its use. Its cost in this country is about $5 per 1,000 feet, board measure, or from twenty to twenty-five cents per tie, and for the latter purpose the committee particularly recommend it.

The work must be well done; but some of the failures were from doing it *too* well, that is, from using solutions of too great strength, thus making the timber brittle.

A solution of two per cent. by weight, of chloride of zinc in water is recommended.

Creosoting, or the injection of timber with hot creosote oil in a cylinder under pressure, is considered to be the very best process that has been fully tested, where *expense* is not considered. It is as yet the only one known that is sure to prevent the destructive attacks of the teredo, or other marine animals, and to give absolute protection against decay in very wet situations. It is a somewhat expensive process, requiring for protection against the teredo from ten to twenty pounds per cubic foot of timber, and costing from $12 to $20 per 1,000 feet board measure. For resisting decay alone, a cost from $10 to $14 is sufficient.

The *Boucherie* process, in which green timber is impregnated with sulpate of copper either by *vital-suction*, *hydraulic-pressure*, or a *vacuum*, when well done, using a solution of one pound of sulphate to 100 of water, has proved fairly successful.

Under the head of "miscellaneous," are classed forty-one experiments with almost as many substances, sulphate and pyrolignite of iron, lime, resin oil, tar, etc., but with as yet no commercial success.

The general principles laid down are, to select the process with reference to the subsequent exposure. Use *open-grained, porous*, timber, for that reason in *general*, the cheaper wood.

Extract the sap and water to make room for the material to be injected, natural seasoning, except for the Boucherie process, being very desirable. Steaming takes the place of seasoning.

Use enough of the antiseptic to insure a good result, and then let the timber dry before using, as its durability will be thus increased. Do not hasten the work if it is to be well done. Protect ties or timber in the track as far as may be from water by drainage.

Contract only with reliable parties of established reputation under a skilled inspector, who must be in constant attendance when the magnitude of the order warrants.

There is at the close a discussion of the question, Will any preserving process pay? This is answered in the affirmative. The chairman of the committee gives a careful estimate in one of the appendices in an actual case in this country; another general estimate is given based on European experience; and three other separate appendices give different methods of examining the question of economy and comparing values.

Other appendices (to the number of twenty in all) treat of the general question of destruction, and conservation of forests, and gives reports of the personal experience of a number of engineers, with methods pursued, apparatus used, etc.

Comparative Merits of Anthracite and Bituminous Coal.

A board of officers recently appointed by the Navy Department to investigate the comparative merits of anthracite and bituminous coal for ordinary naval uses, and the points of each are summarized as follows:—

Heating Power.—In reference to this quality the Navy Department was originally induced to employ anthracite, chiefly in consequence of the report of Prof. Walter R. Johnson of Washington, in 1844, that the evaporative efficiency of average anthracite was superior to that of bituminous coal, the figures being 9.5648 pounds of water evaporated per pound of coal in the former case, and 8.944 in the latter. They did not fully include the very important circumstances that anthracite fires need to be cleaned in longer service than about 12 hours, and after that time should be more or less thoroughly cleaned once in every 12 hours. This causes loss of evaporative power in the following ways, to which the fires of free-burning coals are subject in a much less degree: (*a*) By the direct abstraction of heat from the combustible portion of the fuel to bring the earthy matter and ash to the high furnace temperature; (*b*) by the direct loss of heat when the clinkers and ashes are withdrawn at that high temperature; (*c*) by the unavoidable loss of some unconsumed coal during the abstraction of the clinkers; (*d*) by the influx of cold air through the open furnace door during the operation of cleaning fires; (*e*) by the loss of heat expended in raising the temperature of air over and above the quantity needed for combustion; (*f*) by the loss of effect during the time that the fire newly cleaned requires to recover full action. The average evaporative power of the semi-bituminous coals is higher than the average evaporative power of the anthracites, being 9.9804 and 9.5648 pounds of water from 212° F., respectively. Their conclusion is strengthened by results of Isherwood's experiments with several marine boilers, some, however, being flue boilers, in which Cumberland semi-bituminous coal generally evaporated more water than Pennsylvania and other anthracites. And these results are further corroborated by experiments of the Baltimore & Ohio Railroad, in which the evaporative effect of 1 ton of Cumberland coal was found to equal that of $1\frac{1}{4}$ tons of anthracite. It is asserted that, when combustion is forced, the economic evaporation is relatively less with free-burning coal than with anthracite, but it may be answered that, under the circumstances in which the blast or steam-jet is used, economy is temporarily ignored, the object being to produce active combustion regardless of cost.

Promptness of Ignition.—On this point the report shows that this quality is so valuable in a naval vessel that it almost precludes the employment of anthracite in time of war in favor of a more free-burning coal, and that it has considerable advantages in time of peace.

Weight of a Given Bulk.—The report says that the average of all the semi-bituminous coals of Maryland gives rather the smallest space occupied per ton (42.0372 cubic feet), the anthracite ranking second (42.13 cubic feet), the bituminous coals of Pennsylvania being third, but with very trifling difference (42.671 cubic feet), the coking coals of Virginia being the only free-burning varieties which are decidedly lighter (45.8804 cubic feet), indicating that anthracite is the heaviest class of coal.

Smoke and Soot.—In non-production of smoke anthracite takes the lead; also in freedom from soot.

Action upon Boilers, Grates, Etc.—In this respect, the report says, it is likely that there is not much to choose between the anthracites and free-burning coals, at least with iron boilers, for, whereas the intense local heat of an anthracite fire searches and develops any tendency towards blistering or lamination in boiler iron, there are several varieties of free burning coal which contain sulphur, and which are injurious on that account to tube-ends, etc. Both classes will under certain circumstances, warp and destroy grate-bars.

Impurities.—This subject has been covered in a former division of the report. If spontaneous combustion is feared, the coal should be free from pyrites.

Deterioration.—It is probably true that anthracite will scarcely deteriorate in heat-giving power except after long exposure to the direct action of the sun, as in the coal piled on the sandy beach at St. Paul de Loanda from about 1862 to 1882, for the similar coal at Fernando Po, having been overgrown with weeds and trees, and therefore sheltered from the rays of the sun, was almost as efficient after twenty years as when it was fresh. The free-burning coals, on the other hand, rapidly lose their cohesion and heat-giving power. Anthracite, under favorable circumstances, would last almost indefinitely.

Friability.—The slack of anthracite is worthless on the grates of a boiler, whereas if a free burning coal, if not too old, it is tolerably efficient in the formation of steam.

Completeness of Combustion.—This is a quality possessed to a greater degree in most of the semi-bituminous coals than in most of the anthracites. Besides the wastefulness caused in the furnace by the greater average formation of clinker with the latter coal, there is the greater labor necessary and time lost in their removal from the boiler and their being disposed of.

Spontaneous Combustion.—In this respect anthracite exceeds all other coals, being entirely free from this source of danger.

Price.—This subject is treated simply from a naval standpoint.—*Mechanics.*

Diamonds in South Africa.

Among the "curiosities of commerce" none, perhaps, is more curious than that the major portion of the produce exported from South Africa is simply used for the adornment of ladies. Out of a total value exported of $36,000,000, ostrich feathers and diamonds account for $25,000,000. Twenty years ago all known diamonds had come to Europe or the United States from immemorial Eastern stocks or from the scanty produce of mines in Brazil and elsewhere, which were calculated to yield not more than $250,000 worth in the year. To-day, situated in the midst of a wide stretching plain affording at all points a sea-line horizon of flat "veldt," we find this town of Kimberly with a large European population of wealthy and well-to-do people, and a large native population earning every year more than $5,000,000 in wages. And from this mining oasis in the agricultural desert has been sent in the last fifteen years something like $200,000,000 worth of diamond in the rough, which, with the cost of cutting, setting, and selling, must have taken from the pockets of the consumers something approaching $500,000,000.

As all the world knows, the South African diamond mines have their own story of unexpected discovery at the least as startling as that of any gold field or other rich mineral deposit in the world. In 1867 the first diamond was found, the favorite toy of a little Boer girl, which she had picked out from among the roots of an old tree. Its genuineness was not long in doubt, and in a few months the bed of the Vaal River was known as a profitable diamond region. Prospecting became the rage, and here and there on the open, flat, grassy veldt diamonds were found in spots with common peculiarities of soil and so forth. In three years' time the secret of the diamond deposits had been so far fathomed as to prove that they were strange circular deposits or patches of peculiar earth, isolated from one another and few in number. These were at once "rushed," and a regulation digging community took possession of the new district. Private individuals, previous proprietors and Governments fought for the claim to these new mineral riches, but despite these squabbles the practical work was carried on of marking out these circular patches in diggers' claims over the flat surface. At first the rule was each digger for himself; and with pick and shovel diamonds were brought to grass in such profusion that the whole mining world was startled by a discovery exceeding in magnitude, real and prospective, any previous find. But as men dug deeper in their claims, so they found it necessary to arrange and amalgamate with their neighbors; moreover, the deeper they went the more necessity for machinery to hoist the soil to the surface. And then, as they passed on through the top "yellow" they came upon a "blue" soil which was yet more rich in diamonds.

Suffice it to say that in ten years' time each one of these greater circular areas had been so far emptied of soil as to represent great quarries 100 to 200 yards across and 300 or 400 feet deep. Early in the digging the geologist stepped in to point out that these circular basins were evidently a species of volcanic crater, hollowed out in the surface rock by subterranean action and filled up to the surface with a blue diamondiferous mud. The walls of these basins are locally known as "the reefs," and in their greed to secure all they could the old miners cut out all the "blue" right up to the reef. When, however, the cuttings got down deep the wall or reefs began to fall in, owing to the disintegrating action of boiling sun and heavy rain, covering up in their fall large areas of valuable blue. At first the digging was simple and cheap—the mere turning up and searching of loose soil; a second stage was reached when the soil had to be cut and hauled up to the surface with the aid of machinery; a third stage brought the miners to a stiffened blue, which had not only to be brought to the surface, but then spread about and broken up by hand labor and exposure to the weather, and at the present moment all around the mines are to be seen literally miles of the "blue" laid out in shallow layers over the open veldt. With these more extended operations came elaborate machinery for hoisting, for spreading on the "floors" and for sorting. Now, round each great basin or quarry is a circle of steam engines working wire-rope lifts up and down to the bottom of the quarry, and round the brink run locomotives and trains of trucks whisking the "blue" so brought up away to be spread out like so much manure over the veldt, and to be taken thence, when duly disintegrated by the weather, broken up by hand and harrowed and rolled, to the washing places, where it is all sent by hydraulic action through a series of rotary sieves and pulsators, on the principle of, in successive mechanical operations, washing away all dirt that is lighter than diamonds.

The washers are so arranged that the outfall of each portion is graduated in size and falls on a series of sorting tables. At these stand five or six of the principal men—owners and directors of companies among them—spreading out the clean washed stuff, graduated from the size of pebbles to that of sand; and the visitor may stand by in wonder to see the searcher at the one end pick out his eight or ten "big" stones per hour, or assist the searcher at the other, busily sorting out of the sand innumerable white specks of diamonds. The day's work, tumbled into small snuff-boxes, will frequently reach a local value of $5,000. None can fail to be struck, on looking into one of these great mines or quarries, that the whole of that great mass of earth and rock has been dug out, pulverized and searched for the diamonds it contains. One can look into a quarry of slates or stone and see the rocks themselves cut down and carted away for use, but in these quarries the soil and the rock are cut out and dug out, and what for? Simply that out of every 100 tons raised out of the quarry an ounce weight of diamonds may be secured. It is a startling and impressive thought in gazing into these great quarries that all that soil should have been dug out at a cost for labor alone of something like $75,000,000, and with the aid of invested capital of $5,000,000 in machinery, in order to distribute so many hundred weight of precious stones to decorate the ladies of civilized centers.

And now a fourth stage has been arrived at. As has been stated, these diggings have reached a depth of 300 or 400 feet, and the sides of the quarries are falling in. The new problem is how to continue to dig out the blue which now lies practically beneath the reef. The consequence is that around these quarries regular mining shafts are being sunk, and the "blue" is to be attacked by underground work. Good mining judges maintain that this is the wrong system, and that it would be better to terrace the reef sides and always work them as open mines or quarries. Thus, as years go by the cost of getting out these diamonds increases steadily, but it also happens that the price of diamonds has steadily and greatly fallen. The all-round price per carat has fallen from $14 to $3.75 per carat. At this one cannot be surprised. The fall in price has, however, already checked the output, as several of the smaller mining bodies and also those working the less profitable mines have ceased work. It seems probable also that even the larger mines will reduce operations in the face of the low prices, and then as the supply falls off so may prices again be expected to rise.

But this fall in price is not only due to overproduction. It is estimated that ten to fifteen per cent. of the fall is due to the sale of stolen diamonds. These, of course, can be and are sold at a very low price, as their cost of production usually means some trifling sum paid to a native laborer for what he can secrete on his person or otherwise smuggle out of the mine. In the early days, when each man worked for himself, there was no diamond stealing, but as it grew to be necessary to work on a larger scale and by the aid of hired labor, and as at the same time the process of operating afforded new opportunities for stealing, this crime grew to be one of the great curses of the industry. At present at every stage of the process laborers or employees come across diamonds. The men down in the mine, blasting and picking out the blue, frequently come upon the valued stones: and as the "stuff" is handled at every stage diamonds show themselves. The natives posted to empty the buckets coming up from the mine watch keenly for what may gleam in the process, and so does the engine-driver or mule-man who runs the laden trucks out to the floors. And on these floors the regular gangs who unload and break it up find many and large "stones:" and so, right through the process, there is ample opportunity at every turn to pick up a stone which is sure to be worth many dollars and may be worth thousands of dollars.

How to prevent or even to check this thieving has taxed the best energies of proprietors and police for many years past. Success has not yet appeared, for with every new appliance some new form of theft seems to come into being. There are endless means actually adopted. Swallowing the stones is quite common, and at one time the thief threw them wrapped in dough to dogs, which were killed and cut open by his confederates outside. Hiding them about the dress and pitching them away to be picked up at night are among the other means. From the commencement the method of collecting the stones has been rough and ready rather than careful and complete, and to the stranger there appears to be not only every chance, but every temptation, for employees to steal perpetually. The evils of this diamond stealing are far-reaching. Foremost among them stands an unnatural lowering of prices. The possessor of the stolen stone has paid but little for it, and, although he will naturally endeavor to realize as high a price as he can, he nevertheless greatly undersells the possessors of stones that have honestly paid all the expenses of production. It is estimated that every year from one-fifth to one-sixth of the stones exported are stolen, or, in other words, something like £500,000 worth of stolen diamonds leaves the colony annually. At the diggings at first there was a not unnatural laxity in dealing with this new and prolific wealth, and the social soil was at the least congenial to the development of this laxity into customs little less than criminal. Nowadays there is danger that this stealing, with its necessary complement, the "illicit diamond buying," or "I. D. B. trade," as it is euphemistically known, may sap the morality of the community, and against this vigorous protest is now being made. The mine owners are willing to pay large sums to stop this illicit trade. One mine calculates it loses each year at present £100,000 in unnecessarily depreciated price, and £100,000 in value of diamonds stolen, or a total loss of £200,000 in an output of £1,000,000, but there seems ground for hope that this great evil may be successfully put an end to.—*The Iron Age.*

Concentration.

Among the powers of the human mind that seem of themselves to make life worth living, that of concentration occupies a prominent place. To be able to fix the thoughts or the attention exclusively upon one subject, and to keep them there without wavering as long as is necessary, is a most important element of success in every occupation. It is a common mistake to think that although this ability is essential in professions, in literary pursuits, in the management of large enterprises, or in any position involving the laying of plans or the carrying out of systems, for the ordinary and commonplace worker, especially if his work be chiefly manual, it is of little consequence. This is one of those fallacies which lie at the root of much of the poor, inefficient, and inferior quality of work which is offered to the world in quantities far exceeding the demand. It is a well known fact that while hundreds of unserviceable men and women stand idle, waiting for employment which does not come, every one who is able and ready to do superior work in any department is eagerly caught up, and may almost command his own terms.

One of the most radical differences between these two classes of workers is this very power of concentrating the energy and strength of both body and mind upon the work immediately at hand. Two men working side by side in the field or factory, may be equally competent, as far as knowledge or physical strength or previous training go, to perform the labor before them. They begin with equal promise of good success, but in a short time, while one is persisting, the other is relaxing in effort. One pursues his work with unremitting zeal; the other spasmodically, with intervals of wandering thoughts and flagging attention. It is already an assured fact that the one who has acquired the habit of concentration will be the successful competitor. He will be anxiously sought for and re-engaged, while the other will soon go to swell the ranks of the unemployed. It matters not what is to be done; from the simplest mechanical work to the most obtruse and complex mental operation, the power of putting all the thought, energy, and attention on that and nothing else for the time being, will largely determine the quality and amount of labor performed.

To some extent this is a natural gift. We see children at play, who, without other motive than their instinctive tendencies, persist continuously in any effort they make, or purpose they form, with a perseverance and earnestness that may well shame many of their elders, while others will be distracted by every passing object, and forget their determinations as soon as they are formed. Yet here, perhaps more than in most tendencies, culture and practice come in to strengthen what is lacking. The discipline of the schools is most valuable in developing the concentrative power in the province of thought, and it would be a blessing to every child if, in some way, a like discipline helped him in the work on his hands. Like every other faculty, this, too, is strengthened by exercise. Each time we recall our scattering energies and wandering thoughts, and force them resolutely in one direction, we increase the power and develop the habit, and the exertion, at first painful and laborious, becomes in time easy and agreeable.

Mr. Thomas A. Edison attributes his success as an inventor largely to this faculty, which he gained by steadfast exertion, once being able to only think upon a given subject for ten minutes before something else would come into his mind, but gaining by long practice the power of continuous and interrupted thought for hours on a simple topic. At one time he worked with his assistants in trying to connect a piece of carbon to a wire. Each time it would break, and they would spend several hours in making another, until after working in this way one day and two nights they finally succeeded.

This habit does not necessarily make a person so absorbed in one thing as to become narrow and one sided. He may become so by yielding wholly to a native impulse of dwelling on one thing; but the same self-control that concentrates his energies at will can also divert them at will into another channel when the proper time arrives. Many things rightly claim our attention, but none of them will receive it aright if our thoughts aimlessly wander from one to another, without compass or guide.—*Phila. Ledger.*

A FLOATING paragraph says:—Thomas Lipsey, foreman in the foundry of the Scioto Valley car shops in Portsmouth, Ohio, after long and patient experiments, can take scraps of worthless iron, such as old bolts, bits of wrought and cast-iron, oyster cans, and rusty scraps, commanding only half-a-cent a pound, and make steel of a finer grain than the Bessemer steel, not only with the strength of wrought iron, but more than 50 *times its strength.*"

This paragraph, before being swallowed, should be well salted, to reduce the strength about 97 per cent! If he used the oysters themselves, instead of the cans, at this time of the year, the strength claimed might possibly be approximated.

The Locomotive.

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Turned Pins or Bolts vs. Split Pins for Brace Fastenings.

The manner in which a brace is attached to the head or crown-sheet of a boiler is a matter of the greatest importance, for unless it is well fastened, the best brace it is possible to make may be perfectly useless, and in some cases, worse than useless.

FIG. 1 shows the method we recommend for the attachment of braces to the ordinary crow-foot, T, or angle iron. The holes through jaw of brace and crow-foot are drilled, not punched, and a turned pin or bolt, preferably a bolt, is fitted to the jaw. The nut screwed up into contact with the jaw of the brace prevents any spreading of the jaw which might occur.

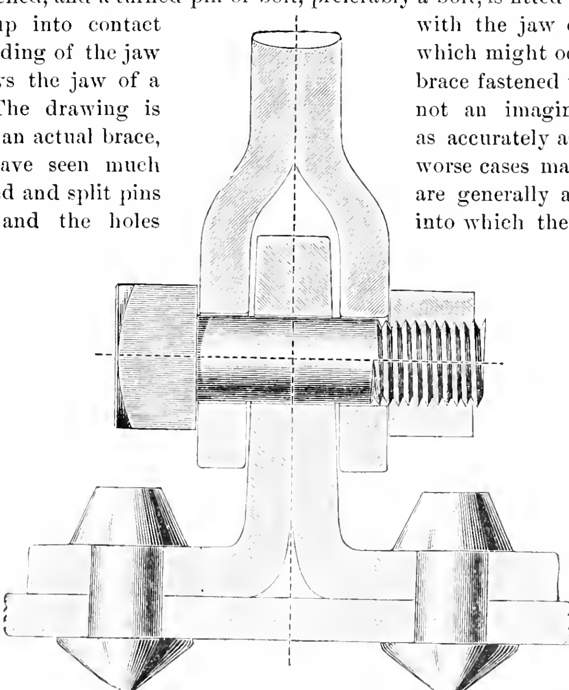


FIG. 1.

FIG. 2 shows the jaw of a brace fastened to a crow-foot by a split pin. The drawing is not an imaginary sketch, but was made from an actual brace, as accurately as we could measure it. We have seen much worse cases many times.

These forged and split pins are generally at least $\frac{1}{16}$ of an inch tapering, and the holes into which they fit being made with a drift-pin are in about the same condition. Then again, consider the fact that the holes hardly ever come fair, and the pin is driven into place whether it does or not, and it will readily be seen that the general bearing between it and the jaw of the brace will be very apt to be quite defective. "Skewing" is the word which best expresses its position in the majority of cases. And right here we would enter a strong protest against the practice which prevails in many shops of driving these pins in when the brace is not just the right length. Where it is done, it is not possible to obtain a uniform tension on the braces under any circumstances. We have known of cases where braces put on flat crown sheets, in this manner had to be all removed, owing to the fact that the unequal tension on some of the braces, caused by driving in these tapering pins, loosened up all the others. Several cases of this nature have been discovered by our inspectors, and the number of boilers sent out in this condition, which have never been subjected to impartial examination, is probably very great.

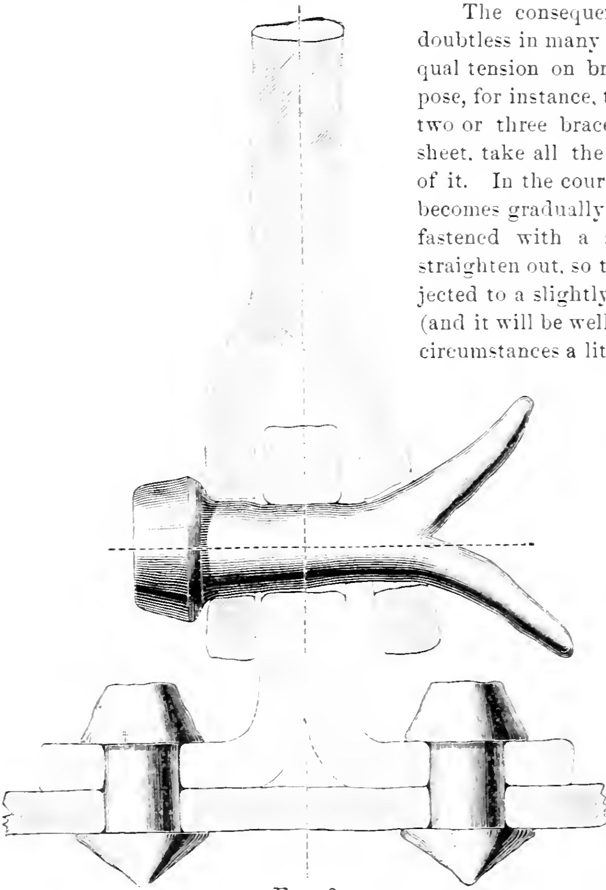


FIG. 2.

The consequences which may result, and doubtless in many cases have resulted from unequal tension on braces, are very serious. Suppose, for instance, that through unequal tension, two or three braces on a large head or crown-sheet, take all the stress, or the greater portion of it. In the course of time, suppose the brace becomes gradually weakened by corrosion, or, if fastened with a split pin which begins to straighten out, so that upon the boiler being subjected to a slightly greater pressure than usual (and it will be well to remember that under these circumstances a little increase of pressure on the boiler may be equivalent to a great increase of stress on the brace), one or more of these braces suddenly gives a little, through the jaw of brace spreading, or otherwise, then it is evident that a sudden stress will be brought to bear upon the adjacent brace or braces. Under these circumstances it would be quite possible for one or two braces to break suddenly, and this would be more than likely to be followed by the collapse of the entire crown-sheet, or the explosion of the boiler. Many explosions have probably been caused this manner. There is no good reason for braces being put into a boiler with an injurious amount of unequal tension. If their length is just right it cannot exist. If a brace is too long or too short, it is a perfectly easy matter to upset or draw it out slightly, so that it may be just right, and then if the holes are not quite fair, use a reamer instead of a drift-pin to bring them fair, and there will be little chance for trouble.

Inspectors' Reports.

JUNE, 1885.

Our usual monthly summary of the work of this department shows 3,209 inspection trips, 5,515 boilers visited, 2,111 inspected internally, 433 tested by hydrostatic pressure, and 23 condemned. 3,727 defects were reported, of which 467 were considered dangerous. Appended is the usual tabular statement of defects.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	494	30
Cases of incrustation and scale,	600	23
Cases of internal grooving,	27	3

Nature of defects.	Whole number.	Dangerous.
Cases of internal corrosion,	147	11
Cases of external corrosion,	286	20
Broken and loose braces and stays,	54	21
Settings defective,	174	17
Furnaces out of shape,	196	9
Fractured plates,	145	41
Burned plates,	81	19
Blistered plates,	233	16
Defective rivets,	136	42
Defective heads,	36	14
Leakage around tubes,	501	84
Leakage at seams,	172	16
Water gauges defective,	117	31
Blow-out defective,	23	10
Cases of deficiency of water,	6	3
Safety-valves overloaded,	24	11
Safety-valves defective,	25	13
Pressure gauges defective,	247	31
Boilers without pressure-gauges,	3	2
Total,	3,727	467

Blistered Plates continue to be a source of great annoyance, and always will so long as iron plates are made in the usual way. Defective welding of the pile is unavoidable at times; and no matter how conscientious the iron manufacturer may be, once in a while these defective plates will escape detection, and be made up into boilers. Indeed, in the majority of cases the defects can only be detected as they develop into blisters, of greater or less extent, under the conditions of ordinary use. Of course the better grades of charcoal iron are much less liable to this defect than the cheaper grades, and steel, from the nature of its process of manufacture, is almost wholly free from the possibility of lamination, which is the prime cause of blisters on boiler plates.

While we are considering the question of blistered plates, it may not be amiss to mention a little point on which purchasers of boilers are often deceived by boiler-makers who are inclined to be dishonest. We refer to the practice of representing *refined* iron to be of the best quality. To one unacquainted with the significance of the different brands used by iron manufacturers to designate the quality of their product, the term *refined* is apt to convey the impression that iron so stamped is of a very superior quality, while the fact is, it is the poorest grade but one that is made, and is *entirely* unfit for boiler plate. We have previously referred to this matter, but it will easily bear another reference. The different brands, with the quality which they indicate, is as follows, with most iron manufacturers:

1. C. H. NO. 1 FLANGE.
2. C. H. NO. 1 FIRE-BOX.
3. SHELL.
4. REFINED.
5. TANK.

If these brands are honestly used, as they are by most of the leading iron manufacturers of established reputation, they represent the following qualities of iron:

C. H. No. 1 Flange and C. H. No. 1 Fire-box are made entirely of charcoal iron, and the material is selected and worked with especial reference to the use for which the plates are intended, which intended uses are indicated by the brand. Shell has an outer skin of charcoal iron only, and is used for boiler shells and similar work, though Fire-box and Flange are better and more reliable, and should always be used when a boiler is subjected to hard usage. Refined iron is not made for use in boiler shells, but for ordinary uses where a cheap grade of plate iron is required. It is simply refined from the pig. The quality of Tank iron is sufficiently indicated by its name.

Boiler Explosions.

JUNE, 1885.

PHOSPHATE WORKS (68).—One of the boilers at Linstedt's Phosphate Works, near John's Island Ferry, S. C., exploded, June 2d, with fatal results. The explosion was caused by the blowing out of the head of one of the boilers and was due to a flaw in the cast iron. Sam. Asgill, the engineer, who was standing at his post beside the engine at the time of the explosion, was so severely injured that he died in a few minutes. Antony Broughton, a laborer, was standing about one hundred and twenty-five feet from the boiler, and was instantly killed by the falling material. Jim Gibbes, the fireman, was also in the immediate neighborhood of the boiler at the time, and was severely scalded and bruised. The boiler and engine-house was completely demolished. The entire damage to the works will amount to $1,500.

STEAMBOAT (69).—S. H. and Dean Denman, father and son, were killed by the bursting of a boiler in their small steamboat, on Cedar river, a few miles below Cedar Rapids, Iowa, June 10th. The father was thrown one hundred and fifty feet and killed instantly. The son lived three hours.

LOCOMOTIVE (70).—While standing near the depot in Palestine, Tex., June 11th, passenger engine No. 757 of the International & Great Northern Railroad, exploded its boiler with terrific force. It was just on the point of pulling out for Houston. The explosion shook the entire town. Fireman Wilcox was the only person on the engine at the time, and he miraculously escaped with a few slight hurts.

FLOURING MILL (71).—The boiler of Smith's flouring mill at Ozark, Ark., exploded June 12th. John Malloy was almost instantly killed. The mill was entirely destroyed.

SAW-MILL (72).—At the Big River saw-mill, near Mendocino, Cal., June 15th, one of the boilers exploded, being torn out from among the boilers and hurled some distance west of the mill, tearing out a corner of the brick smokestack in its progress. The steam-drum and boiler-head were carried in opposite directions into the mill, doing considerable damage. The concussion completely demolished the boiler-house and the wall of the mill adjacent. The two firemen, Andrew McLeod and Hans Hansen, were struck by the flying pieces and fatally scalded by the steam, both dying within two hours. They were married men and had long resided in Mendocino. There would have been a greater loss of life, but the mill had just been shut down and the men called off to the other side of the mill to assist in putting on a belt, so that only the two firemen were near enough to be hit. Four men always work where they would surely have been killed but for this.

SAW-MILL (73).—The boiler in A. Gaunt's saw-mill, near Wabash, Ind., exploded June 23d. The mill was wrecked, but fortunately no one was seriously injured.

PORTABLE BOILER (74).—A portable engine and boiler on Bean's coal wharf, Medford, Mass., which was being used to hoist coal, exploded June 23d, wrecking the wharf. Robert Burnett of Charleston, the engineer, who was standing a few feet distant, received terrible bruises and cuts. Serious results are feared. The boiler was lifted seventy feet by the force of the explosion, and fell into the middle of the Mystic river

A large number of red-hot coals, scattered by the explosion, set fire to more than a dozen buildings adjoining, but the fire was extinguished before much damage was done. It is said that there was only a small quantity of water in the boiler, which caused the explosion.

Flouring Mill (75).—A two-flue boiler in Mountain & Sons' grist-mill, Mobile, Ala., exploded June 24th, demolishing the boiler-house and parts of the adjacent buildings. Henry Scott, Joe Richardson, and L. Matthews (colored), employees, were killed by the explosion. Sally Matthews, who had just brought her husband his dinner, was buried with him in the ruins, and was fatally injured.

Manufactory (76).—The boiler in the rear of Frank Killer's lead-pipe factory, Nos. 45 and 47 Mechanic street, Newark, N. J., exploded June 25th, demolishing the boiler-house, wrecking the engine-room, and tearing out the rear wall of the main building. George Thompson (colored), was buried in the ruins, but when extricated was found not to be seriously injured. He had several bad bruises and was scalded about the arms by steam, but was not otherwise injured. The loss on the building is estimated at $2,000, and on its contents at $8,000. The cause of the explosion is unknown.

Distillery (77).—The boiler at the distillery of Matingly & Moore, at Bardstown, Ky., exploded June 26th. Three of the workhands were killed instantly, and another so badly burned and bruised that it is thought he will die. The killed are Charles McAtee, Charles Spalding, and Mason Bard. The wounded man is named Bemis Allen. All were colored. The scene at the distillery was horrible. Matingly & Moore's loss is great, as the building is wrecked and the machinery ruined; but the amount of damage has not been estimated.

Iron Works (78).—One of the boilers at the Union malleable iron-works, in Moline, Ill., exploded June 27th. It was supplied with water from a self-acting pump, which had stopped working until the boiler was empty and red-hot, when it started up again, hence the explosion. The engineer was off duty and his substitute had neglected to watch the gauge. No one was hurt. The damage was several hundred dollars.

Portable Hoister (79).—The boiler of a hoisting engine employed for unloading a cargo of the ship Agenor, lying at the wharf at East Boston, Mass., exploded June 30th, doing some damage to surrounding property, and injuring Michael Doran seriously, and inflicting bruises on several others.

Foreign.—A dispatch from Turcoing, near Lille, states that a boiler in Prosper's scouring works, exploded June 22d, killing seven persons and wounding forty. The owner was among the killed. A detachment of troops was promptly dispatched from Lille, as soon as the news of the explosion reached that city. The soldiers are now at work in the ruins of the buildings searching for the missing.

Newspapers printed at sea are not uncommon. The practice of publishing a paper on board ships was inaugurated on the steamer Great Britain, which started for Australia on August 21, 1851. Several of the mail steamers of the Cunard line now carry printing offices, and we believe that it is intended that all shall do so in the future. The seaborn journals do much to relieve the monotony of the passage, filled as they are with stories, burlesque telegrams and jokes by the passengers, and all the drift of spicy incidents that happen from week to week on shipboard.—*The Paper World.*

The Locomotive.

HARTFORD, AUGUST, 1885.

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.

Obituary.

DAVID C. FREEMAN.

It becomes our painful duty to chronicle the death of David C. Freeman, which occurred on the 21st of July. Mr. Freeman occupied the position of General Agent in the home department of the Hartford Steam Boiler Inspection and Insurance Company's business. His connection with the company dates almost from its organization. He was a faithful officer of the company, courteous in his bearing, and kind and genial in his friendships. His death is the first in the ranks of the home office force of the company. He was 50 years of age. Burial services were held in Collinsville, this State, on the 23d of July.

WE notice in certain circulars which have found their way to our office, an attempt to persuade people that the inspection of steam boilers is of little account compared with the advantages derived from insurance, especially the life feature, which has been so sensationally advertised. A so-called Steam Boiler Inspection Bill before the last legislature of Pennsylvania, had the same idea incorporated into it. It made no provision for careful and thorough inspections. No system or plan for accomplishing this important work was laid down. But the bill did provide that every boiler insurance company doing business in the State should insure the lives of persons in all their policies, and any steam-user holding such a policy was to be exempt from the State inspection. Another strange fact in this connection is that prominent manufacturers in the western part of the State aided and supported this bill to the extent, we are informed, of sending a delegation to Harrisburg to influence its passage. It is reported that among these delegates were persons who are financially interested in a company that advocates the same ideas set forth in the bill. This method of preventing accidents in the use of steam power, is in striking contrast with a bill prepared by a scientific commission appointed by the mayor in the city of Philadelphia. This commission went to work in a careful and intelligent way, taking up the question of material, its strength and ductility, rivets and riveted joints, with their power of resistance to internal pressure, together with the details of construction and necessary attachments and appliances for safety. The marked difference in handling this important subject by the different ends of the State has provoked no little criticism on the utterly valueless bill that was pushed with so much persistence but ultimately defeated. Intelligent men are not usually led astray in such matters unless personal or selfish interests warp their better judgment. The value of careful and thorough inspection of steam boilers is recognized the world over, and almost every nation in which steam is used has some law regulating its use. The Hartford Steam Boiler Inspection and Insurance Company has a wide correspondence with government and other mechanical engineers in all parts of the world, and we know how much attention is being paid to proper construction, and especially to quality of material used in the construction of steam boilers. It is a well-known fact that a large amount of cheap material, both iron and steel, is thrown on to the markets of the world, and especially it is so in this country. Grades that are extensively advertised when put to the proper tests fail in ductility, or show a dangerous variation under different temperatures. Our experiments in this line have developed some astonishing results. Another point is the proper setting of boilers with a view to economy and safety. We have laid out many large plants that are running to-day with great satisfaction. Pipe arrangements, feed and blow, and numerous details are all important for safety and true economy. The water to be used in boilers is another important question for the steam-user. The records of our laboratory show the analyses of waters from Maine to Alabama, and from the Atlantic to the Pacific. With these facts before us, we know what advice is best in each case, and whether the water in any case can be made suitable for use in boilers by proper correctives. A case occurred recently where the inspector of a competing company recommended a change of feed-water from a pond of clear limpid water to a well contaminated by surface drainage from the vicinity of the works. The boilers were nearly ruined, and the proprietor sought our advice. The two sources of water-supply were chemically examined, and the utter ignorance of the man recommending the change was clearly proved. It is conceded that such inspections are worse than none, and the manufacturer who secures such advice will wisely insure the life of every person within a mile of his works. We believe in careful and thorough inspections, intelligently made, not putting the steam-user to unnecessary expenses, but advising with him as to the best way of securing greater efficiency and safety. We think intelligent manufacturers, uninfluenced by selfish motives, will still see that careful inspection of steam boilers is a valuable thing for them and for the public as well.

A New Motor.

Probably many of our readers have had their attention called within the past two years to a wonderful new motor (*not* the Keely Motor), for which the most extravagant claims have been made. We have carefully read everything pertaining to it that has come under our notice, and lately visited a city in a neighboring State, and saw the motor in operation. Perhaps a short account of it, the general principles upon which it is constructed, and its performance, so far as we could obtain the facts in the limited time at our disposal, may be of interest if not of profit, to our readers.

In the first place, we would distinctly state that we do not criticise the management of the motor company, or in any way impugn the motives, or question the honesty of any one connected with it. This *has* been done by many papers and individuals, but it is beyond our province, and we shall content ourselves by simply giving some general facts regarding the motor itself.

The way the motor operates is this: — A steam boiler is set up and operated in the usual manner. The steam, instead of being used directly in the engine, is conducted to what is simply a closed heater, where it is employed to heat a body of carbon bisulphide, in exactly the same manner that feed-water is heated in ordinary cases by exhaust steam. The vapor of carbon bisulphide thus generated, is used in the cylinder of the engine, which is an ordinary steam engine, in precisely the same manner that steam is used in ordinary practice. A surface condenser is used to condense the exhaust vapor from the engine, and it is returned to the heater or generator in exactly the same manner that the exhaust steam is condensed and returned to the boilers where surface condensers are used in connection with steam engines. The steam from the boiler which is condensed in the heater during the generation of the bisulphide vapor is returned to the boiler, continuously, and used again.

It will be seen from the above, that the salient point in the working of the motor is this: The steam, generated in the usual manner, instead of being used in the cylinder of the engine as in ordinary practice, is employed, in a separate vessel, to generate bisulphide of carbon vapor, which is used in the engine to do the work.

What advantages are claimed for this method of obtaining power for industrial purposes, and on what are the claims based?

The advantage claimed, as stated to the writer by a gentleman present at the time of his visit, and who was introduced to him as Dr. Colwell, is that *four times the amount of work can be gotten out of any given quantity of fuel by the use of bisulphide of carbon vapor, generated and used in this manner, than could be obtained by the use of steam alone.* This, it will be seen, is a pretty loud claim, and needs careful attention. Let us examine it a little.

The first fact to be considered in the matter, is that the work done by an engine is done solely *by* heat. In fact, heat *is* the power, as it is usually called, and the nature of the fluid used in the boiler, *in itself*, has nothing whatever to do with the economy of the engine. It merely performs the functions of a *heat-carrier*. The economy of the engine depends solely on the percentage of heat transmitted to the fluid in the boiler which can be utilized in the cylinder of the engine. Now, the percentage of heat which *should* reappear as work in the cylinder, is dependent entirely upon the temperatures at which the vapor enters and is exhausted from the cylinder. These are no mere theories, but are scientific truths, and can be as easily demonstrated as the fact that if we have a known quantity of water falling a definite height, we can expect just so much power from it and *no more*. In fact, the two cases are exactly similar.

These facts are perfectly well known to all engineers worthy of the name, and have been so known for more than a generation past.

Having stated these preliminary facts, let us see how the theoretical limit of efficiency of the motor in question will compare with that of the steam engine, after which we will compare its *actual performance*, with that of the steam engine.

When the writer visited the motor, he learned the following: — A horizontal tubular boiler having between fifteen and sixteen square feet of grate surface, was carrying a steam pressure of seventy-two pounds per square inch, the steam after passing through a reducing valve entered the bisulphide heater at a pressure of about seventeen and one-half pounds per square inch; pressure of vapor of bisulphide, eighty pounds per square inch: this was running a 14″ x 28″ automatic cut-off engine one hundred and ten revolutions per minute, and driving three dynamos which furnished current for about sixty-seven Thomson-Houston electric arc lights, lighting the streets.

The theoretical limit of efficiency of the performance in the cylinder of any heat engine is given by the following rule:

From the highest temperature of the vapor in the cylinder, subtract its lowest temperature in the cylinder, and divide the remainder by 461 *plus the highest temperature.*

At the time of the writer's visit the highest temperature, when in the cylinder, of the bisulphide vapor, was 264° Fahr.; while its lowest temperature, when in the cylinder, was 119° Fahr.

Applying the above rule, we have

$$\frac{264 - 119}{461 + 264} = .2 \text{ exactly.}$$

as the maximum theoretical limit of efficiency of the bisulphide vapor engine.

Applying the same rule to a steam engine working with an initial pressure equal to that at which the boiler was run, viz., seventy-two pounds per square inch, the highest temperature of which would be about 317° Fahr., and the temperature of the condenser, as before, 119° Fahr., we have

$$\frac{317-119}{461+317} = .254,$$

or twenty-seven per cent. greater, it will be seen, than can be obtained by the use of the bisulphide vapor under the present conditions of use.

This 27 per cent. represents the greater theoretical *possibility* of steam under the conditions which existed at the time of our visit. Now let us see what the *actual* results are, taking the plant as a whole.

The power required to drive the above lamps would be about 67-horse power. The motor officials claimed 70-horse power, which, for the sake of argument, we are perfectly willing to allow.

The amount of coal actually burned under the boiler *in a five hours'* run was stated to the writer by Dr. Colwell to average between ten and twelve hundred pounds.

Upon this basis, the amount of coal consumed *per horse power per hour* would be from $2\frac{7}{8}$ to $3\frac{7}{16}$ pounds.

It is not uncommon for *non-condensing* steam engines of similar sizes, using like boilers, to perform the same duty with a coal consumption of $2\frac{1}{3}$ pounds per horse power per hour.

Recollecting that these figures as to power developed and coal consumed by the bisulphide engine were given by the Dr. Colwell referred to above, and who is supposed to be deeply interested in the motor, it will be seen that the economical features of the plant are wanting, when compared with a simple steam plant.

Further comment would seem to be unnecessary, but for the benefit of our readers we will add a few facts of general interest.

Assume the boiler used in connection with the motor to be 30-horse power nominal, as rated by the officials of the motor company. This has nothing to do with its actual performance. The grate surface is between fifteen and sixteen square feet, say for example it is but fifteen square feet. With good chimney draught 15 pounds of coal per square foot of grate surface per hour may be burned. At least 9 pounds of water should be evaporated per pound of coal burned; this would give $15 \times 15 \times 9 = 2025$ pounds of steam per hour. A condensing engine of the description used will easily furnish an indicated horse power, using steam of 72 pounds pressure, with 20 pounds of steam per hour. This would give $\frac{2025}{20} = 101 +$ horse power developed by the boiler under these conditions.

But from the figures given (1,000 to 1,200 pounds in a five hours' run), we see that the consumption of coal per square foot of grate surface per hour is about $12\frac{1}{2}$ pounds. This is a good ordinary rate of combustion. Allowing 9 pounds of water evaporated per pound of coal we then have $15 \times 12\frac{1}{2} \times 9 = 1687\frac{1}{2}$ pounds of steam per hour. At 20 pounds of steam per horse power per hour this would give $\frac{1687.5}{20} = 84 +$ horse power, which is considerably above what is being done with the vapor arrangement.

A good *non*-condensing *steam* engine running with a steam pressure of 72 pounds per square inch will develop an indicated horse power with a consumption of 25 pounds of steam per hour. With the above rates of combustion and evaporation, the power furnished would be, in the first instance 81 horse power, and in the second 67 horse power.

From the foregoing it will readily be seen by any intelligent person, whether he be versed in steam engineering or not, that whatever the *claims* of the new motor are, the fact remains that the *actual* performance *is*, and is likely to remain inferior to that of a good steam engine.

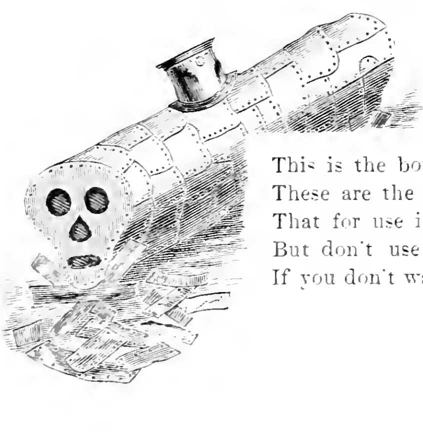
It may be claimed that the latent heat of evaporation of carbon bisulphide is, in round numbers, only about one-fourth that of water. Granted. But the density of its vapor is greater in exactly the same proportion, so that although it requires less heat to convert a pound of the liquid into vapor of any given pressure than it does to convert a pound of water into steam of the same pressure, we have got to evaporate *about four times as much of it* to get the same amount of work, so that the total heat expended is the same in one case as in the other. This question of latent heat (so misnamed) is another stumbling-block to the uneducated. Suffice it to say the relation between latent heat of evaporation and density of vapors is such that they are inversely proportional to each other, and one being known, the other may be calculated from it.

In our opinion the rock on which most of the honest people who have invested money in the enterprise have foundered is this: In front of the bisulphide generator there is an array of pressure gauges showing the pressures on the boiler, in shell of generator, and the pressure of the vapor itself in the generator. They see that steam is going into the generator at say 17½ pounds per square inch, and the vapor generated by it coming out and passing to the engine at a pressure of 80 pounds per square inch. This is to most people conclusive evidence that the increase in power must be in just the same proportion, or, as the motor company claims, that "the power is multiplied four-fold." Instead of this it means simply that carbon-bisulphide has a lower boiling point under like pressures than water: — only this and nothing more. Its boiling point at the ordinary pressure of the atmosphere is 118.4° Fahr., while that of water is 212° F.

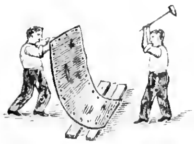
But this is foreign to the purpose with which we started, which was to show that the new motor in actual use was no more economical than a steam engine. Questions relating to *heat* may be found fully answered in any treatise on heat.

A great many attempts have been made to use carbon-bisulphide, ether, ammonia, wood alcohol, and various other liquids instead of water in steam boilers, but they have always failed, and always will, for aside from the fact that no greater economy *can* be obtained by their use than can be had with water, they are expensive, dangerous, and disagreeable substances. In this latter quality carbon-bisulphide stands pre-eminent.

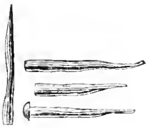
The Boiler that Jack Built.



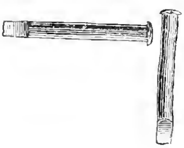
This is the boiler that Jack built.
These are the plates marked B for best
That for use in tanks may stand the test,
But don't use them in boilers is our request,
If you don't want a boiler like Jack built.



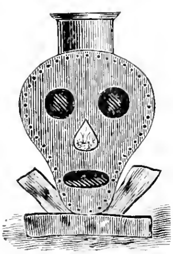
This is the way the plates were bent,
Making fractured holes and serious dents,
And time and labor foolishly spent,
In making the boiler that Jack built.



These are the drift-pins tapered so fine,
Driven into blind holes to force them in line,
And driven hard in with murderous clip,
Starting cracks from the holes, causing deadly seam rip,
In the plates of the boiler that Jack built.



This is the chisel so easy to prove,
That is foremost in starting the treacherous groove,
By scoring the plates with its corners so keen,
And gouging in deep along the whole seam,
That little strength 's left is easily seen,
In the plates of the boiler that Jack built.



This is the boiler looking so slick,
For both inside and out the paint laid on thick,
And all ready to test for the owner to see,
And as the pump starts, so the boiler leaks free,
Owner is dodging the streams squirting round,
Gauge kicking hard to pass fifty pounds.

Pumping is stopped as crack goes a seam,
Owner's told 50 cold 's good for hundred in steam,
And that all new work leaks some, but that little sup,
Why when steam is on will all take up, and soon will be tight
as a cup,
So off goes the boiler that Jack built.

This is the take-up sure enough,
Of boilers built of doubtful stuff,
And fractured plates and drifted holes,
And sledge blows used in place of rolls,
And deadly grooves with chisels keen.
The result of such is often seen,
That in such a take-up means a general wake-up,
And the homes of many break up, as their loved ones
lives were gave up,
In the bursting of the boiler that Jack built.

Table showing the Contents in Cubic Feet and U. S. Gallons of Pipes and Cylinders of Various Diameters and 1 Foot in Length.

(From Trautwine's Engineer's Pocket Book.)

1 GALLON = 231 CUBIC INCHES. 1 CUBIC FOOT = 7.4805 GALLONS.

Diameter in Inches.	Diameter in Decimals of a Foot.	For 1 Foot in Length.		Diameter in Inches.	Diameter in Decimals of a Foot.	For 1 Foot in Length.	
		Cubic Feet also Area in Square Feet.	U. S. Gallons, 231 cubic inches.			Cubic Feet also Area in Square Feet.	U. S. Gallons, 231 cubic inches.
1/4	.0208	.0003	.0025	11¼	.9375	.6903	5.164
5/16	.0260	.0005	.004	11½	.9583	.7213	5.396
3/8	.0313	.0008	.0057	11¾	.9792	.7530	5.633
7/16	.0365	.001	.0078	12	1 foot.	.7854	5.875
1/2	.0417	.0014	.0102	12½	1.042	.8522	6.375
9/16	.0469	.0017	.0129	13	1.083	.9218	6.895
5/8	.0521	.0021	.0159	13½	1.125	.994	7.436
11/16	.0573	.0026	.0193	14	1.167	1.069	7.997
3/4	.0625	.0031	.0230	14½	1.208	1.147	8.578
13/16	.0677	.0036	.0269	15	1.25	1.227	9.180
7/8	.0729	.0042	.0312	15½	1.292	1.310	9.801
15/16	.0781	.0048	.0359	16	1.333	1.396	10.44
1	.0833	.0055	.0408	16½	1.375	1.485	11.11
1¼	.1042	.0085	.0638	17	1.417	1.576	11.79
1½	.1250	.0123	.0918	17½	1.458	1.670	12.49
1¾	.1458	.0167	.1249	18	1.5	1.768	13.22
2	.1667	.0218	.1632	18½	1.542	1.867	13.96
2¼	.1875	.0276	.2066	19	1.583	1.969	14.73
2½	.2083	.0341	.2550	19½	1.625	2.074	15.51
2¾	.2292	.0412	.3085	20	1.667	2.182	16.32
3	.25	.0491	.3672	20½	1.708	2.292	17.15
3¼	.2708	.0576	.4309	21	1.75	2.405	17.99
3½	.2917	.0668	.4998	21½	1.792	2.521	18.86
3¾	.3125	.0767	.5738	22	1.833	2.640	19.75
4	.3333	.0873	.6528	22½	1.875	2.761	20.66
4¼	.3542	.0985	.7369	23	1.917	2.885	21.58
4½	.375	.1134	.8263	23½	1.958	3.012	22.53
4¾	.3958	.1334	.9206	24	2 feet.	3.142	23.50
5	.4167	.1364	1.020	25	2.083	3.409	25.50
5¼	.4375	.1503	1.125	26	2.167	3.687	27.58
5½	.4583	.1650	1.234	27	2.25	3.976	29.74
5¾	.4792	.1803	1.349	28	2.333	4.276	31.99
6	.5	.1963	1.469	29	2.417	4.581	34.41
6¼	.5208	.2131	1.594	30	2.5	4.909	36.72
6½	.5417	.2304	1.724	31	2.583	5.241	39.21
6¾	.5625	.2485	1.859	32	2.667	5.585	41.78
7	.5833	.2673	1.999	33	2.75	5.940	44.43
7¼	.6042	.2867	2.145	34	2.833	6.305	47.16
7½	.625	.3068	2.295	35	2.917	6.681	49.98
7¾	.6458	.3276	2.45	36	3 feet.	7.069	52.88
8	.6667	.3491	2.611	37	3.083	7.467	55.86
8¼	.6875	.3712	2.777	38	3.167	7.876	58.92
8½	.7083	.3941	2.948	39	3.25	8.296	62.06
8¾	.7292	.4176	3.125	40	3.333	8.727	65.28
9	.75	.4418	3.305	41	3.417	9.168	68.58
9¼	.7708	.4667	3.491	42	3.5	9.621	71.97
9½	.7917	.4922	3.682	43	3.583	10.085	75.44
9¾	.8125	.5185	3.879	44	3.667	10.559	78.99
10	.8333	.5454	4.08	45	3.75	11.045	82.62
10¼	.8542	.5730	4.286	46	3.833	11.541	86.33
10½	.875	.6013	4.498	47	3.917	12.048	90.13
10¾	.8958	.6303	4.715	48	4 feet.	12.566	94.00
11	.9167	.66	4.937				

The above table will be found useful for comparison of pipes of different sizes, and also for finding their capacities in the various cases that arise in practice.

To find the capacity of pipes greater than the largest given in the table, look in the table for a pipe of one-half the given size, and multiply its capacity by 4; or one of one-third its size, and multiply its capacity by 9, etc.

To find the *weight* of water in any of the given sizes multiply the capacity in cubic feet by 62¼, or if a closer approximation is required by the weight of a cubic foot of water at the actual temperature in the pipe.

The table gives the capacities for one foot in length; for greater lengths, multiply the tabular numbers by the given length.

The Biggest Things on Earth—Some Interesting Facts.

The highest range of mountains is the Himalaya, the mean elevation being estimated at from 16,000 to 18,000 feet.

The loftiest mountain is Mountain Everest, or Guarisanker, of the Himalayas range, having an elevation of 29,002 feet above the sea level.

The largest city in the world is London. Its population numbers 3,020,871 souls. New York, with a population of 1,250,000, comes fifth in the list of great cities.

The largest theatre is the new Opera House in Paris. It covers nearly three acres of ground. Its cubic mass is 4,287,000 feet. It cost about 100,000,000 francs.

The largest suspension bridge is the one between New York city and Brooklyn. The length of the main span is 1,595 feet, 6 inches; the entire length of the bridge is 5,980 feet.

The loftiest active volcano is Popocatapetl—"smoking mountain"—thirty-five miles southwest of Puebla, Mexico. It is 17,784 feet above the sea level, and has a crater three miles in circumference and a thousand feet deep.

The largest island in the world, which is also regarded as a continent, is Australia. It is 2,500 miles in length from east to west, and 1,850 miles from north to south. Its area is 2,984,287 square miles.

The longest span of wire in the world is used for a telegraph in India, over the river Kistnah, between Bezorah and Seetynagrum. It is more than 6,000 feet in length, and is 1,200 feet high.

The largest ship in the world is the Great Eastern. She is 680 feet long, 83 feet broad, and 60 feet deep, being 28,627 tons burden, 18,915 gross, and 13,344 net register. She was built at Millwall on the Thames, and was launched January 31, 1857.

The largest university is Oxford, in England, in the city of the same name, fifty-five miles from London. It consists of twenty-one colleges and five halls. Oxford was a seat of learning as early as the time of Edward the Confessor. University College claims to have been founded by Alfred.

The largest body of fresh water on the globe is Lake Superior, 400 miles long, 160 wide at its greatest breadth, and having an area of 32,000 square miles. Its mean depth is 900 feet, and its greatest depth is said to be about 200 fathoms. Its surface is about 635 feet above the level of the sea.

The biggest cavern is the Mammoth Cave, in Edmonson County, Ky. It is near Green River, about six miles from Cave City, and twenty-eight from Bowling Green. The cave consists of a succession of irregular chambers, some of which are large, situated on different levels. Some of these are traversed by navigable branches of the subterranean Echo River. Blind fish are found in its waters.

The longest tunnel in the world is that of the St. Gothard, on the line of railroad between Lucerne and Milan. The summit of the tunnel is 900 feet below the surface at Andermatt, and 6,600 feet beneath the peak of Kastelhorn, of the St. Gothard group. The tunnel is $26\frac{1}{2}$ feet wide, and is 18 feet and 10 inches from the floor to the crown of the arched roof. It is $9\frac{1}{2}$ miles long, $1\frac{5}{8}$ miles longer than the Mt. Cenis tunnel.

The biggest trees in the world are the mammoth trees of California. One of a grove in Tulare County, according to measurements made by members of the State geological survey, was shown to be 276 feet in height, 108 feet in circumference at base, and 76 feet at a point 12 feet above ground. Some of the trees are 376 feet high and 34 feet in diameter. Some of the largest that have been felled indicate an age of from 2,000 to 2,500 years.

The largest library is the Bibliotheque National in Paris, founded by Louis XIV. It contains 1,400,000 volumes, 300,000 pamphlets, 175,000 manuscripts, 300,000 maps and charts, 150,000 coins and medals. The collection of engravings exceeds 1,300,000, contained in some 10,000 volumes. The portraits number about 100,000. The building which contains these treasures is situated on the Rue Richelieu. Its length is 540 feet, its breadth 130 feet. The largest library in New York is, in respect of separate works, the Astor. About 190,000 volumes are on its shelves.

The largest desert is that of Sahara, a vast region of Northern Africa, extending from the Atlantic Ocean on the west to the valley of the Nile on the east. The length from east to west is about 3,000 miles, its average breadth about 900 miles, its area 2,000,000 square miles. Rain falls in torrents in the Sahara at intervals of five, ten, and twenty years. In summer the heat during the day is excessive, but the nights are often cold. In winter the temperature is sometimes below freezing point.

The greatest pyramid is that of Cheops, one of the three pyramids forming the Memphis group, situated on a plateau about 137 feet above the level of the highest rise in the Nile. Its dimensions have been reduced by the removal of the outer portions to furnish stone for the city of Cairo. Its masonry consisted originally of 89,028,000 cubic feet, and still amounts to 82,111,000 feet. The present vertical height is 450 feet, against 479 originally. The total weight of the stone is estimated at 6,316,000 tons.

The greatest fortress from a strategical point of view is the famous stronghold of Gibraltar, belonging to Great Britain, situated upon the most southern point of land upon the coast of southwestern Spain. It occupies a rocky peninsula, jutting out into the sea, about three miles long and three-quarters of a mile wide. One central rock rises to a height of 1,435 feet above the sea level. Its northern face is almost perpendicular, while its east side is full of tremendous precipices. On the south it terminates in what is called Europa Point. The west side is less steep than the east, and between its base and the sea is the narrow, almost level span on which the town of Gibraltar is built. The fortress is considered impregnable to military assault. The regular garrison in time of peace numbers about 7,000.

The largest inland sea is the Caspian, lying between Europe and Asia. Its greatest length is 760 miles, and its area 180,000 square miles. Great Salt Lake, in Utah, which may properly be termed an inland sea, is about ninety miles long, and has a varying breadth of from twenty to twenty-five miles. Its surface is 4,200 feet above the level of the sea, whereas the surface of the Caspian is eighty-four feet below the ocean level.

The largest empire in the world is that of Great Britain, comprising 8,557,558 square miles, more than a sixth part of the land of the globe, and embracing under its rule nearly a sixth part of the population of the world. In territorial extent the United States ranks third, containing 3,580,242 square miles, including Alaska; in population it ranks fourth, with its 50,000,000 of people. Russia ranks second, having 8,351,940 square miles.

The highest monolith is the obelisk at Karnak, in Egypt. Karnak is on the east bank of the Nile, near Luxor, and occupies a part of the site of ancient Thebes. The obelisk is ascribed to Hatasu, sister of Pharaoh Thothmes III, who reigned about 1600 B. C. The whole length is 122 feet, its weight 400 tons. Its height without pedestal is 108 feet 10 inches. The height of the obelisk in Central Park without pedestal is 68 feet 11 inches, its weight about 168 tons.

The largest bell in the world is the great bell of Moscow, at the foot of the Kremlin. Its circumference at the bottom is nearly 68 feet, and its height more than 21 feet. In its stoutest part it is 23 inches thick, and its weight has been computed to be 443,722 pounds. It has never been hung, and was probably cast on the spot where it now stands. A piece of the bell is broken off. The fracture is supposed to have been occasioned by water having been thrown upon it when heated by the building erected over it being on fire.—*Boston Journal of Commerce.*

Pressure at Great Sea Depths.

In *Science* for July 17th, p. 54, the deep sea fishes secured by the "Challenger" are mentioned as coming from "regions where the water permeating all their bodies is under immense pressure; but the tissues must be loose to admit of such permeation, or they would be crushed and ruined under a weight which shivers solid glass to powder." The statement needs revision, as to both fact and theory. We will see the theory first; the facts may come later.

Obviously the same rules of pressure apply in every instance, be the amount of pressure greater or less, on the surface of the sea (our ordinary status), or at 10,000 fathoms. Action and reaction are equal, and where pressure is fully counterbalanced it becomes actually no pressure. We say that ordinary pressure of the atmosphere is, in round numbers, fifteen pounds to the square inch, and the common air-pump experiment proves it. When we open the stop-cock, the receiver, which had been firmly fixed to the plate, at once becomes loose and free. Why? There is precisely the same amount of pressure on its external surface that existed a moment before, and yet we lift it now easily, and we say truly that it is because the pressure within and without is the same, and that the result is *no pressure.*

In our own personal condition, we move without consciousness of any difficulty whatever, notwithstanding that mythical number of tons that the school books figure out for us as our normal load, by applying the regular fifteen pounds to our superficial inches, and we are every one of us conscious that no such burden has any existence. It is truly a myth and a most absurd one. The simple truth is that each individual microscopic cell of our entire structure, though not in sensible manifestation filled with air, is in direct correlation and connection with the surrounding atmosphere, as completely as though we could show it by microscope and test-tube. The air cells of our lungs are no more truly balanced in air pressure than are the microscopic cells constituting the membranes which form each air cell, and, being thus balanced in all parts, the superincumbent atmosphere is to us no "Old Man of the Sea," and we are as free to move as though it had no weight whatever. This, our continued experience shows us, and we feel no wonder at it. But the same thing must necessarily be true under other degrees of pressure, and a fish at 5,000 or 10,000 fathoms doubtless experiences no sense of burden, nor does he find any more difficulty in moving than a trout in his native brook or a gold fish in one of our glass globes. Every cell of his tissues is perfectly balanced in its relations to the surrounding water, and his organs of motion show us beyond question that his movements are as free as ours in the air.

The proposition as given above, that "the tissues must be loose to admit of such permeation," etc., can scarcely be maintained by good argument. No reason is apparent why water at any depth should not balance itself as readily in firm tissues as in those that are loose, and we know, in fact, that it does so. Every one of the deep sea fishes has more or less of parts that are relatively solid, although the muscular fibers may be loosely aggregated. Bones are manifest, and it is plain that every one of these must be subject only to balanced pressure, that is, no pressure. If we suppose even a single fiber to be subjected to "a weight which shivers solid glass to powder" (provided there is an air space in the glass), it is not difficult to see what result must take place. The jaws of a vise or the end of a set screw could not jam it tighter, and every semblance of organization would be obliterated. Such pressure never occurs to any living creatures, or to any of their parts, without their instantaneous destruction.

But having looked now at the theory, a word is due, also, as to the facts concerning the residents of the deep sea. The looseness of tissue among the fishes generally is not disputed, but the same thing is not true concerning the animals of lower grade. Crustaceans, mollusks, etc., are found in large numbers, and their construction is in wide contrast with that of the fishes; they are reasonably firm and solid, which necessarily could not be were looseness and great depth correlative conditions.

We can now readily understand how incorrect and inconclusive were the experiments of M. Regnard last year on this point. He used a special apparatus by means of which he could bring to bear a pressure of 1,000 atmospheres. He tried it on a "golden cyprin" in water, and at 400 atmospheres the fish was "dead and absolutely rigid;" nor can we wonder, although the curious and inexplicable attempt had been made to save him by exhausting his air-bladder in advance. His tissues were of course adjusted in balance to only our surface pressure, and the artificial and rapid addition first paralyzed him, and then literally squeezed him to death. Solid iron could not have crushed him tighter. Theoretically it would be possible for a fish of the deep sea to change his habitat to the upper waters by making the transit through slow gradations, but that this is ever done practically we have no means of knowing. The specimen of *malacosteus*, the earliest known of these deep sea fishes, was found floating at the surface, but he was nearly dead, and had doubtless come up from some abnormal cause.

W. O. Ayres in Scientific American.

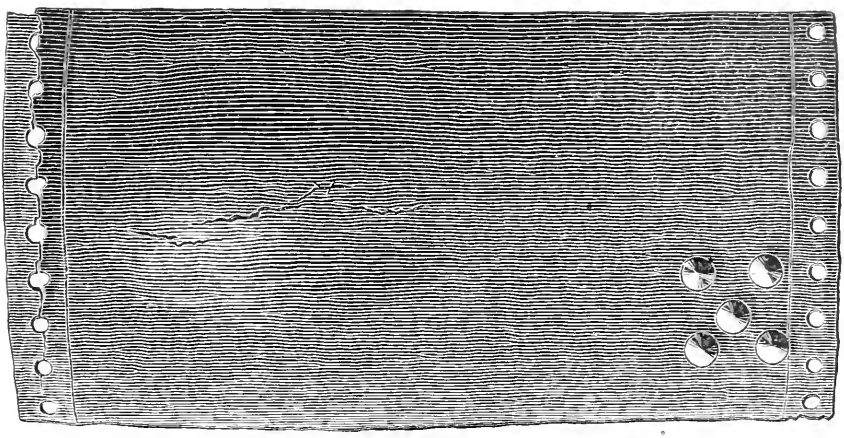
The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

New Series—Vol. VI. HARTFORD, CONN., SEPTEMBER, 1885. No. 9.

Dangerous Boiler Settings.

The setting of boilers, which is frequently done, with an arch over the top open to the furnace, is a dangerous practice, as we have frequently pointed out, and we are glad to see that, in this section of the country at least, it is quite rapidly going into disuse.



Our engraving with this number shows a plate taken from a boiler which was set with an open space entirely around it. This, of course, gave the heat a good opportunity to circulate entirely around the shell, and an inspection of the cut shows that it improved the opportunity to the fullest extent. The specification for the patent on this setting contains the claim that the steam will be superheated, but the facts seem to be that the boiler-shell above the water-line got most of the superheating claimed.

This form of setting is even more objectionable than those having a flue passing over the top. With the latter form, so long as the walls remain in the proper position, the boiler stands some chance to escape injury from direct burning, as the heat is obliged to pass under the boiler, and back through the tubes, by which means its temperature is greatly reduced, before it comes in contact with any portion of the shell which is unprotected by water. With the former, however, it has, from the first, free access to all parts of the shell, and a very short time, comparatively, is usually sufficient to ruin one or more sheets of the boiler-shell. It ought to be made a penal offense to set a boiler in this manner.

The fracture in the plate shown in the cut is the result of a half-day's run under the conditions which caused it.

In another similar case five fractures on top of the shell called for five different patches in a short time after starting up.

Another amusing case was where the man in charge of a large establishment turned the arch over his boilers and left the wooden centers in to burn out. They *did* burn out, so did the top of the boiler-shells. Some of the corrugations caused in this case by the steam pressure acting on the overheated and softened iron were six inches high!

One interesting fact to be borne in mind in connection with the claims for economy made for this style of setting, is that the reverse is always found to be true. This is explained as follows:

One of the conditions essential to the economical generation of steam in any boiler, is a free and rapid circulation of water over the heating surfaces. This, of course, is favored by applying the heat at the bottom of the shell, and then giving the water a free run, that is, good ample space between tubes, and between tubes and shell. Now intense heat applied at, or above the water line, checks circulation by breaking up the currents. The result is defective circulation, foaming of the water in the boiler, and a low measure of economy in the performance of the boiler. This is *not* a theoretical question, but has been demonstrated practically. In one case, where, upon our recommendation, the setting was changed, two boilers did the work which required three with the old style of setting.

Inspectors' Reports.

JULY, 1885.

There were made during the month of July last, 3,364 inspection trips, in the course of which 6,333 boilers were visited. Of this number 3,019 were inspected internally, 426 were tested by hydrostatic pressure, and 32 were found to be unfit for further use, and were condemned.

Our usual statement of defects reported is given below, from which it will be seen that 5,164 defects were found, of which 917 were considered dangerous.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	607	66
Cases of incrustation and scale,	810	63
Cases of internal grooving,	21	7
Cases of internal corrosion,	270	19
Cases of external corrosion,	347	34
Broken and loose braces and stays,	91	24
Settings defective,	225	25
Furnaces out of shape,	193	12
Fractured plates,	241	103
Burned plates,	145	50
Blistered plates,	362	35
Cases of defective riveting,	402	57
Defective heads,	57	19
Serious leakage around tube ends,	584	219
Serious leakage at seams,	235	54
Defective water gauges,	137	46
Defective blow-offs,	43	7
Cases of deficiency of water,	12	2
Safety-valves overloaded,	47	11
Safety-valves defective in construction,	59	27
Pressure-gauges defective,	269	32
Boilers without pressure-guages,	7	0
Total,	5,164	917

Steam boilers are many times injured seriously through the injudicious use of solvents, which, with proper use would prove very effective, and all that could be desired. It would seem to be almost unnecessary to say, that when a solvent is used in a boiler which contains a large amount of scale, and considerable quantities of it are loosened and fall down on the bottom of the boiler-shell, it is very essential that it should be removed. If it is not, there is a very strong probability that the boiler will be burned the first time it is fired up after lying idle a day or so. This has happened many times in our experience, and we find it necessary in most cases to specially insist upon a thorough cleaning following the application of a solvent to a foul boiler.

Generally it is necessary to shut down and blow off a boiler and open the handholes to do the necessary cleaning. With these plates removed it is a very easy matter to thoroughly rake out all loose scale. In most cases, it is also well to remove the manhole plate, send a man inside with suitable chisels and scraping tools, and scrape off all pieces of scale which have become partially loosened, and see that they, also, are raked out. This sort of treatment will not only prevent any damage to the boiler-shell, but will, if faithfully followed up, generally result in perfectly clean boilers in a comparatively short time.

Boiler Explosions.

JULY, 1885.

Steamer (80). — The steam yacht *Otis Smith*, which is used as a ferry-boat between Troy and the village of Green Island, N. Y., was blown to splinters July 1st, by the explosion of its boiler. Pieces of the boiler and machinery were picked up at points 600 feet distant from the dock at which the boat was moored. Albert Roberts, the engineer, who was about to go on board the boat as the explosion occurred, was severely burned. The fires had been left as usual, banked for the night before 10 o'clock. Capt. Cooley, the owner of the boat, cannot account for the bursting of the boiler except on the theory that some evil-disposed person went on board, shut the door of the furnace, and fastened down the safety-valve. The boiler was in good condition and had never been patched.

Hoisting Engine (81). — The boiler of a dock engine of the Cleveland Rolling Mill Company exploded, July 7th, at Cleveland, Ohio. John W. Visey of 15 Root street, and Charles Patch of 41 Genga street, were terribly scalded.

Portable (82). — The boiler of a portable engine which was being tested in Cunningham & Temple's machine shop, Lafayette, Ind., exploded July 6th, badly hurting five persons. The boiler weighed about 6000 pounds, and was carried 200 feet across the street. The gauge registered only sixty-five pounds of steam.

Saw-mill (83). — A boiler in Pratt & Bently's shingle mill, three miles from Titusville, Penn., exploded July 8th, instantly killing fireman Elliott Alcorn, and seriously cutting and scalding Jacob Miller, William Langworthy, and A. W. Massieer. The mill was a total wreck, the explosion being terrific. The accident was caused by the fireman pumping cold water into an empty and red-hot boiler. He had only worked in the mill five hours.

Threshing Engine (84). — A special from Fulton, Kent County, Delaware, says that a boiler of a threshing engine on the farm of J. W. Downham, near that town, exploded July 8th, killing Benjamin Anderson and severely injuring five or six others. It is thought some of the injured will die.

Rendering Tank (85). — A large rendering tank at the establishment of C. H. North & Co., Boston, Mass., exploded July 8th. No one was injured.

PAPER MILL (86).—A boiler explosion occurred in the West Flamborough Paper mills, eight miles northwest of Hamilton, Ont., July 10th, with fatal results. A part of the boiler was blown nearly 300 yards. Edward Maloney, fireman, was blown about twenty-five feet. He was instantly killed. John A. Stutt, a member of the firm, was standing near the boiler when the explosion occurred. He was struck on the head and when found was dead. Samuel Adams, who was working in an out-building some distance away, was badly hurt by the collapse of the roof over him.

THRESHING ENGINE (87).—A straw-burning engine which was running a thresher on the ranch of James Nichols, near San Pablo, Cal., exploded, July 18th, instantly killing the engineer, and injuring seriously a lad named Pablo Castro, who was feeding the engine. The young lad was thrown some distance and received injuries of a dangerous character in the abdomen. The engineer was an American, and leaves a wife and several children. His name was not ascertained. The accident is alleged to have been due to the engineer's carelessness.

SAW-MILL (88).—The boiler of the saw-mill engine of John R. Evans, Halcyondale, Ga., burst, July 20th, killing two of his sons, and seriously if not fatally, injuring Mr. Evans. Shep Williams, who was fireman, was slightly injured, and some of the other hands around the mill were hurt, but none fatally.

STEEL WORKS (89).—A tubular boiler at the steel-mill in New Castle, Pa., exploded July 27th, and made sad havoc of the boiler-house. Two stacks were blown down and a large piece of the boiler-sheeting torn off. Notwithstanding the fact that many employees of the works were about the place, and that the bricks and lumber were sent flying in all directions, no one was injured.

Expensive Metals.

Following are the names of those metals valued at over $1,000 an avoirdupois pound, the figures given representing the value per pound:

Vanadium.—A white metal discovered in 1830, $10,000.

Rubiidium — An alkaline metal, so called for exhibiting dark red lines in the spectrum analysis, $9,070.

Zirconium.— A metal obtained from the minerals zircon and hyacinth, in the form of a black powder, $7,200.

Lithium.— An alkaline metal; the lightest metal known, $7,000.

Glucinum.— A metal in the form of a grayish black powder, $5,400.

Calcium.— The metallic base of lime, $4,500.

Strontium.— A malleable metal of a yellowish color, $4,200.

Terbium.— Obtained from the mineral gadolinite, found in Sweden, $4,080.

Yttrium.— Discovered in 1828, is of a grayish black color, and its luster perfectly metallic, $4,080.

Erbium.— A metal found associated with yttrium, $3,400.

Cerium.— A metal of high specific gravity, a grayish white color, and a lamellar texture, $3,400.

Didymium.— A metal found associated with cerium, $3,200.

Ruthenium.— Of a gray color, very hard and brittle, extracted from the ores of platinum, $2,400.

Rhodium.— Of a white color and metallic luster, and extremely hard and brittle. It requires the strongest heat that can be produced by a wind furnace for its fusion, $2,300.

Niobium.— Previously named columbium, first discovered in an ore found at New London, Conn., $2,300.

Barium.— The metallic base of baryta, $1,800.

Palladium.— A metal discovered in 1802, and found in very small grains of a steel gray color, and fibrous structure, $1,400.

Osmium.— A brittle, gray colored metal, found with platinum, $1,300.

Iridium.— Found native as an alloy with osmium in lead gray scales, and is th heaviest of known substances, $1,090.—*Boston Journal of Commerce.*

The Locomotive.

HARTFORD, SEPTEMBER, 1885.

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

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Bound volumes one dollar each.

Grate and Heating Surface.

One of the most common errors made in designing and setting boilers consists in making the grate surface too large in proportion to the heating surface of the boiler. This results in a great loss of heat, especially if it is necessary to force the boiler, or to run it to something near its full capacity.

The greatest economy in the use of fuel will be obtained when the proportion of grate to heating surface is so small that the fire may be forced to its full extent, and still have the products of combustion enter the chimney only a few degrees hotter than the temperature of the steam in the boiler.

The object of forcing the fire is to obtain as high a temperature as possible in the furnace, as, the higher the temperature the greater the percentage of the total heat developed by the combustion of the fuel which may be utilized. This is evident when we consider that it is only the *difference* between the temperature of the furnace and that of the steam in the boiler that *can* be utilized, hence the greater this difference is, the greater the proportion of heat which will be transmitted to the water in the boiler.

For example, if the temperature in the furnace be 975 degrees, and the temperature due to a steam pressure of 80 lbs. be 325 degrees, it will be plain that but $\frac{2}{3}$ of the total heat could possibly be utilized, while if the temperature of the furnace were 2,600 degrees under the same conditions $\frac{7}{8}$ of the whole heat would be available if there were no losses due to practical conditions.

Experiments made to determine the precise value of these points are very conclusive. D. K. Clark gives a very complete account in his *Manual* of trials made with different grate areas, which show a most decided economy for the smaller grate. The boilers were first run with the full length of grate, 6 feet; a grate 4 feet in length was then substituted, and similar trials were made. We give the summary of a trial made with a Lancashire boiler.

Length of grate, ...	6 ft.	4 ft.
State of damper, ...	$\frac{2}{3}$ closed,	fully open.
Coal per hour, ...	4 cwt.	4.14 cwt.
" " sq. ft. of grate per hour, . .	14 lbs.	23 lbs.
Water at 100° evaporated per hour, . .	65 cubic ft.	72.6 cubic ft.
" " 212° per lb. of coal, . . .	10.1 lbs.	10.91 lbs.

In the first case the ratio of grate to heating surface was 1 to 24.4; in the second case it was 1 to 36.5. There was less smoke made when the 4-foot grate was used than when the 6-foot grate was in use. In the general deductions on the above tabulated experiments Mr. Clark says: "When equal quantities of coal were burned per hour, the fires being 12 inches thick, 8 per cent. more efficiency, and 12 per cent. greater rapidity of evaporation were obtained from the shorter grate."

One reason why the smaller grate having the hotter fire gives greater economy is because the radiant heat is more intense, and consequently, much more effective. About half of the value of fuel is due to the radiant heat. It is probable that over one-half the steam generated in a boiler of the ordinary type is formed from that portion of the shell exposed to direct radiation from the mass of incandescent fuel on the grate, the remaining 50 per cent. being generated by the tubes, and that portion of the shell back of the bridge wall. Hence the importance of battering side and bridge walls, so that as large a portion of the surface of the shell as possible may be exposed to this action.

The actual ratio of grate to heating surface should not in any case be less than 1 to 40, and may be 1 to 50 with advantage in many cases. This proportion will allow of very sharp fires, and still insure the greater portion of the heat being transmitted to the water in the boiler. The chimney should, in all cases, be of ample size to furnish sufficient draft, with the temperature in it not exceeding from 400 to 450 degrees Fahrenheit. The maximum draft is attained in a chimney when the temperature of the gases in it is about 625 degrees, but gases should never be allowed to leave a boiler at this temperature unless there is an economizer in the flue leading to the chimney.

In many cases which have occurred in our experience, we have recommended a reduction of grate surface, with an increase in the rate of combustion with excellent results. In manufactories where a single boiler furnishes power, and steam for heating purposes in the winter season, it is always advisable to reduce the grate surface in summer, when steam is needed for power purposes only.

THE careless use of the word "angle" by many writers in mechanical papers is to be condemned. It is used extensively where the words "oblique angle" should be used. For instance, we read: "The arm, A, stands at angle with the body, B." In this case we are at a loss to know *what* angle is meant. It might be a right angle, in which case, it would be better to say it "stands square," &c., which is a good shop term, but it would be better to say "perpendicular" instead of square. In any other case one ought to say "oblique angle," or if it is necessary to know just what the angle is, it should be expressed in degrees. An angle simply may be anything from 0 to 360 degrees, *including* the right angle, or "square."

THE *Interoceanic Problem and its Scientific Solution*, is the title of an address delivered before the A. A. A. S., at the Ann Arbor meeting, August 26th last, by E. L. Corthell, which has been received from the author. It is a neat forty-page pamphlet with six large plates, wherein are set forth the advantages of the Tehuantepec Ship Railway, and its advantages over other means of communication. It is worthy a careful perusal.

A SECOND-HAND dealer was trying to sell a boiler which had a badly bagged crown-sheet. "I say," said the customer, pointing to it, "how is that? That don't appear to be just right, does it?" "My friend," said the dealer confidentially, "they make 'em all that way now-days. Didn't you know that the inverted arch was one of the strongest forms of construction ever introduced into machinery?" Fact.

THE *American Eagle*, devoted to the interests of the American Exhibition to be holden in London, England, in 1886, is regularly received and contains all information relating to the exhibition, officers, etc., necessary for intending exhibitors. The London office is 7, Poultry, E. C., where all communications should be addressed.

The current number of the *Journal of the Franklin Institute* contains the first installment of what promises to be a very interesting and valuable paper on "Cylinder Condensation in Steam Engines," by Messrs. Chas. L. Gately and Alvin P. Kletzsch, with an introd .ction by Prof. R. H. Thurston of Cornell University.

Another Invention.

While we are "on" the motor question, it may be well, perhaps, to pay our respects to another one, which has been the subject of some inquiry recently. With regard to this one, we cannot do better than comment upon a most remarkable letter concerning it which appeared in the *Boston Journal* of August 13th last. The remarkable points of this letter are: the way in which the inventor is lauded; the ignorance of his subject displayed by the writer; and the grossly exaggerated estimates (?) made by him of the saving in fuel, and the benefits which will accrue to the human race generally by the adoption of the wonderful system of which he writes.

The letter is too long to be published in full, so we must content ourselves with brief extracts from it.

First, our writer says the system "which is just launched into successful operation after years spent in perfecting it, would seem to be the finality of dynamical science." This is a very pretty and high-sounding phrase; but when he goes on to say, "the various elemental devices which enter into it are covered by no less than 250 separate and distinct patents," we are strongly inclined to believe that the aforesaid finality is quite too heavily handicapped to be of much account. We are inclined to think that the "finality" of the apparatus, when compared with ordinary apparatus, must be of the same character as that of the Irishman's horse in the race, that is, behind everything else. This pleased Pat greatly, and, when asked the reason of his joy, replied, "Why is it? An' begorra, don't you see how beautifully he drives everything before him?"

He also says: "Science admits an utter loss of ninety per cent. and upward in the conversion" of heat into work. In the new system the figures are reversed, "ninety per cent. being utilized, and less than ten per cent. going to waste." To render this *possible*, in accordance with the natural law that water runs down hill instead of up, and admitting no loss in the boiler furnace, the temperature of the steam used would have to be about 1,200 degrees Fahrenheit above the highest temperature he *claims* in the boiler furnace! This must be a case where temperature lifts itself by its boot-straps.

After enlarging upon the greatness of the British Empire (the letter was written before the races between the Puritan and Genesta had been sailed), showing that it was wholly due to coal, the supply of which would be exhausted within a century, after which that nation would rapidly decline (Mr. Parnell will please make a note of this), and showing that the system of which he writes will surely prolong the life of the English nation to 1,000 years, he adds, "He really accomplishes much more than the figures given, which are placed at the lowest possible estimate, lest they stagger belief." That's right. Don't stagger our belief. We can stand the revolutionizing of our industrial system, and the prolongation of the life of the British Empire another thousand years, but to "stagger belief" would be just a little too much.

Our humorist says the inventor has "successfully solved the problem as to what the proportionate supply of air should be, and has devised means of measuring and furnishing it as required."

Right here it will be proper to remark that the amount of air required for the *complete* combustion of a pound of coal is twelve pounds, the volume of which, at 32° Fahrenheit, is about 150 cubic feet. The quantity which actually passes through the grates under a boiler is usually about twenty-four pounds with chimney draught. This being understood, we are ready for our writer's following remarkable statements:

"One thing is certain. Dr. Blanchard has proved that the calorific equivalents in a pound of coal are considerably beyond the present accepted theoretical estimate. Or may it not be that the hydrogen contained in the natural moisture of the great volume of air supplied to the furnace, which is estimated at not less than one-fourth of one per cent., which would give one cubic foot of water to every four hundred cubic feet of air, is also utilized as fuel, the water being decomposed in the terrific heat of the upper furnace, and the escaping hydrogen combined again with the necessary equivalents of oxygen to effect its combustion? Even were this true, the economy of coal would be the same by this system. The Blanchard furnace uses 1,200 cubic feet of air to every pound of coal consumed, which, on the above basis, would contain three cubic feet, or one hundred and eighty-seven pounds of water, which goes into the furnace with every pound of coal used. If it has come to the point that water, as well as earthy elements, can be utilized as fuel we shall never lack a supply so long as the world is habitable."

We almost despair of doing justice to these statements. Let us see. A saturated mixture of air and aqueous vapor at the temperature of 60° Fahrenheit contains about eleven per cent. by weight of aqueous vapor, instead of one-fourth of one per cent., and 1,200 cubic feet would weigh $91\frac{68}{1000}$ pounds, of which $\frac{954}{1000}$, or less than one pound, would consist of water. Recollect that this is the *greatest* amount of watery vapor which air at this temperature can hold. If more is added it is deposited on the surrounding objects as dew, or falls as rain. 187½ pounds is a remarkably close calculation. Great is the power of figures in the hands of one who knows nothing about them!

And then the statement that 1,200 cubic feet of air is required for every pound of fuel consumed. We have shown that 150 cubic feet is required for complete combustion. Any excess in the quantity of air above this results in a loss of heat, for it is simply so much air which has to be heated to a high temperature, and passes off through the chimney.

And if one pound of coal not only evaporates, but furnishes sufficient heat to decompose into its elementary constituents three cubic feet, or 187½ pounds of water, why not utilize the immense quantity of steam thus capable of being generated, instead of burning it under the boiler for the sake of producing a paltry eighteen or twenty pounds of steam, as claimed? Perhaps the "doctor" has not thought of this. He is welcome to the hint.

But we despair of doing justice to the remaining half of the letter. We only mention one or two things. The evaporative power of one pound of ordinary coal is about 14½ pounds of water from and at 212° Fahrenheit. In the letter referred to the statement is made that the evaporation under ordinary conditions is about six pounds, while the Blanchard boiler actually evaporates from eighteen to twenty pounds. As a matter of fact, ten pounds of water per pound of coal is an ordinary performance, while the actual evaporation of the Blanchard boiler, while it was being tested was about seven pounds per pound of coal. The inference is plain.

We will pass over the graphic description of the engine invented by the same parties, which is given in the letter. Suffice it to say, that the salient points seem to be that all joints are packed and kept tight by a stream of super-heated water from the boiler! We cannot refrain, however, from giving the concluding paragraph of the epistle verbatim. Here it is:

"A very elaborate work, explanatory of the Blanchard system, has been prepared by the doctor, and is now in press. It contains thirty large full-page steel-plate engravings, illustrating every part of the system, the working of which is fully elucidated in the letterpress. The book when completed will be seventeen by nineteen inches in dimensions, and contain 142 pages. It is to be superbly bound in green morocco, decorated in gold leaf, and will sell for $25 a copy. Experts who have examined it pronounce it the most perfectly illustrated and complete work of the kind yet issued, a worthy exponent of the marvelous system destined to work such wonders in the industrial world."

Boiler Inspection.

"There were two terrible boiler explosions yesterday, — one at ——, and the other at ——, seven persons being killed or fatally injured by the two accidents. One explosion was found to have been caused by mud in the boiler. No boiler is exploded except by carelessness or neglect to cast off an old and worn-out boiler. Every State should have severe laws, requiring careful inspection of boilers once if not twice a year. The inspection should be *by the State.*"

The above, which appeared in a daily paper of recent date, exhibits the popular idea of the way by which boiler explosions may be surely prevented. While the idea in itself is all right, and while it is undoubtedly true that many explosions would be prevented if such a law were in force in every State in the Union, as it is in some with good effects, still we must be allowed to take exception to the extreme measures that seem to be implied by the italics in the last paragraph. If we are not mistaken, *that* means, that in the editor's opinion, State inspection would prevent all accidents of this sort. From this latter opinion we respectfully but most emphatically dissent.

It will be found that there are certain practical difficulties which interfere with the efficient operation of such laws in many cases. All State or National officials of this class are quite apt to be appointed, not for their special fitness for the duties they are to perform, but for political reasons. Now boiler inspection is a peculiar business, and men engaged in it should be selected for such work on account of their ability and trustworthiness. Being found competent and honest, he should not only be left undisturbed to perform his duties, but he should have some guarantee that such should be the case, so long as he performed his duties properly. We think that any fair minded person will admit that under any political *regime* which is liable to change this would *not* be the case. If the inspector feels that he is liable at any time to be removed for no good reason, and some one put in his place who is more than likely to be incompetent, he will naturally fail to give his work the conscientious attention that it requires, and if he be of the average character of political appointees, he will be quite as likely to give more attention to the matter of perquisites than to boiler inspection. It is much more agreeable work.

Politically useful men, of any party, are not usually the kind of men a private individual would select to make boiler inspections, if he had a direct pecuniary interest in the result depending thereon. This of course *should not* be so, but the fact remains that it *is*, and it will probably continue to be so as long as human nature possesses the characteristics that it does at present.

Another thing that militates against the perfect operation of any law is this: When an official inspector has made an examination of a boiler, and issued a certificate, that ends the matter so far as he is concerned. If it explodes he loses nothing, and is not held responsible. If his position or his salary were to be forfeited, the character of the inspection might be different in many cases.

But we do not wish it to be inferred from the foregoing that we are not in accord with the spirit of such laws. That is a thing to which no possible exception could be taken; we only wish to call attention to certain practical difficulties which would arise in many localities against the proper working of it. Of course there would be many exceptions, as there are differences in many communities, and in many cities that have similar laws in effect, their working is all that can be desired, while at the same time, in other places, they are of no use whatever, and for the very reasons which we have mentioned.

The Forced Draft Problem.

Recent experiments conducted at the Brooklyn Navy Yard to test the effect of a screw propeller for producing forced draft have yielded some very striking results, and seem to indicate that a practicable solution of the forced-draft problem has at length been obtained. The trials were made with the boiler in the foundry of the steam engineering department, and showed that with natural draft and the full grate surface of the boiler — 24 square feet — a ratio of heating to grate surface of 23.87 to 1, and a calorimeter through the tubes of about one-seventh per grate surface, the mean of fifteen experiments of sixteen hours each gave a consumption of 15.417 pounds of coal per hour per square foot of grate with clean fires forced to a maximum. With a screw in operation in the chimney, the mean of 10 experiments, averaging sixteen hours each, gave a combustion of 17.917 pounds per square foot of grate, with 0.39 of one per cent. less water evaporated per pound of coal, but with a total evaporation of about one sixth more. In a second series of experiments, in which the area of the grate was reduced to 13½ square feet, giving a ratio of heating surface to grate of 42.44 to 1, and a calorimeter through the tubes of about one-fourth the grate surface, the maximum consumption with natural draft was 19 pounds of coal per square foot of grate per hour. With the screw at work and the same proportion of boiler a combustion of 38.44 pounds was obtained with an evaporation of 0.777 pounds of water less per pound of coal than with natural draft. The rate of combustion, however, was more than doubled, and the quantity of steam generated per unit of time was 80 per cent. more in the latter case.

Comparison of the figures thus obtained can leave little doubt as to the value of the forced draft as supplied in this particular instance, and no time should be lost in taking advantage of benefits so clearly demonstrated. The experiments have shown that boilers can be fitted with an appliance that will double their power in cases of emergency, without in any way interfering with the ordinary conditions of burning coal with natural draft, as it was found that the presence of the screw in the chimney did not at all affect the rate of combustion with natural draft. In comparing this system on board of vessels with that of the closed fire-room, where the pressure of air is maintained above atmospheric pressure, it would seem at first sight to be less economical, so far as power required to produce draft is concerned, since the gases generated by the combustion of coal, as well as the air supplied for combustion, must be moved by the screw in the chimney when they are highly heated, and hence have a greatly increased volume, while with a closed fire-room the air moved is of the temperature of the atmosphere. As pointed out, however, by Assistant Engineer John C. Kafer, U. S. N., in dwelling upon the subject, the volume of air moved in the case of the closed fire-room may be much greater than the volume of heated gases in the chimney, on account of the unavoidable leakage which in large fire and boiler-rooms is very great. The coal bunkers also must be under pressure, as a free communication must be maintained between them and the fire-room. It is consequently not improbable that less power will be required to drive the screw than to maintain the required pressure in the fire-room. Further investigation, however, must be depended upon for more definite information on this point and to supplement the general results of the preliminary experiments. — *The Iron Age.*

Hydraulic Lime.

Hitherto this useful building material, although in very general use in Europe, has been almost unknown in the United States, owing probably to the high cost of importation. In France the famous hydraulic lime of Teil, manufactured at the rate of 10,000 barrels per day, is very generally used for brick, stone, and concrete work.

The ordinary quick or "fat" lime so universally used in this country for mortar has no inherent *setting* properties, and when used in a wet or damp place will never harden. General Treussart in 1822 found in one of the bastions of the citadel of Strasburg, built in 1666, that the mortar used in its construction was still soft. In free contact with the air, lime-mortar dries out, and under favorable circumstances slowly absorbs carbonic acid from the atmosphere. Experts assert that ordinary lime-mortar laid in the interior walls of brick buildings does not get thoroughly carbonized and hardened for fifty years. That the process of recarbonization is a very slow one, may be seen by examining mortar after it has been in a wall for a lifetime. Moisten it and it can easily be crumbled.

On the other hand, if lime-mortar is subjected to exposure, as in the case of chimney-tops, outer courses of brickwork, etc., rain and extremes of heat and cold are sure to disengage the mortar and allow the bricks to tumble out of place. *The process of recarbonization does not keep place with the disintegrating influences of the elements.*

In case of fire, common lime-mortar is quickly dried out, and the carbonic acid that has been absorbed is expelled, leaving the mortar a crumbling mass that has nearly or quite lost its cementing properties.

Hydraulic lime has inherent *setting* qualities, and the water of mixture is retained and becomes the water of crystalization. This hydraulic property renders it peculiarly valuable in many varieties of work, notably in foundations, cellars, bath-rooms, kitchens, and laundries, as moisture only serves to harden it.

Architects and builders often require a mixture of common lime and cement to give mortar hydraulicity and strength. This forms a hydraulic lime-mortar, but the combination is only *mechanical*, whereas in natural hydraulic lime-mortar the combination is strictly *chemical* or a true *silicate of lime*, the only mortar-making material that can endure for ages the disintegrating effects of the sudden and extreme variations of temperature and other changes in our climate.

In case of fire the extreme heat will only serve to glaze hydraulic lime over, and cement the material together all the more firmly. In a few days after it is used, hydraulic lime begins to change and gradually hardens. At the end of a month it will appear like cement, and in time will become as hard as the material which it binds together.

Hydraulic lime as prepared for market is pulverized as fine as flour, and needs only to be mixed with sand and water to be ready for use. It requires no slaking; will keep for a year or more in barrels or sacks without deterioration; it has all the smooth and slow-working qualities and the sand carrying capacity of common lime, and when used for plastering requires no hair, and does not "pop out" or blister.

Many fine structures have been erected in Europe of concrete made of three parts of lime of Teil and one part of water mixed with ten parts of sand, incorporates with an equal bulk of broken stone or coarse gravel.

Of the Vanne acqueduct for supplying water to Paris, thirty-seven miles have been executed in this concrete; in the forest of Fontainebleau, there are about three miles of arches, some of which are fifty feet high, the whole structure, including arches and pipe, is one mass of solid masonry without joints. A Gothic church at Vezinet, near Paris, having a spire 130 feet high, is also a monolith of concrete of lime of Teil.

The lighthouse at Port Said, the northern terminus of the Suez canal, is also built of concrete of Teil lime and Port Said sand, and is a monolith 180 feet high.

The jetties which form the harbor of Port Said are built of huge blocks of concrete formed of the same material. In their construction 120,000 tons of Teil hydraulic lime were used. There were 25,000 blocks, each weighing twenty-five tons. The docks of Marseilles were constructed of similar concrete. At the harbor of Algiers, commencing in 1833, the French constructed blocks of hydraulic lime concrete, containing 353 cubic feet each, to withstand the force of the sea. The blocks weigh about twenty-five tons each. The harbor works of Alexandria, Egypt, consumed 175,000 tons of Teil lime in the construction of concrete blocks similar to those of Port Said.—*Hartford Courant.*

Thoroughness in Work.

Here is a little story, the origin of which we do not know, but which we presume has often been reprinted, and may be familiar to many of our readers.

A prominent judge, living near Cincinnati, wishing to have a rough fence built, sent for a carpenter, and said to him:

"I want this fence mended to keep out the cattle. There are some unplaned boards — use them. It is out of sight from the house, so you need not take time to make it a neat job. I will only pay you a dollar and a half."

However, afterward, the judge, coming to look at the work, found that the boards were planed and the fence finished with exceeding neatness. Supposing the young man did it in order to make a costly job of it, he said angrily:

"I told you this fence was to be covered with vines. I do not care how it looks."

"I do," said the carpenter.

"How much do you charge?" asked the judge.

"A dollar and a half," said the man, shouldering his tools.

"Why did you spend all that labor on the job, if not for money?"

"For the job, sir."

"Nobody would have seen the poor work on it."

"But I should have known it was there. No; I'll only take the dollar and a half." And he took it and went away.

Ten years afterward the judge had a contract to give for the building of certain magnificent public buildings. There were many applicants among master-builders, but one face attracted his attention. It was that of the man who had built the fence.

"I knew," said the judge, afterward telling the story, "we should have only good, genuine work from him. I gave him the contract, and it made a rich man of him."

So runs the story. The reader may object to it as being too much on the order of that other story about the boy who applied to a rich merchant for employment, and while leaving the room after being refused, saw a pin on the floor and stooped to pick it up, which action being observed by the merchant, caused him to recall the boy, who was given a situation, was taken into partnership, married the daughter, of course, and ultimately became the head of the house. The reader may also make the practical comment that the question whether a boy should stop to pick up a pin, depends on whether he is idle or is going in haste on an important errand; and the same critic may assert that on general principles the man does not act wisely who puts three dollars' worth of work into a job of only half the intrinsic value. To adopt that course on the chance of some time being awarded a fat contract, is not unlike the scheme of the other boy, who, having read the pin story, went about dropping pins and picking them up in the hope that some discriminating capitalist would see and reward him according to the fable; but who got summarily turned out of doors and treated with indignity until he finally concluded to try some other and less romantic method of acquiring a fortune.

To turn to the case in hand, it must undoubtedly be admitted that at least nine men out of ten need to be admonished to do their work thoroughly, while the tenth man may possibly be in danger of going to the opposite extreme and turning a cardinal virtue into a fault. He would be by no means a judicious teacher who would dwell much on the danger of excessive painstaking. With young persons especially, the tendency to slight the work in hand, to hurry through it and get rid of it, whether as well done as it should be or not, is vastly more common than the propensity to be "too particular." Yet, that the latter propensity does exist, and is a hurtful one, there can be no manner of doubt. One of the most able and truthful writers on shop practice ("Chordal") says: "Some men don't think work can be too well done. There is as much work done too well as too poorly. There is work upon which refinement is wasted." To say that the two opposite faults prevail to an equal extent is putting the case, in our opinion much too strongly; but even if the proposition is more sweeping than it should be, the principle at the bottom of it is a simple and sound one.

So far as the story of the judge and the carpenter is concerned, the error (whether the story itself be true or not) lies in the absurdity of the example given to enforce what is in general a wholesome maxim. "Do your work thoroughly" is a saying worthy of all acceptation; but it does not by any means imply that a rough job should be done in the style required for delicate and costly work. The man who has skill but no judgment may follow that method; but the man who has both, will perform his task with just the degree of precision and polish required, and no more. The best character in the book published by the writer we have just quoted, is a lathesman, of whom he says: "He is a machinist, and will hustle out any job you bring him, and will do it as well as you want it done, and no better." That is precisely what the model carpenter in the story should have done. In refusing to do it, he showed conceit rather than discretion; and any one who copies his example will be very apt to lose money if he keeps up the practice long enough. No romantic turn of fortune, which may happen to one man in a hundred thousand, can be relied upon to make up for a life-long departure from sound business principles. There is after all no higher wisdom than that of common sense.—*The Mechanical News.*

The Despised Tin Can.

The empty tin can at last has a mission, and a profitable one at that. Emptied of its contents of peaches or tomatoes, discarded and thrown out at the kitchen gate, it may soon be sent in at the front door or find an honored place in the best room in the house. Thousands of these cans are gathered in Philadelphia every week, and made into shining sheets, and used to decorate or cover traveling trunks, and thus get a promotion from the back yard to the boudoir. On the outskirts of the city, within a short time, a number of factories for the conversion of these old buffeted and battered cans and other tin refuse from the ash heaps have sprung up, and the business is a growing one. One of considerable size is in the Moyamensing avenue, below Mifflin street, where a large force of men is kept busy day in and day out. The cans are collected in various ways, but principally from the city ash heaps and the hotels and large boarding-houses. At the factory the soldered seams are subjected to an intense heat in such a way that the solder is allowed to run into a receptacle, and is carefully saved and sold, the profit from this source alone almost paying for the expense of the gathering and handling of the cans. The tops and bottoms of the cans are melted and turned into window-sash weights. The labels on the tin plates are easily taken off after they have been thoroughly soaked in water, and the plates themselves rolled out flat by machinery. As the insides of the plates are not much discolored by the contents of the can, they present a clean surface, and make excellent covers for trunks, the seams being hidden by the trunk braces, either of wood or sheet iron. Other uses are also made of the tin plates, and there is considerable profit in the business. The process is quite simple, and very little capital is required. One concern in that city rolled out 40,000 of these plates in less than two months, and the industry promises to be largely developed both there and elsewhere.—*Philadelphia Record.*

Confederate Money.

The Confederate government did not lack for money. In 1861 it issued $100,000,000, and until the last year of the war continued to send out bills of every convenient denomination, from $1,000 to 25 cents. There were green 5-cent postage stamps, with profile of Jefferson Davis on them, and these were sometimes used in making "change," but the man who did it was always pitied as a penurious, rascally fellow. Confederate money is handsome. Of course the paper is inferior, but some of the designs are well executed. It has a blue back, on which are intricate curves and circles and curls, and its value denoted by a single word in letters an inch and a half tall. There is no uniformity in the designs. On some bills there will be imaginary heads and sketches, a woman, a pile of arms, a rush to battle. On others appear likenesses of Confederate heroes and Confederate state houses,—as Jefferson Davis on the fifties and Alexander H. Stephens on the twenties; the Nashville, Tenn., state house on the tens and the Richmond, Va., state house on the fives. The face of Confederate money is colored pink around the likenesses. The first bills were simple notes, payable in six months. The second and all subsequent issues were made payable at different times "after a ratification of a treaty of peace between the Confederate States of America and the United States."

Confederate money was not long in going below par. During the war it was not the extortion of merchants which ran up prices to fabulous figures, but it was the depreciation of the currency. In some sections calico sold for $10 a yard, good shoes at $80 and $100 a pair. Fifteen dollars would purchase a spool of thread or a paper of pins. Medicines and all luxuries were not in the market for that sort of paper. A silver dollar was worth at least thirty Confederate dollars. The Confederacy understood that it had to protect its currency as well as its rights, and an act was passed making it treason for moneys to be exchanged at different values.

There has never been a craze among the curiosity collectors for Confederate money. The $1,000 bill is scarce, and readily finds buyers at $2 or $3 each; the $500 bill can be bought for 20 or 30 cents, the others denominations can be had for a song. Soon after the war men and women began to know for a certainty that their money was valuable only as paper. The ingenious housewives began to use it as money never before was used. They would paper their walls with old Journals and periodicals, and put on a border made of Confederate money. Screens were made of bonds with money borders—in fact, every thing susceptible of ornamentation received its supply of paste and pink treasury notes.—*Cincinnati Enquirer.*

How To Tell When a Boiler Will Explode.

"Say, where is the boiler editor of this paper?"

"Down in the cellar. What do you want?"

"Well, I heard that editors knew everything, and I've got a steam boiler down at my place that acts queerly. What I want to know is, how can I tell if it is going to explode. What would you advise?"

"Sell it to some man who lives in the next county, and then watch the accident column of your daily paper."—*Chicago Herald.*

How Vaccination Works.

Pasteur had little difficulty in establishing the parasitic origin of fowl cholera; indeed, the parasite had been observed by others before him. But by his successive cultivations, he rendered the solution sure. His next step will remain forever memorable in the history of medicine. I allude to what he calls "virus attenuation." And here it may be well to throw out a few remarks in advance. When a tree or a bundle of wheat or barley straw is burned, a certain amount of mineral matter remains in the ashes—extremely small in comparison with the bulk of the tree or of the straw, but absolutely essential to its growth. In a soil lacking or exhausted of the necessary constituents, the tree cannot live, the crop cannot grow. Now, contagia are living things, which demand certain elements of life just as inexorably as trees, or wheat, or barley; and it is not difficult to see that a crop of a given parasite may so far use up a constituent existing in small quantities in the body, but essential in the growth of the parasite, as to render the body unfit for the production of a second crop. The soil is exhausted, and, until the lost constituent is restored, the body is protected from any further attack from the same disorder. Such an explanation of non-recurrent diseases naturally presents itself to a thorough believer in the germ theory, and such was the solution which, in reply to a question, I ventured to offer nearly fifteen years ago to an eminent physician. To exhaust a soil, however, a parasite less vigorous and destructive than the really virulent one may suffice; and if, after having, by means of a feebler organism, exhausted the soil without fatal result, the most highly virulent parasite be introduced into the system, it will prove powerless. This, in the language of the germ theory, is the whole secret of vaccination.—*Professor Tyndall.*

A Dog that Could not be Cheated.

After many other performances, M. Leonard invited a gentleman to play a game of dominoes with one of his dogs. The younger and slighter dog then seated himself on a chair at the table, and the writer and M. Leonard seated themselves opposite. Six dominoes were placed on their edges in the usual manner, before the dog, and a like number before the writer. The dog, having a double number, took one up in his mouth and put it in the middle of the table; the writer placed a corresponding piece on one side; the dog immediately played another correctly, and so on until all the pieces were engaged. Other six dominoes were then given to each, and the writer intentionally played a wrong number. The dog looked surprised, stared very earnestly at the writer, growled, and finally barked angrily. Finding that no notice was taken of his remonstrances, he pushed away the wrong domino with his nose and took up a suitable one from his own pieces and played it in its stead. The writer then played correctly; the dog followed and won the game. Not the slightest intimation could have been given by M. Leonard to the dog. This mode of play must have been entirely the result of his own observation and judgment. It should be added that the performances were strictly private. The owner of the dogs was a gentleman of independent fortune, and the instruction of his dogs had been taken up merely as a curious and amusing investigation.—*Cassell's Natural History.*

A STATIONER is one who had a "station" or stand in the market-place for the sale of books, in order to attract the passers-by as customers. An *upholsterer*, originally *upholster*, was, it would seem, an auctioneer, who "held up" his wares in order to show them off. The double *er* in this word is superfluous, as in *poult-er-er*. A *haberdasher* was so called from his selling a stuff called *hapertas* in old French, which is supposed to be from a Scandinavian word meaning peddlers' wares, from the *haversack* in which they were carried. — *Chambers's Journal.*

The Locomotive.

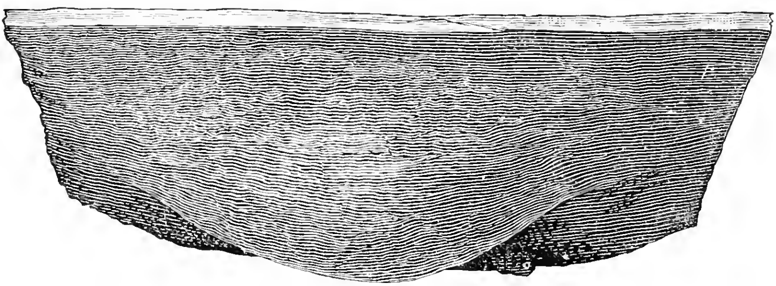
PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

New Series—Vol. VI. HARTFORD, CONN., OCTOBER, 1885. No. 10.

Accidents Resulting from Faulty Practice.

Our illustration this month show the results which may follow the use of very good feed-water when a wrong course of practice is followed in the management of the boilers.

The plate shown in the engraving was cut from one of five new boilers which all burned and bagged as shown inside of three weeks after they were first started up. The water used was of very good quality, making but little scale or sediment, and the accidents were due entirely to the manner in which the fires were managed. The burns all occurred within a few inches of the front heads of the boilers, and all occurred at the same hour of the day, although on different days.



It was customary to bank the fires at noon, or rather to fill the furnace full of soft coal, and leave the fire doors open, instead of closing the damper partially, to check the formation of steam. This allowed a current of cold air to enter above the fuel and impinge on the fire sheet. This, of course, would check the circulation, and what little sediment the water held in suspension, and which would circulate with the water as long as steam was being rapidly generated, would naturally be deposited on the bottom of the boiler near the front end.

Upon starting the works at one o'clock, it was the practice to run a slice bar through the thick layer of coal put on an hour or so before, and which had in the meantime become thoroughly coked, and break it up thoroughly, then close the fire door. This intense heat thus suddenly applied to the boiler burned the sediment on to the fire sheets before a brisk circulation of the water could be established, which would have gradually picked it up and prevented any damage. But after it was once baked on the shell it could not be removed by the circulating water, and the overheating, bagging, and burning of the iron followed naturally in a short time.

The bag or pocket shown in the illustration is about four inches deep, fifteen inches broad at the base, and at the lowest point the iron is thoroughly burned out. The thickness of the layer of sediment on the interior is but about one-sixteenth of an inch. Upon careful examination by our inspector, a change in practice was made, and no further trouble has occurred for several years.

Another similar case occurred at about the same time in another locality, where, in a battery of fourteen boilers, three of them "came down" at once. This latter case was due to the peculiar method of "banking" the fires, and was stopped, as was the first one, by a change in practice.

Too much care cannot be exercised in cases similar to the above in the method of firing the boilers. Fires should be started and steam raised gradually, that circulation may be established in a proper manner. This will not only prevent such accidents as have been described, but will also prevent undue strains on different portions of the shells, due to differences of temperature. Many boilers have undoubtedly been ruined by injudicious firing, and the fault attributed to some defect in the boiler, when in reality none existed.

Inspectors' Reports.

AUGUST, 1885.

There were made during the month of August last 3,457 inspection trips; 6,615 boilers were examined, of which 2,633 were inspected internally, 506 were subjected to hydrostatic pressure, and 24 were condemned. The number of defects reported was 3,692, of which 456 were considered dangerous. Our usual detailed statement is given:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	396	40
Cases of incrustation and scale,	557	41
Cases of internal grooving,	25	7
Cases of internal corrosion,	127	9
Cases of external corrosion,	281	27
Broken and loose braces and stays,	52	9
Settings defective,	168	15
Furnaces out of shape,	182	16
Fractured plates,	51	27
Burned plates,	73	16
Blistered plates,	162	25
Cases of defective riveting,	243	27
Defective heads,	49	9
Serious leakage around tube ends,	601	80
Serious leakage at seams,	178	15
Defective water gauges,	121	17
Defective blow-offs,	62	9
Cases of deficiency of water,	5	3
Safety-valves overloaded,	33	20
Safety-valves defective in construction,	69	13
Pressure-gauges defective,	255	31
Boilers without pressure-guages,	2	0
Total,	3,692	456

The pressure-gauge being an important fitting on a boiler should be made so that the figures on the dial can be easily read across the boiler-room, so placed that it can be seen without hunting for it, and so put up that it shall at all times be subjected to the steam-pressure in the boiler, and *no other* pressure, and should then be corrected and kept correct, by comparing it as often as may be convenient or necessary with some standard *known* to be correct.

Gauges are not always made so that the figures on the dial are easily read a short distance away. The figures may be of a wrong design, or they may be too crowded, or upside down, and in many cases the boiler-maker insists upon having his name and address placed upon the face in large black letters, that cover it all over. All these things interfere with that quick and accurate reading, at a glance, of the pressure indicated. Nothing but the figures should ever be allowed on the dial of a steam-gauge.

In many places pressure-gauges will be found put up a long distance from the boilers. This should be avoided. The gauge indicating the pressure on any boiler should be placed *on* that boiler, and the pipe connection should be made as short as practicable. Long pipes of the sizes used for steam-gauge connection, when carried from the boiler to some distant part of the boiler-room, are more than likely to give trouble by filling up with sediment. They are almost certain to do so.

Gauges on some kinds of upright boilers are so connected that, in addition to the steam-pressure, they also have the additional pressure due to the weight of a column of water several feet in height upon them. Roughly, a column of water 27 inches high produces a pressure of one pound per square inch. While the tendency of this defect, if it may be so called, is in the direction of safety, still it must be remembered that it is not the steam pressure that the gauge indicates, and due allowance should be made for it when comparing data relating to the engine.

A good gauge will, if properly connected, serve its purpose for years without much variation from the correct point. If they are so connected to the boiler-front, as many of them are, that they are constantly heated to a high temperature, nothing certain can be predicated of their reading.

Boiler Explosions.

AUGUST, 1885.

Bullion Furnace (90). — An explosion occurred at six o'clock, A. M., August 2d, at Balbach & Co.'s lead and bullion refinery, on the Morris Canal, just below Newark, N. J , and two men were terribly burned. The explosion was investigated, and it was found that the crown-sheet of the boiler had cracked and allowed a jet of water to run in on the lead. If the explosion had occurred an hour later the number of men injured would have been large.

Iron Foundry (91). — The steam boiler of the Karl foundry at Chanesville, Ohio, exploded August 6th, with force sufficient to lift the boiler from its foundation and shoot it through the air a distance of 120 feet, where it crushed through one building and came to a stop in another, the timbers of which checked its flight. Two men, Allen Kock and J. J. Karl. were working at the engine and about eight feet from the boiler when it exploded. Although the entire roof was blown from the engine-room and its walls leveled to the earth, these men were almost unharmed. Pieces of timber and bars of iron were thrown into the air at a distance of 100 feet.

Agricultural Engine (92). — A boiler attached to a harvesting machine exploded in Carson, Nev., August 10th. The engineer was blown 150 feet and killed outright. Four other men were more or less injured, and one is expected to die. The machine was owned by McCaffery of Sacramento, and the men working it say that he was drunk and put a stranger on to run the engine. The stranger was killed, and was so mangled that he could not be identified. McCaffery claimed that a discharged engineer tampered with the safety-valve.

Paper-Mill (93). — A disastrous boiler explosion occurred August 11th, in the rag boiling department of the Ivanhoe Paper Mill on Spruce street, Paterson, N. J. The boiler was a large rotary one used for boiling rags. The head went through an eight-inch wall, then through the picking-room, and then through a twelve-inch brick wall into the street. The main part went up through the roof, and coming down again lodged on the rear wall. Two buildings, one brick and one stone, were badly wrecked. The damage will reach several thousand dollars. A number of employees in the picking-room were injured, as follows :—James Graham of No. 49 Jersey street, terribly scalded and bruised; Lizzie Wallace of No. 43 Cross street, face and body badly scalded and head cut, her clothing was stripped from her shoulders; Mary Ames of Pine and Oliver streets, painfully scalded and otherwise hurt. These three were taken to St. Joseph's Hospital. Their injuries are dangerous. William Campbell of Walnut street, and Superintendent George Hunt, were painfully hurt, but were able to walk home. Two or three others were slightly injured.

Colliery (94). — One of the boilers at the colliery of the Hillman Vein Company, Wilkesbarre, Pa., exploded August 12th. "Barney" Toole, the fireman, was the only man in the boiler-house at the time. He was hurled a distance of forty yards, and half buried among the debris. He was badly scalded, and otherwise so much injured that he cannot recover. The boiler-house was torn to atoms and the wreck was hurled to a great distance on all sides. Fortunately the boiler was not the one supplying the engine of the fan, or the result would have been disastrous. So fiery is the mine that five minutes' stoppage of the fan is almost certain to result in an explosion.

Colliery (95). — Two of a group of fourteen boilers, at the Shenandoah city colliery of the Philadelphia and Reading Coal and Iron Company, burst August 12th, blowing the boiler-house, a large frame structure, to atoms, and completely wrecking the engine-house. Engineer Williams was found near the engine-house, where he had been blown by the force of the explosion, fatally scalded and otherwise injured by flying missiles. Five men who were about the mine at the time of the explosion were severely injured by being struck by the flying timbers, and had a narrow escape from death. The cause of the explosion is not definitely known, but is attributed to defective parts in the boilers, which, it is said, were unfit for service. The loss will probably reach $12,000 to $15,000. Several hundred men and boys will be thrown idle for several weeks in consequence of the accident.

Saw-mill (96). — In a boiler explosion at the saw-mill of M. McGinty, Athens, Ga., August 18th, Thomas Richardson and Philip Barnett were blown into shreds, not a particle of their bodies hanging together.

Steam Thresher (97). — The boiler of a steam thresher exploded near Wyoming, Ont., August 20th, instantly killing James Duncan, and mortally wounding Isaac Maw. Maw's nephew had a leg broken, and was dangerously scalded. The engine was lifted bodily from the trucks and thrown through the side of a barn into a grain mow.

Saw-mill (98). — Three men were fatally injured, August 31st, by the explosion of a boiler in J. B. Williams' mill at Bowling Green, Ky.

Foreign Steamer. — The boilers of the steamer *Parquite de los Velos* exploded while she was on a voyage from Coquimos to Valparaiso, killing five persons and wounding six others.

We would suggest that when our esteemed contemporaries clip portions of our articles and reprint them *verbatim*, it would be a matter of simple justice to their subscribers, if not to us, to give due credit in order that they may know where the remaining and most valuable portions of the articles may be found.

The Locomotive.

HARTFORD, OCTOBER, 1885.

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.

IT becomes our painful duty to chronicle the death of Ex-Governor Thomas Talbot of Massachusetts, which occurred October 6th, at his home in Billerica, Mass. He was 67 years of age. He had been a director of the Hartford Steam Boiler Inspection and Insurance Company since 1875.

A VERY lively discussion is at present going on in the English technical journals regarding the merits or demerits of compound locomotives. Mr. Webb, the master mechanic of one of the principal roads in the kingdom, has been running them for some time, and we infer, from what has come under our notice, that they have not proved as successful as it was hoped they would. Some of the writers, therefore, jump at the conclusion that the principle is wrong, and that *compounding* has proved a failure. We do not see that this conclusion is justified by the circumstances of the case. As a rule, when a new departure is made in any department of engineering, the forms of construction first tried are either abandoned or modified to overcome difficulties arising in practice, and which could not be foreseen. We hazard the prediction that compounding will ultimately prove as successful on locomotive as it has in marine and stationary practice, — whatever may be said to the contrary.

SOME experiments which have been made at Creil, France, on the transmission of power by electricity do not seem to have been eminently successful. The idea seems to be to utilize the power of distant waterfalls to generate the power, which is then conveyed to any desired point by electricity, and there used for any desired purpose. Theoretically this seems to be all right, but practically, for manufacturing purposes, it seems to be decidedly cheaper for a man to locate his shop close to the source of power, and use it directly, instead of at second hand. In these days of railroads and cheap transportation, it is found cheaper to transport manufactured goods than power, with its attendant loss of 50 per cent., to say nothing of its uncertainties.

THE German savans have discovered that there has been an increase in the past few years in the damage to buildings from lightning. Of course they disagree in regard to the cause, some stoutly averring that there has been a corresponding increase in the frequency and destructiveness of storms accompanied by lightning, while others, basing their belief on meteorological records, say positively that there has been no such increase, and attribute the damage to the fact that the conditions now-a days are such as to more frequently invite the danger. To us it seems quite likely that in these times such occurrences are apt to be more fully reported than formerly, and it is possible that the more complete record thus kept may be sufficient to account for the seemingly slight increase in the rate of damage to buildings from this cause.

Steel Boiler Plates.

We are in receipt of the following Circular from the Treasury Department relative to the ductility of steel boiler plates:

CIRCULAR.

AMENDED REGULATION CONCERNING THE DUCTILITY OF STEEL BOILER-PLATE.

1885. Department No. 147. Steamboat-Inspection Service.

TREASURY DEPARTMENT,
WASHINGTON, D. C., Sept. 28, 1885.

Supervising and Local Inspectors of Steam-Vessels and others:

It having been ascertained to the satisfaction of the Department that the regulation promulgated in Department Circular No. 29, February 25, 1885, to take effect September 1st, instant, requiring a reduction of area of 53 per cent. on all steel boiler-plates of 65,000 pounds tensile strength and upward, is an actual prohibition of the manufacture of such plates, said regulation is hereby modified so as to require a reduction of area as follows:

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

This regulation will remain in force unless otherwise ordered at the close of the next annual meeting of the Board of Supervising Inspectors.

DANIEL MANNING, *Secretary.*

Evaporative Power and Efficiency of Steam Boilers.

It is always well for the steam-user to know not only the evaporative power of his boilers, but also their efficiency. The evaporative power is measured by the gross amount of water which the boilers are capable of converting into steam in any given time, and is a measure of their power or capacity; while their efficiency is measured by the amount of water converted into steam with a given quantity of fuel. This is the measure of their economical performance; and in general terms it may be stated that the boiler which furnishes the greatest amount of dry steam for the least pecuniary outlay is the most economical. In making this estimate, all expenses of construction, attendance, maintenance, etc., should be taken into account.

It is almost unnecessary to state that the conditions under which the above determinations are made should be, not those of an expert test, but those which obtain in ordinary, available, every-day practice. It is not difficult or expensive to determine the power and efficiency of steam boilers under the conditions of every day work, and in many of our large establishments a daily record is made and preserved of the quantity of coal burned, and the amount of water evaporated. But in a far greater number of cases a record of the coal burned only, is kept, the evaporative performance being left to take care of itself. As would naturally be expected, we find the best degree of economy where the complete record is made daily; the next best where a record of the coal consumption is kept, while in those cases where no record whatever is made, the question of economy is entirely lost sight of.

The only apparatus necessary for the determination of a complete daily record, is a pair of platform scales, for weighing coal and ashes, a water meter for measuring the quantity of water fed to the boilers, and a thermometer in the feed-pipe to determine its temperature. The meter when put in should be rated under the conditions in which it is to run; that is, its error should be determined, and the thermometer should be one of the better and more accurate kind. Its indications should not be more than one degree from the truth between 32 and 212 degrees Fahrenheit. We speak of this particularly because ordinary thermometers *are* more than this amount in error, generally, and sometimes considerably more, and it is important, if accurate results are desired, that the temperature of the feed-water should be correctly known.

The weight of the ashes and refuse from the furnaces should be always weighed if possible, as it forms not only a valuable index of the value of the coal, but of the skill of the fireman as well; and this is a most important factor where economy is desired.

With a complete record of boiler and engine performance, the manufacturer is enabled not only to see at a glance just what he is doing at any time, but to note any variation in work from day to day, and locate it accurately. Any falling off in the economical performance of either engine or boilers is at once noted, and proper steps may be taken to remedy the fault. The element of guess-work, and the "think so" of any one in charge is eliminated.

Knowing the daily performance of the boilers, it is easy to see how they compare with any of the nominal standards of horse-power which have been proposed by various authorities, or whether they work easily up to the claims of the boilermaker who may have furnished them. The question of boiler horse-power is rather an indefinite one; some standard must be assumed and agreed upon, such as the evaporation of a certain amount of water from a given temperature, into steam of some given pressure, or its equivalent. It matters little what this standard is, so long as it is something that is definite, and is a real measure of the capacity of the boiler. The term horse-power should never have been applied to boiler capacity, for a horse-power means a certain definite amount of work performed, while a boiler has nothing to do with the performance of mechanical work. Its function is to generate steam, which, after being generated, may or may not be used to perform mechanical work, according to circumstances. And even if it is used to yield a certain number of horses' power through the medium of a steam engine, the conditions under which it may be used by different engines vary so greatly that the quantity of steam which would easily furnish one horse-power in one case, might not furnish one fourth of one horse-power in another case. And yet the power or capacity of the boiler would be exactly the same in both instances.

But the term horse-power *has* been applied to boilers, and has been so long used in connection therewith that it will probably "stick," so we must make the best of it. This can only be done by assuming some standard evaporative power for a measure, and rating boilers accordingly. Such a standard, one with which no possible fault can be found, and one which represents very closely the power which will actually be yielded by a boiler when the steam furnished by it is used in an ordinarily good steam engine, is that which was recommended by the judges of Group XX at the Centennial Exposition in 1876.

This standard is: The evaporation of 30 pounds of water per hour from feed-water having a temperature of 100° Fahrenheit, into steam having a pressure of 70 lbs. per square inch above the atmosphere, is equal to one horse-power.

This differs by only about one-thirtieth of one per cent. from an evaporation of 34½ lbs. of water per hour from and at 212° Fahrenheit, which is the standard for one boiler horse-power recommended by a committee appointed by the American Society of Mechanical Engineers to consider the subject; hence, the two standards are practically the same.

But the feed temperatures and steam pressures are constantly varying in practice, so that it becomes necessary to have recourse to calculation to compare results. To facilitate this comparison we have computed the following table, which gives the equivalent evaporation from feed at 100° into steam of 70 lbs. pressure, for various other pressures and temperatures occurring in practice. A single example will show the application of the table.

Table

Showing the equivalent evaporation from feed at 100° into steam of 70 lbs. pressure for various other pressures, and temperatures of feed-water.

Temp. of the Feed Water.	PRESSURE IN POUNDS PER SQUARE INCH ABOVE THE ATMOSPHERE.															
	0	10	20	30	40	45	50	60	70	75	80	90	100	120	140	160
32	1.033	1.04	1.046	1 05	1.053	1 055	1.056	1.059	1.061	1.063	1 064	1.066	1.068	1.071	1.074	1.076
40	1.025	1.033	1.039	1.043	1.046	1.048	1.05	1.052	1.054	1.055	1.056	1.058	1.06	1.064	1.067	1.069
50	1.016	1.024	1.03	1.034	1.037	1.039	1.04	1.043	1.045	1.046	1.047	1.049	1.051	1.055	1.057	1.06
60	1.008	1.015	1.02	1.025	1.028	1.03	1.031	1.034	1.036	1.037	1.038	1.04	1.042	1.046	1.048	1.051
70	999	1.006	1.012	1.016	1.019	1.02	1.022	1 025	1.027	1.028	1.029	1.031	1.033	1.036	1.039	1.042
80	.989	.997	1.003	1.007	1 009	1 01	1.013	1.016	1.018	1.019	1.02	1.022	1.024	1.027	1.031	1.033
90	.98	.988	.993	.998	1.001	1.003	1.004	1.007	1.009	1.01	1.011	1.013	1.015	1.018	1.021	1.024
100	.971	.979	.984	.989	.992	.994	.995	.998	1.	1.001	1.002	1.004	1.006	1.009	1.012	1.015
110	.962	.97	.975	.979	.983	.985	.986	.989	.991	.992	.993	.995	.997	1.	1.003	1.006
120	.954	.961	.966	.97	.974	.976	.977	.98	.982	.983	.984	.986	.988	.991	.994	.997
130	.944	.952	.957	.961	.965	.966	.968	.971	.973	.974	.975	.977	.979	.982	.985	.988
140	.935	.943	.948	.952	.956	.957	.959	.962	.964	.965	.966	.968	.97	.973	.976	.979
150	.926	934	939	.943	.947	.948	.95	.952	.955	.956	.957	.959	.961	.964	.967	.97
160	.917	.925	.93	.934	.938	.939	.941	.943	.946	.947	.948	.95	.952	.955	.958	.961
170	.908	.916	.921	.925	.929	.93	.932	.934	.937	.938	.939	941	.943	.946	.949	.952
180	.9	.907	912	.916	.919	.921	.923	.925	.928	.929	.93	.932	.934	.937	.94	.943
190	.89	.898	.903	.907	.91	.912	.913	.916	.919	.92	.921	.923	.924	.928	.931	.934
200	.881	.888	.894	.898	.901	.903	.904	.907	.909	.011	.912	.914	915	.919	.922	.924
210	.872	.88	.885	.889	.892	.894	.895	.898	.9	.901	.902	.904	.805	.909	.913	.915
212	.87	.877	.883	.887	.89	.892	.893	.896	.898	.899	.901	.903	.904	.908	.911	.914

Suppose we have a boiler which evaporates 2,400 lbs. of water in one hour from feed at 70° into steam at 80 lbs. per square inch, what is the equivalent evaporation from 100° into steam of 70 lbs.?

Looking in the first column under "Temperature of the Feed" we find 70; following along the horizontal line from this point until we reach the line of pressures having 80 at the top we find 1.029; multiplying this by 2,400 we have 2,469.6 for the equivalent evaporation from 100° at 70 lbs., and the nominal horse-power of the boiler would be, by the Centennial Committee's Standard, 2,469.6÷30 = 82.3 horse-power, and similarly in any other case.

Conflicting Authorities.

The following, we received several months since from an intelligent working engineer, was accidentally mislaid and forgotten. It will repay a careful perusal:

Any person who will carefully read instructions, which are published at different times concerning the care and management of steam boilers, pumps, and engines will be surprised at the discrepancy in the statements, although the authors may be considered good authority on the subject. For while one will say blow off your boiler at a pressure of 35 or 40 pounds, another will say do not exceed 20 pounds, while still another will say do not blow off under pressure at all, but cool your boiler off, and then let the water run out. Again, one writer on the subject says: "Never fill a warm boiler with cold water," while another will say that when the hydrostatic test is to be applied, the boiler must be blown off under pressure and immediately filled with water, as when the test is applied the temperature of the water must not be less than 160°, and that you must proceed in the same manner every time that you wish to clean the boiler, in order that the soft mud and scale may not be baked on the boiler shell and tubes, and then declares that boilers are ruined by this practice and that it should be discontinued.

The publication of such conflicting statements has the effect of destroying confidence, in a measure, in all writers on these subjects, or makes it not easy to decide which is right.

Some time ago, while reading the answers to correspondents in a scientific journal, I found one which recommended the practice of returning the products of combustion back over the top of the boiler to the chimney.

I was surprised to read this, for it was in what I consider one of the most reliable papers published in the country, but I was still more surprised, a few weeks later to see an answer to another correspondent, saying that such a thing should never be done, as it would, in time, ruin the boiler. Now, if we are to refer to this journal in order to settle this point, which of these two are we to believe to be correct?

When an engineer has run an engine for five or ten years, or more, and it has always given satisfaction, and proved to be reasonably economical, and then he reads an article in some paper or book which declares that kind of engine to be made on a wrong principle, that it is uncertain in its action, and that the valve-gear is sure to be a source of annoyance, he naturally concludes that some one has made a mistake.

Again, if a certain kind of pump is recommended by one expert, and it has been in use a number of years, and given satisfaction, and we find another expert who declares that such valves and valve-gear will never run a pump successfully, we are forced to come to the conclusion, that he either does not understand the subject, or else, on account of some pecuniary consideration, he is unable to give an unbiased decision; and I will remark here, that that is one reason why some men recommend an article or a machine and others condemn the same thing, and it is for the same reason that printed testimonials are held in such light esteem by steam users, for if a man is to receive a large percentage for selling or recommending a machine of any kind it will be very apt to cause him to overlook some of its defects.

Probably the best way to settle these disputed points is by observation and by conversing with those who have had an extended experience in this particular line of work, and who cannot be influenced by bad motives in recommending an article.

Much more might be said on this subject and many more instances cited, and also concerning giving directions which cannot be carried into practice, but I will give but one which I consider impracticable:

We are told that when we wish to clean a fire, we should close the damper while we are doing it. Some fire-rooms are so small and the ventilation is so poor that when the furnace door is opened, a man can not stand in front of it unless he is accustomed to endure intense heat, and then imagine a man trying to clean a fire which consists of half a ton of egg coal at a white heat, with the damper closed and all of the heat, smoke, and dust rushing out of the furnace door. I do not say that it is impossible to do it in any case, but think that it is in some, and consider it highly improbable that it is always done so in any place. W. H. WAKEMAN, JR.

Hobbies.

The attacks of certain enterprising journals on steel moves us to write the following. We have copied their style as closely as possible.

A large blister having appeared on the furnace sheet of one of Jones' boilers, it was deemed prudent to shut down the works and have it examined. The *iron* was found to be quite badly laminated. The use of steel plates for boilers has got to be stopped.

Brown, who got drunk the other day and fell off the steps of a bob-tail car, landing squarely on his *bacon* and knocking out *all the brains he* (bacon) *had*, proves to be uninjured. The fast freight lines must go.

Professor Hollenbeffenenhefflengraensteinerberg, of the University of Wissenschaftigkeit, while digging in his back-yard, the other day, for mud worms, found a fragment of one of Lord Timothy Dexter's cast-iron warming pans (which had lain there but forty years), somewhat corroded. This shows that steel plates are entirely unfit to be used in boilers.

The P., Q., R. & S. road refused to give us a free pass the other day, for the reason, as they said, that our cheek was so large that they could only undertake to transport it by a special freight train. Poor old O. & M.! The fast freight lines must go.

Blank's fireman went out "to a funeral," one day last week, and while he was gone the water in the boiler got down below the top row of tubes, which became overheated and started leaking badly. The only safeguard against such accidents is to abandon the use of steel for boilers.

The X., Y. & Z. road in addition to paying its usual four per cent. semi-annual dividend, has during the past year stone-ballasted the greater portion of its track. The payment of ticket commissions has got to be stopped.

The *Jahrbuch für den Berg und Hüttenmann* predicts showers for next Fourth of July. This shows that it will be unsafe to use steel for boiler plates, as the dampness might cause corrosion.

A cyclone visited a western city, the other day. The office of one of the railway papers was blown down but no damage was done. The use of steel for boilers should therefore should be stopped.

The Old Charcoal Furnaces.

Fifty years ago a typical blast-furnace could have been described as a stone stack, 30 feet square at the base, 20 feet square at the top, and 30 feet or less in hight, pierced by one working or forepart arch in the front, and one or two tuyere arches on the sides; but one tuyere, however, was ordinarily used. The forepart arch was fitted with a tympstone, and a forehearth extended out to a damstone. Blast was delivered cold through clay tuyeres, and between the blast-nozzle and tuyre proper there was an annular space through which fully as much air was at times drawn by injection as was delivered through the nozzle under the low pressure of half pound to one pound per square inch. A high breast or overshot water wheel operating wooden blowing "tubs" furnished the blast, which was carried through wooden or tin pipes to the tuyeres, and the wheezing of these tubes could be heard at considerable distances from the blast furnace. The casting-house, tophouse, stockhouse, and store, were often frame buildings, but the extensive stables, the smith-shop, the "mansion," and the office were generally of more substantial construction. The tuyre and forepart arches were covered with heavy iron "sows," cast at some neighboring plant, and similar castings in segments of a circle formed the "ring-plate" placed in the offset of the masonry, on which the "inwalls," built of shale or slate, were raised. The bottom, the crucible (or hearth) and the boshes were built of sandstone, nicely jointed, the masonry being carried out against the buttresses or corners of the stack, which were in many instances braced by heavy timbers and iron rods to preserve the masonry from injury by expansion.

The thickness of the hearth-walls was seldom less than three feet, and the crucible inclosed by these walls was ordinarily from five to seven feet in height, and square in section, the bottom being from twenty-four to twenty seven inches square. From this point the boshes were battered out so as to slope about 40° from the vertical, or ten inches horizontal to twelve inches vertical, and the section worked from a square into a circle, until the greatest diameter at top of bosh (generally eight to nine feet) was reached; from there the inwalls were drawn in until the top or throat of the furnace measured from two and a half to three feet in diameter, and over this an iron plate, with a hole twenty to twenty-four inches in diameter, was placed. The location selected for the blast furnace was generally on the bank of a stream which furnished the water-power, and close to ground, sufficiently elevated to permit of constructing a "bridge-house" from the top of the furnace stack to the general level, on which were placed the charcoal-houses, ore-supply, etc.

When ready to start, the furnace was filled with charcoal, lighted on top, and when the fire reached the tuyres, blast was applied, more charcoal was charged, and the burden of ore and limestone, finely broken, was slowly increased; this generally resulted in a production of from twenty to thirty tons of cold-blast iron per week after the furnace was fairly in operation. The fuel used was exclusively charcoal, which was charged into the tunnel-head by baskets, and the ore and flux were fed by boxes; the number of boxes of ore and the number of baskets of charcoal formed the relation of the "charge." The weekly output above-mentioned was about the average; at the commencement of a "blast" the product was small, but as the campaign progressed it became augmented, owing to the enlargement of the crucible and steepening of the bosh due to the stones being cut back by the intense heat at the zone of fusion. The walls were too thick to admit of conducting the heat away with sufficient rapidity to maintain the original slope given the furnace.

The small opening in the tunnel-head plate insured thorough distribution of the stock in the limited area of the throat of the furnace, thus aiding to secure regularity of operation. From this opening flame was constantly emitted, varying with each stroke of the blowing machinery. At many iron works, pots, kettles, and stove castings were made directly from the furnace by ladling the molten iron out of the large forehearth. The product of the furnace was carried in wagons, often to distant localities, the castings being disposed of in cities and towns, or the pig iron worked into "blooms" or "anchovies" at forges. Often a forge was operated in connection with the furnace.

Each furnace maintained a general store, and most of the pay due the wood-choppers, charcoal-burners, ore-miners, teamsters, furnacemen, etc., was expected to be expended at the store. In fact, it has been claimed that some old managers would reduce the balance due a workman at the end of the year if it was believed that he had "saved too much," or, rather, "traded too little." The question of "company stores" has caused considerable discussion at various times, and in some states legislation now nominally forbids them, or places restrictions upon their management.

As most of the blast furnaces were located in a section of the country where winter interfered with out-of-door work, and as their construction was such that the interior was rapidly destroyed, the practice of making a "blast" every year was followed. Wood would be cut during the winter, and as soon as the weather permitted of doing so, hearths would be leveled among the cut timber, wood would be hauled to these hearths, and there piled into "meilers," covered with leaves and earth and fired. After about two weeks of carbonization the charcoal would be "drawn," and hauled by wagons to the furnace. When a sufficient quantity of charcoal had accumulated to insure a regular supply, the furnace was blown in, and, except for some accident, low stage of water or other disturbing cause, would be continued in blast until all the charcoal which had been made in the coaling season was consumed. This generally permitted the furnace to be active eight or nine months in the year.

The "blowing in" was an important event at the furnace, generally requiring several days, and was ordinarily an annual occurrence each spring, the date being fixed by the possibilities of securing a supply of fresh charcoal. When the furnace was "blown out," it would be cleaned out, the old hearth, which had become considerably enlarged, would be removed and a new one put in place, when the same yearly routine would be continued. The ores used were chiefly brown hematites, which are easily smelted in the furnace, and they are mixed with a small percentage of lime and clay to flux impurities and make cinder. The cinder was allowed to flow continually over the damstone and form into cakes upon stones laid in the floor of the casting-house. When pig iron was cast the iron passed through one long runner to feed pig iron molds at right angles to it, one side of the casting-house being devoted to pig-iron, and the other side to cinder. While many features of plant or practice as described have been abandoned, there are still instances where all of the above-mentioned appliances or methods are in use, and individual plants can be cited for which this description would be practically a record of present arrangement and management. Such instances are, however, becoming less numerous each year.

The stone-masonry of the older stacks was often quite massive, and in many cases they were constructed with such integrity that they have sustained successive enlargements of bosh and increase in height. Some stone blast-furnace stacks are still active which are more than a century old. (The Cronwall charcoal furnace, in Lebanon County, Pa., has been an active iron-producing establishment since 1742, and ranks as the oldest plant in operation in the United States.) The openings provided for a working or forepart-arch, and for tuyere-arches were liberal in width, but generally restricted in height, and did not permit of elevating the tuyeres to points now considered advantageous. The tin blast-pipes and light fixtures stood all the work demanded of them, for, even where the water-power was adequate and the machinery strong enough, an old-time founder would not blow hard for fear of destroying the fuel, or, as he expressed it, of "blowing the charcoal to pieces."

While the construction of the blowing apparatus appeared cumbrous and crude, it gave evidence of careful thought and good workmanship. The wooden blowing-tubs were cylindrical or rectangular in form, from five to seven feet in diameter, or square, and from two to five feet stroke. They were formed of segments or strips cut from one-inch boards, generally pine, glued and doweled together, and then turned or planed to smooth surfaces. There are examples of both cylindrical and rectangular wooden tubs still in use. These tubs when lined with apple or other hard wood, were very durable. Hardwood segments were also placed within tubs made from pine staves secured with bands. Large wooden pistons with leather edging were fitted in the tubs and connected with square wooden piston-rods, working in stuffing-boxes. The blowing-tubs, when single-acting, had the inlet-valves in the piston, and, when double acting, these valves were in the ends of the tubs. Some of these engines were known as "pacers," owing to the motion of the two counterweighted beams which were connected with the two blowing-pistons, but the ordinary appellation for all blowing apparatus was "the blast," whatever its design. A popular arrangement of "the blast" consisted of two vertical single-acting wooden blowing-tubs placed over opposite ends of a vibrating beam which received motion from a crank on the water-wheel shaft; the air was admitted through valves in the piston during the down stroke, and discharged into a third tub placed over the two just described; this third tub had valves in the bottom communicating with the two operating cylinders, and a large floating piston forming the top was weighted with iron to secure the pressure desired; it rose and fell with each stroke of the operating cylinders.

The output of an old-style cold-blast charcoal furnace, nine feet in diameter at bosh, and twenty-eight feet high, was, as stated, from three to five tons of pig-iron per day, the consumption of charcoal being from 150 to 225 bushels per ton. The paper on Mont Alto Furnace work, to which reference has been made in the *Journal* of the United States Association of Charcoal Ironworkers, gives the output of that furnace in 1883, with bosh diameter of nine and a half feet and height of forty-four feet, as averaging twenty-five and a half tons of cold-blast iron on a consumption of 129 bushels of charcoal per ton of iron made. When hot blast was employed, the older furnaces of the above dimensions increased their product to from eight to ten tons per day, but improved appliances and management have latterly obtained thirty to forty tons per day from furnaces of practically the same diameter of bosh, but with larger crucibles and greater height, and the fuel consumption has fallen to 100 bushels per ton. In larger and more modern plants of eleven feet diameter at bosh and 60 feet high, a product of seventy tons per day, and a fuel consumption of less than eighty-five bushels of charcoal per ton have been attained.

The massive stone stack, from which the flame constantly rose and fell with the wheezing of the blast, and around which centered the entire interest of the community dependent upon its action, the battery of ore carts and charcoal wagons, with their motive power represented by 100 braying mules, and the Arcadian simplicity of all the surroundings (save at the mansion-house) were characteristics of the olden-time furnace. The neat, symmetrical furnace stacks, chimneys and hot-blast stoves, the substantial casting, stock, engine and boiler-houses, the absence of flame from the tunnel-head, the puffing of small locomotives drawing ore, flux, fuel, pig-iron or cinder, and the quantity of material thus handled, present a strange contrast to the charcoal furnace of fifty years ago.—John Birkinbine *in Mineral Resources of the United States.*

Glass.

ITS FRAGILITY AND DEFECTS—THE ANNEALING PROCESS.

An important process is required before glass is fit for use, which is that of annealing or cooling very gradually. All glass articles require annealing except those that are very thin and uniform, without joining or burr of any kind. Without this precaution the glass remains always liable to fly by the least change of heat and cold, by the smallest scratch, or even apparently without any external cause. The precise mechanical cause of this disposition to crack in unannealed glass is very difficult to explain, but generally speaking it is supposed to be the forcible contracting of the outer part by sudden cooling, while the inner portion is still soft and half fluid, so that the whole fixes with a permanent strain or inequality of pressure of one part upon the other; and as glass is extremely elastic, though brittle, any force which tears asunder a portion, however small, of the tense part, communicates a strong and sudden impulse over the whole mass. The annealing is generally performed in a hot chamber. The heat is here so moderate as not to soften the glass, and the articles are gradually withdrawn to a cooler part till they are cold enough to be taken out for use. Common articles are generally annealed in the course of a day. The place of all others in which ill-annealed glass is most liable to break is at any point of junction where two pieces are cemented together when hot, and as different kinds of glass contract to a different extent, two dissimilar pieces of glass should not be joined together.

The hard glasses, and those in particular made only with alkali and earths, require much more annealing than the softer and more fusible glasses into which litharge enters largely.

The extraordinary fragility of unannealed glass is shown in a very striking manner by two kinds of ornamental toys made for the purpose, one is the Bologna vial, as it is usually called, and the other the Prince Rupert's drop. The Bologna vial is simply a vial of any form whatever, made of any kind of glass, but much thicker at bottom than at top, and cooled immediately without annealing. These being pretty stout from their thickness, will bear a stout blow with a wooden mallet or any blunt instrument, or the concussion of a leaden bullet dropped into it from a considerable height, without injury; but if any sharp body, however small, such as a large grain of sand, or better, a sliver of a gun-flint be dropped in from only a few inches in height, the bottom cracks all round just above the thickest part and drops off. The same effect happens if the bottom be slightly scratched with any hard body. When very brittle, if a hard angular substance, such as a cut diamond be dropped in, it sometimes will pass through the bottom, though very thick, with apparently as little resistance as through a spider's web. These glasses when they have received the first injury do not always crack immediately, but remain whole sometimes a few minutes, sometimes for hours, and then suddenly give way.

The Rupert's drop is simply a small lump of green bottle glass poured when red hot into water, and therefore is a rounded lump gradually extended into a kind of tail nearly capillary at the extremity. This solid lump will bear very considerable violence on the rounded end without injury, and is altogether extremely tough, but when the least portion of the thin end is broken off, the whole bursts with a smart snap, instantly crumbles into a countless number of fragments as fine as small sand, which from their minuteness do no other injury to the hand holding it than a slight stinging from the sudden concussion.

This most singular phenomenon is obviously owing to some permanent and very strong inequality of pressure, for when they are heated so red as to be soft and merely let cool of themselves, this property of bursting is entirely lost, and at the same time the specific gravity of the drop increased.

The peculiar brittleness of the Bologna vial is also removed by again heating and cooling slowly.

A defect in the annealing of common window glass is also shown when cut by the diamond. When the glass is well annealed the diamond cuts it with moderate ease, making a uniform, smooth furrow, at first dark, but which gradually opens and then appears as a bright silver thread; but when the glass is badly annealed, the diamond works with much more difficulty, the cut opens very slowly, and often flies into a different direction, or the glass entirely breaks.

The other more common defects of glass are a liability to be acted on by corrosive liquors (which takes place when too much saline flux has been used), and also a number of visible imperfections, some of which materially injure the soundness as well as beauty of the manufactured articles. The chief of these visible defects are striæ, threads, tears, and knots. The striæ are undulating waves in the glass, perfectly transparent and vitrified, but which produce much strange distortion when used for windows or for optical purposes. This defect arises from the imperfect mixture of the materials, and the great difference in their specific gravities. For the gravity of glass made simply with alkali and sand is about 2.3 or 2.4, that of alkali and crucible clay about 2.5, that of alkali and chalk 2.7 or 2.8, while the vitrified oxide of manganese alone weighs 3.2 and the glass of lead 7.2 nearly. Therefore when these are all together melted in the glass pot, if they are not thoroughly mixed, they are in the case of liquors of unequal density in contact with each other, and slightly agitated so as to shake the different materials into streaks or waves.

The defect from this cause is seen very strikingly in ordinary prisms, or pieces of solid glass of a certain thickness, which are seldom quite uniform in density throughout. For very nice purposes it is often of use when small movable crucibles are used, to invert them when the glass is melted and empty the contents, whereby the heavier parts become mixed with the lighter as they fall through them.

Threads in glass-making are those streaky filaments which arise from the vitrification of the clay. They are generally green, and often render the glass more liable to crack at these parts.

Another and one of the worst defects is "tears," or drops of vitrified clay falling down from the furnace into open pots and entangled with the glass. Articles made of glass with this defect are always very brittle, and generally break themselves by slight changes of heat and cold. This is the more likely to happen in proportion as the tear is nearer the surface.

Glass, when not sufficiently refined by continuance of the melting heat, is always full of small bubbles. This fault may also happen from a deficiency of flux which renders the glass less fusible, and therefore stiffer during the ordinary time and degree of heating so that the bubbles cannot easily disengage themselves. Hence the soft fusible glasses with much lead are much less liable to this fault than the hard, green bottle glass which is made only of alkali and sand.

Another defect is knots, which arise either from a portion of sand that has escaped vitrification and remains entangled in the glass, or from a remaining quantity of glass-gall; or from bits of the crucible which may be accidentally knocked off by the iron instruments used in the working.—*Pottery and Glassware Reporter.*

A FAILING common to all amateurs or non-professional workers is too great haste. It matters not whether they are amateur machinists, or carvers, or painters, or amateurs in any handicraft, the same weakness affects them all. The amateur wishes to see how his work will look when it is done, and he slights preliminary process and hastens toward the final one, with the result of making a botch of the business in hand. The work shows to the practical eye that it has been done hastily (carelessly is a better word), and it is inferior for that reason. The amateur himself sees it, and after a time, after the first joy of completion is over, he hates the sight of his hurried job, and very often destroys it out of hand. The better way would have been to stifle all impulses to get the work finished before it was fairly entered upon, and go through the processes which all work must go through before it can be properly completed.

If I were asked what was the most necessary qualifications for a successful amateur, I would say patience and perseverance. Rarely do amateurs make good workmen, and it is most frequently for want of these virtues.—*A Machinist, in The Mechanical Engineer.*

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Slotted Mouthpieces and Liner Plates.

One of the greatest sources of trouble and annoyance in connection with boiler settings, consists in the warping and burning out of the cast-iron mouthpiece of the furnace door. As they are usually made and put in they expand under the influence of the heat, and the expansion results in cracking and distortion which renders it almost impossible to keep the front of the furnace lined with fire-brick. This results in overheating and cracking of the cast-iron front, and if the setting is of the flush front type, the portion

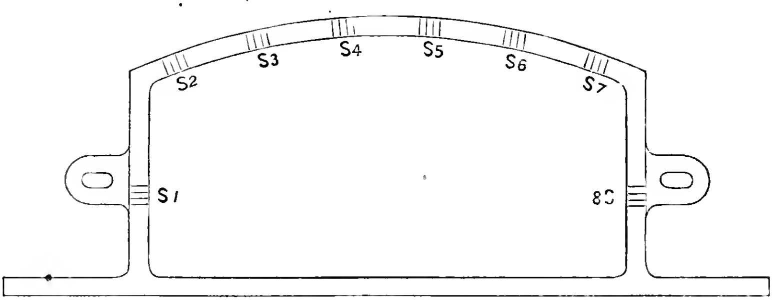

FIG. 1.

of the boiler shell forward of the front head is sure to be burnt also. Our illustration shows a very simple and inexpensive method of overcoming the difficulty.

Fig. 1 is an elevation, and Fig. 2 a plan of a solid mouthpiece as they are usually constructed. On the inner edge of the casting, that is, the edge exposed to the furnace heat, a series of slots are cut as shown in the figures at S_1, S_2, S_3 - - - - S_8. These slots should be about 6 inches apart, and should extend a little over half way through the

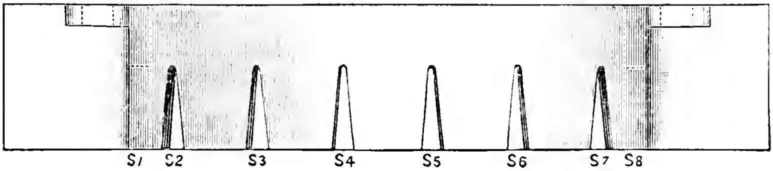

FIG. 2.

casting. For a mouthpiece 9 inches deep, they may be 5 inches deep; their width should be about $\frac{3}{8}$ of an inch at the bottom, and about $1\frac{1}{4}$ inches on the outer edge.

Where castings are already on hand, the slots can be easily made by drilling and chipping; when new ones are ordered, it will be to the interest of the purchaser to have the pattern slotted, as thereby they may be provided without extra cost, as the form of the slots does not interfere with the draft of the pattern.

It will surprise any one who has never tried this plan, to find how nicely the casting will keep its shape when slotted as above shown. The reason is very simple. Under the influence of heat the iron is bound to expand; if the slots are present it has a chance to do so without lateral bulging. Without the slots it must go somewhere, and the result is bulging and warping, with the attendant displacement of the brick-work.

Although iron expands under the influence of heat, it does *not* return to its original dimensions when it cools again. This will be rendered evident by the gradual closing up of the slots shown above, under the conditions of every-day use. We have seen them, in extreme cases, close up during a year's run, so that a close examination was required to find a trace of them. With them spaced about 6 inches apart, however, the expansion in a year's run is not generally enough to close them up. They will remain open. and the mouthpiece will retain its shape until the projecting portions are so wasted away from the action of the heat, that they are not long enough to support the fire brick lining. Longer service than this cannot be expected under any circumstances.

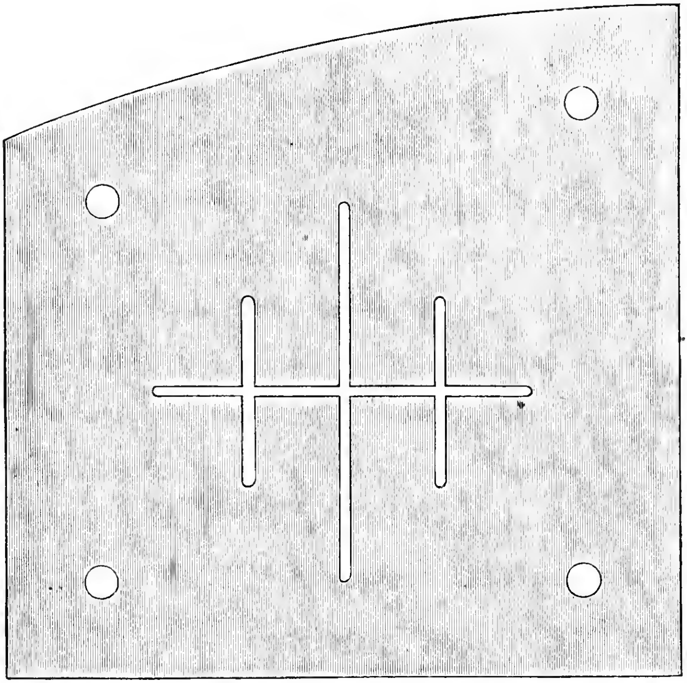

FIG. 3.

The same principles apply to the liner plates for fire doors. These are exposed to very intense heat, and generally warp and bulge badly. Fig. 3 shows the form of slotting which we would recommend for these plates. They allow of the free expansion of the plate toward its center, and this will enable it to keep its shape. These slots may be easily made by drilling and planing or chipping, or if they are made of cast-iron they may be cast in when the plate is made, as in the case of the mouthpieces.

This same principle might be applied with profit in many other cases where plates, exposed to intense heat, give trouble from warping and cracking.

Inspectors' Reports.

SEPTEMBER, 1885.

There were made during the month of September 3,157 visits of inspection, in the course of which 6,035 boilers were visited, 1,989 were thoroughly examined both internally and externally; 471 were tested by hydrostatic pressure, 3,708 defects were reported, of which 719 were considered dangerous, and led to the condemnation of 28 boilers.

Our usual tabular statement of defects is appended.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	343	37
Cases of incrustation and scale,	445	51
Cases of internal grooving,	27	11
Cases of internal corrosion,	137	19
Cases of external corrosion,	279	17
Broken and loose braces and stays,	69	28
Settings defective,	143	31
Furnaces out of shape,	158	30
Fractured plates,	140	60
Burned plates,	71	31
Blistered plates,	170	20
Cases of defective riveting,	517	62
Defective heads,	46	19
Serious leakage around tube ends,	506	139
Serious leakage at seams,	196	53
Defective water-gauges,	126	35
Defective blow-offs,	37	10
Cases of deficiency of water,	7	6
Safety-valves overloaded,	40	15
Safety-valves defective in construction,	57	14
Pressure-gauges defective,	192	30
Boilers without pressure-guages,	2	1
Total,	3,708	719

Defective water-gauges, it is almost needless to say, are not only useless appendages to steam boilers, but are worse than useless, for they not only invite danger, but force the element of danger upon the boiler-user.

Water-gauges may be dangerously defective from several causes. They may be defective in construction, they may be so connected that they do not indicate the true water-level, or they may become stopped up with scale or sediment, through lack of care, so that no reliance can be placed upon their indications.

Only recently a case came under notice where a water-column, with which was combined a patent low-water detector, was put up on a battery of boilers under the special direction of the agent of the apparatus. The pipe connections were so made that when the gauge-glass was filled to a certain height, which in this case happened to be about the proper height for the water to be carried, the water would stay there regardless of the quantity of water in the boiler. The error was discovered by the engineer in consequence of the water getting low in the boiler, and setting the tubes leaking, while the gauge and low-water detector (?) showed plenty of water in the boiler.

All water-gauges are defective in construction which have such small and contracted water spaces, that free circulation does not take place in them at all times, when they are reasonably clean. Also when they are so constructed that they cannot be thoroughly blown out at any time while the boiler is under steam.

The stopping up of the pipes and connections is, of course, mainly the fault of those in charge of the boilers, though it frequently is the case that the connections are so small and the construction such that with bad water it is almost impossible to keep a water column clean. In localities where the water is very hard, or very muddy, nothing but the simplest apparatus should be allowed on boilers for water-gauges, such, for instance, as plain gauge-cocks, and these should be very frequently opened to their full extent. When a water column is used in such places, the pipes connecting it with the boiler should not be less than $1\frac{1}{4}$ inches in diameter, and should be so put up that they can be scraped out without disconnecting them from the boiler.

All these points can be provided for when putting up boilers, and the first expense is no greater than a makeshift arrangement, while the chances are that some time or other a serious accident, involving an expense of hundreds of dollars, would be averted by the use of proper apparatus.

Boiler Explosions.

SEPTEMBER, 1885.

RENDERING TANK (99). — A most terrible accident occurred August 19th, near Harshmanville, Ohio, a small place a few miles east of Dayton, where is located a fertilizing establishment. Isaac McCullum, an employee and a brother to the proprietor, was the victim. In the factory is a huge tank wherein the animal tissues are rendered by the process of steam. In the bottom of it is a door, which was found to be leaking, and McCullum got under it to repair the leak, when the door exploded, letting the hundreds of gallons of rendered grease fall on the unfortunate man. He was thrown a distance of thirty feet by the force of the explosion. By some means most wonderful his head and face were not scalded or burned, but the remainder of his body from the soles of his feet was terribly scalded.

LOCOMOTIVE (100). — By the bursting of a flue sheet, August 14th, on the locomotive J. S. Farlow, near Lawrence, N. Y., engineer Fred Lewis of Malone, N. Y., was badly scalded and injured internally, and will probably die. The fireman, John Chilton of Malone, was also badly scalded, but will recover.

SAW-MILL (101). — A boiler in the saw-mill of S. M. Winchester of Newport, Ky., exploded September 3d, killing two men and seriously wounding several others.

PORTABLE ENGINE BOILER (102). — Andrew Hillig was drilling a natural gas well at Greenville, Mercer county, Pa., September ——, when the boiler exploded with terrific force killing Henry Faust, aged sixty-five years, and seriously wounding several others. Fragments of the boiler-iron crashed through a barn standing near, almost completely wrecking the structure. Windows in the vicinity were shattered by the concussion, and pieces of the boiler were picked up 500 feet from the scene of the explosion.

THRESHING MACHINE (103). — The boiler of a portable threshing machine on a farm a few miles from Reese, Mich., exploded September 15th, injuring five or six persons, one of whom will be crippled for life and another may die. The most seriously injured are Alfred Hauteberger, owner of the machine, who was so badly cut about the lower limbs that he will be permanently crippled, and Charles Collerton, son of the farmer they were threshing for, who may die. The engine was completely wrecked.

THRESHING MACHINE (104). — While a threshing machine was in operation on the farm of Richard Lord, at Bryon, Ohio, September 14th, the boiler exploded, killing C. G. Pastor and Wesley Henner. The victims were badly mangled.

BREWERY (105). — The boiler in Reutlinger & Eisfelder's brewery, Henderson, Ky., exploded September 16th, making a complete wreck of the east end of the building. Fortunately no one was in the boiler-room at the time of the accident. The fireman, however, had a narrow escape. He was in a little room drinking beer, when a piece of the boiler tore away a portion of the wall against which he was leaning. The damage amounts to fully $6,000; no insurance.

SAW-MILL (106). — The boiler of a saw-mill, the property of James Bartleson at Grand Chain, Ill., exploded September 17th, two men being killed, and one injured so badly that he will not recover. Robert McIntyre, the engineer, was blown about one hundred feet from the wreck, and portions of his body were found hanging on the limbs of the trees around the mill. Silas Creamer was killed and Orrin Morris will die. No water in the boiler was said to have been the cause of the accident. The boiler was torn into a thousand pieces, and the mill building and machinery are completely wrecked.

SAW-MILL (107). — The boilers of the large saw and planing mill owned by Nathan C. McGill of Greensburg, W. Va., exploded Sept. 18th, with terrific force. Mr. McGill was instantly killed, and the mill, valued at several thousand dollars, was totally destroyed.

SOAP WORKS (108). — The boiler in Fabel's soap factory, Louisville, Ky., exploded at noon September 22d. Edward Ernest, the engineer, was instantly killed, his body being blown into a creek fifty feet distant. The damage to the building is $15,000. A boiler in the same factory exploded two years ago and killed two men. The cause of the explosion is unknown.

FLOURING MILL (109). — The steam boiler in Bush and Stockwell's flouring mill at Wilson, Niagara county, N. Y., exploded September 24th, one half the boiler going through the side of the mill to a distance of ten rods. Fortunately no one was hurt. Damage $10,000.

FOREIGN STEAMER. — MADRID, September 11th. — It is reported that the boiler of the Spanish cruiser *Castilla*, lying at Cadiz, has exploded. The *Castilla* is the largest cruiser of the Spanish navy.

Salicylic Lemonade.

As a "hospital beverage," says the *British and Colonial Druggist*, which has lately been found of great value in typhoid and other fevers, scurvy, and gout, the following cannot be too widely known, it having been, we understand, first devised by a late medical officer attached to the Soudan expedition: Fruct. limoni, No. 10; acid citric, ½ oz; acid salicylic, 200 grains; sacch. alb. and water q. s. Squeeze the lemons and put the juice aside; boil the fruit in half or three-quarters of a gallon of water for fifteen or twenty minutes; after standing for six hours take out the lemons, and again press them before throwing the exhausted pieces away. Add the juice and citric acid to the liquid, boil five minutes, and strain. While hot, add the salicylic acid, and stir until dissolved. Sweeten to taste with sugar, and make up the bulk to one gallon with water.

Salicylic lemonade may be taken freely, either of the strength here given, or diluted with half its bulk of water. It should be freshly made every two or three days, unless it be permissible to "qualify" it by the addition of a little pure French brandy. If required to be in a "bright" condition, add, when cold, a little beaten up with white of egg. Boil for three minutes, and then filter. If found too harsh for some tastes, dissolve in the boiling liquid, before straining, half an ounce of Nelson's patent opaque gelatine, previously swelled for five hours in cold water.

The Locomotive.

HARTFORD, NOVEMBER, 1885.

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.*

MR. L. B. Perkins, who has been with this Company a number of years, has been appointed General Agent at the home office; to fill the position made vacant by the death of Mr. D. C. Freeman.

THE report of a committee appointed by the French Academy to inquire into the superheated water theory of steam-boiler explosions has been published in the *Annales des Mines*. The committee did their work very thoroughly. They constructed suitable apparatus, experimented in the most exhaustive manner with it, and investigated several explosions, claimed by the advocates of the theory to have been due to this cause. They failed utterly to superheat water under all conditions which could possibly occur in practice, and all the explosions investigated were shown conclusively to have resulted from simple deterioration of the boilers, or from carelessness. Their refutation of the theory is most signal and complete, and we hope to give our readers next month some extracts from the report, which is decidedly interesting. It is about time that we heard the last of this most absurd theory, and the report in question will go far to give it its quietus.

PROBABLY many of our readers, especially those who are the possessors of optical instruments, have, at some time or other, been in need of a "dead black" paint or varnish for brass work, such as tubes, diaphragms, etc. We have been very much in the same boat, and all the formulae and recipes given in the books were unsatisfactory because of their vagueness. The following can be relied upon to give a first-rate dead black, and it is easily made:

Take two grains of lamp-black, put it into any smooth, shallow dish, such as a saucer or small butter-plate, add a little gold size, and thoroughly mix the two together. Just enough gold size should be used to hold the lamp-black together; about three drops of such size as may be had by dipping the point of a lead pencil about half an inch into the gold size will be found right for the above quantity of lamp-black; it should be added a drop at a time, however. After the lamp-black and size are thoroughly mixed and worked, add 24 drops of turpentine, and again mix and work. It is then ready for use. Apply it thin with a camel's hair brush, and when it is thoroughly dry the articles will have as fine a dead black as they did when they came from the optician's hands.

IT appears that the great blast at Flood Rock, Hell Gate, did not break up the rock as much as was desirable, or as much as was expected. The roof of the mine was left too thick, and the quantity of explosives used was too small, and the condition of the rock is such the cost of dredging the *débris* will be very much greater than it should be.

HERR H. MINSSEN, editor of the *Zeitschrift des Verbandes der Dampfkessel-Ueberwachungs Vereine*, in Breslau, sends us a copy of a translation into the German language of the poem, "The Boiler that Jack Built," which appeared in our August number. The work is very well done, and the illustrations are first-rate.

Combustion.

Much has been said and written upon the subject of firing steam boilers, how it should be done to secure the best results, to prevent smoke, etc., and each and every writer generally assumes that his practice is better than any one's else, but the fact remains that different kinds of fuel, and different arrangements of the boiler-plant, requires different styles of handling to give the best result. No hard and fast rule can be given for firing that will be the best in all cases.

It may, without fear of contradiction, be said, that as high, if not a higher degree of skill is required in the fire-room than in the engine-room. Given, a good engine in first rate condition, and no degree of skill is required to "run" it, and it will do its work with about the same degree of economy whether it is started and stopped by novice or expert. With the very best boiler-plant the case is different. Care and judgment must be exercised constantly, the method of firing must be adapted to the kind of fuel used, cleaning of fires must be done with judgment at the proper times, the draft must be properly controlled, and the boilers must be kept clean. This last matter may not appear to have any connection with the firing of the boilers, *per se*, yet it should be attended to by the person in charge, and is the rock on which many men, expert in handling engines though they were, have been hopelessly stranded.

Although many first-class firemen whom we have met are ignorant of the scientific principles of combustion, there is no reason to suppose, as some writers would have us believe, that they would be less skillful if they were thoroughly acquainted therewith. We will therefore give the rationale of combustion, and we cannot state it better than in the words of Rankine. Although Rankine is generally held up as the personification of abstruseness, the fact remains that his statement of the principles of combustion is more clear, concise, and exact than that of any other writer with whose works we are acquainted. We therefore quote from his *Steam Engine*, page 267, *et seq*:—

"Every chemical combination is accompanied by a production of heat: . . . *Combustion* or *burning* is a rapid chemical combination. The only kind of combustion which is used to produce heat for driving heat engines, is the combination of fuel of different kinds with oxygen. In the ordinary sense of the word *combustible*, it means, *capable of combining rapidly with oxygen so as to produce heat rapidly*. . . . The chief elementary combustible constituents of ordinary fuel are *carbon* and *hydrogen*. . . . Substances combine chemically in certain proportions only. . . .

"The following table shows the total heat of combustion with oxygen of *one pound* of each of the elementary substances named in it, in thermal units, and also in pounds of water evaporated from 212 degrees. It also shows the weight of oxygen required to combine with each pound of the combustible element, and the weight of air necessary in order to supply that oxygen.

Combustible.	Lbs. oxygen per lb. of combustible.	Lbs. air.	Total heat in thermal units.	Evaporative power from 212°.
Hydrogen Gas, ...	8	36	62,032	64.2
Carbon, imperfectly burned so as to make carbonic oxide, ...	$1\frac{1}{3}$	6	4,400	4.55
Carbon, completely burned so as make carbonic acid, ...	$2\frac{2}{3}$	12	14,500	15.00
Carbonic Oxide, as much as is made by the imperfect combustion of 1 pound of carbon, viz., $2\frac{1}{3}$ pounds, ...	$1\frac{1}{3}$	6	10,100	10.45

"It is to be observed, that the imperfect combustion of carbon, making carbonic oxide, produces *less than one third* of the heat which is yielded by the complete combustion. . . .

"With regard to . . . the total heat of combustion respectively of carbon completely burned, carbon imperfectly burned, and carbonic oxide, the following explanation has to be made:—

"The burning of carbon is always complete at first; that is to say, one pound of carbon combines with $2\frac{2}{3}$ pounds of oxygen, and makes $3\frac{2}{3}$ pounds of carbonic acid; and although the carbon is solid immediately before the combustion, it passes during the combustion into the gaseous state, and the carbonic acid is gaseous. This terminates the process when the layer of carbon is not so thick, and the supply of air is not so small, but that oxygen in sufficient quantity can get direct access to all the solid carbon. The quantity of heat produced is 14,500 thermal units per pound of carbon, as already stated.

"But in other cases part of the solid carbon is not supplied directly with oxygen, but is first heated, and then dissolved into the gaseous state, by the hot carbonic acid gas from the other parts of the furnace. The $3\frac{2}{3}$ pounds of carbonic acid gas from one pound of carbon, are capable of dissolving an additional pound of carbon, making $4\frac{2}{3}$ pounds of *carbonic oxide* gas; and the volume of this gas is double of that of the carbonic acid gas which produces it. In this case, the heat produced, instead of being that due to the complete combustion of one pound of carbon, or 14,500 thermal units, falls to the amount due to the imperfect combustion of
two pounds of carbon, or - - - - - - $2 \times 4{,}400 =$ 8,800 thermal units,

showing a loss of heat to the amount of - - - 5,700 thermal units,
which disappears in volatilizing the second pound of carbon. Should the process stop here, as it does in furnaces ill supplied with air, the waste of fuel is very great. But when the $4\frac{2}{3}$ pounds of carbonic oxide gas, containing two pounds of carbon, is mixed with a sufficient supply of fresh air, it burns with a blue flame, combining with an additional $2\frac{2}{3}$ pounds of oxygen, making $7\frac{1}{3}$ pounds of carbonic acid gas, and giving additional heat of double the amount due to the combustion of $1\frac{1}{3}$ pounds of carbonic oxide; that is to say, - - - - - - - $10{,}100 \times 2 = 20{,}200$ thermal units,
to which being added the heat produced by the imperfect combustion of two pounds of carbon, or - - 8,800 thermal units,

there is obtained the heat due to the complete combustion of two pounds of carbon, or - - $2 \times 14{,}500 = 29{,}000$ thermal units."

From the foregoing it will be seen that a most important point in firing is to give the fuel the proper amount of air at the right time. One essential condition to this is a good chimney-draft which can be controlled perfectly, the remaining conditions are in the hands of the fireman, and upon his skill and knowledge depends their fulfillment.

The method of handling the fires should be different with different kinds of fuel, to obtain the best results. This is evident where we consider the varying composition of different kinds of coal.

Coals are classified as anthracite, bituminous, and hydrogenous, according to the amount of carbon and volatile matter present in their composition. Their constitution varies so much that one variety shades into the other, and it is impossible to draw a precise line of separation between the different classes.

In general it may be stated, the harder the coal the stronger the draft that will be required to burn it successfully. There being very little volatile matter to pass off and be burned when the coal is put on the fire, there will be few or no precautions to be taken to guard against smoke. No air will be necessary above the grates. The fires should be carried of moderate thickness, and plenty of draft given. With the softest coals there is great danger of smoke unless the firing is carefully attended to. Large air space should be allowed between the grates, the fires should be kept clean, and when coal is first put on the fire door should be left partly open, for from three to five minutes; (the exact amount and time of opening will depend upon the circumstances of each particular case) this will prevent smoke and insure the combustion of the volatile products. After the volatile products are completely burned, the fire-doors should be closed, as any further admission of air above the fire is detrimental to economy.

For intermediate varieties of coal the practice should be adapted to each particular case. In general, it may be said that with a good ordinary furnace, with good draft, any kind of coal may be completely burned, without smoke, by proper handling of the fires; and without the aid of any special appliances.

(*The Iron Age.*)

The Manufacture of Steel Castings.*

BY P. G. SALOM, PHILADELPHIA, PA.

The manufacture of steel castings has become one of the important industries of the times. The late Mr. Alexander L. Holley published in 1878, in the *Metallurgical Review*, an able paper, entitled "Solid Steel Castings," showing how all manner of castings could be made advantageously of steel. Mr. Holley had then but lately returned from the great iron and steel works of Terrenoire, France, which were engaged, I believe, almost exclusively on large castings of a simple type for the government, and were repeating the same operation from day to day. These conditions are, as experience has shown, very different from those of ordinary practice in miscellaneous castings; and Mr. Holley might have been less confident if he had actually gone into the business. More than seven years have passed, and as yet the magnificent possibilities held forth in his paper have not been realized. There are only six steel-casting establishments in the United States, and their total output of castings is certainly not as much as 20,000 tons per annum, and probably not more than 10,000 tons, whereas it should be over 200,000 tons to supply the needs of the country.

A large number of so-called steel castings are made, however, which are nothing more than malleable iron. The best of these castings are made from a superior white pig, as low in silicon and phosphorus as possible. They are made in the same manner as ordinary iron castings, except that the metal, having so little silicon, chills much quicker than ordinary No. 1 foundry iron, and the liability to shrinkage cracks renders it necessary to put large "rising-heads" on the castings. The castings, after cooling, are very hard and almost as brittle as glass, and are, or should be preferably, perfectly white throughout. They are then annealed in ore or scale, to which a little sal ammoniac has been added. This latter operation, which requires about two weeks, produces on the entire surface of the casting a coating of malleable iron, about $\frac{1}{16}$ inch thick, and renders the inside sufficiently soft to be tooled without any difficulty. For small castings such a metal is admirably adapted; but castings several inches thick made in this way are only slightly superior to good pig iron in having perhaps a little greater tensile strength. What then, are the reasons, in view of what has been said above, for such a small production of genuine steel castings? This question is best answered by a short description of the three general methods employed in the manufacture of steel castings, viz., the crucible, the Bessemer, and the open-hearth processes.

CRUCIBLE STEEL CASTINGS. — I have no hesitation in saying, and say it without fear

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* Read at the Chattanooga meeting, May, 1885.

of contradiction, that crucible steel castings are a failure and always will be. I do not mean by this statement to say that it is impossible to make crucible steel castings satisfactory. But with the single exception of a particular class of work where hardness and ultimate strength are alone desired (for which acquirements they are well adapted), there are always a number of distributing elements that will eventually result in the total disuse of crucible castings. The value of the small steel castings depends on the possession of qualities that render them equal or superior to forgings. When it is attempted to make a steel with the requisite qualities the troubles begin. First, in order to get such a steel, muck bar must be used almost exclusively. This, as every one knows, is very difficult to melt in a crucible furnace, and, after melting, it is almost impossible to pour it, as the metal chills before the pots can be emptied. If, however, after unusual exertions, a successful cast be made, the castings are found to be full of blow-holes. There are two means employed to remedy the latter defect — first, by the use of ferrosilicon, and, second, by making a steel higher in carbon, and therefore more fusible. When sufficient ferrosilicon is added to give from 0.5 to 1.0 of silicon in the steel, the metal is not difficult to melt; but the resulting castings, while soft and solid, have lost all their ductility and are simply a superior form of pig iron, with a tensile strength of about 50,000 pounds. If, on the other hand, the pots are charged with stock higher in carbon and only a small percentage of ferrosilicon is added, the castings are solid, but are brittle, and so hard as to be difficult to tool. Their hardness is extremely objectionable to machinists, but their brittleness is a still greater evil and precludes the possibility of their replacing forgings. It has been attempted to overcome the latter difficulty by annealing, and by this means a really superior crucible casting can be made. But the additional cost of production is greater than consumers are willing to pay for the castings.

BESSEMER STEEL CASTINGS. — The Bessemer process, however, in the manufacture of steel castings, is as yet open to the objection of making a less homogeneous and a harder metal than the open-hearth. Some months ago I saw a number of large Bessemer steel cranks, weighing from 7,000 to 8,000 pounds each, that had broken in half when it was attempted to shrink them on the shafts for which they were intended. A number of open-hearth cast-steel cranks of the same size, made at the Chester Rolling Mills in 1882, easily withstood the shrinkage test and are still in service. Notwithstanding the failures in this respect, which have greatly prejudiced consumers and prevented thus far a more general adoption of steel castings, I believe that in a few more years all steel castings will be made by the Bessemer or an equivalent pneumatic process.

OPEN-HEARTH STEEL CASTINGS. — I am glad to be able to say positively that this method can now be relied upon to make a very large class of important castings with entire success. Mr. Holley has given such a thorough and admirable description of this process that I cannot refrain from quoting it in part, omitting details, after which I will confine my remarks to some of the difficulties that a practical study of the subject has developed, and to the chemical and physical qualities of the castings. Mr. Holley says:*

"The operation consists: 1. In the formation of an initial bath of manganiferous pig to prevent oxidation during the process. 2. In dissolving such softening or decarbonizing materials as wrought iron in this bath. 3. In the addition, at the end of the operation, of silicon and manganese in such order and proportion as to prevent the formation of blow-holes while casting, and at the same time give to the steel certain special physical qualities.

"Another very important feature of the process is the method of taking tests. We

* Solid Steel Castings for ordnance, structures, and general machinery by the Terrenoire process. By A. L. Holley, C. E. (reprint from the *Metallurgical Review*, New York, 1878, vol. ii, p. 205).

will now describe in detail the different stages of the operation, and we will suppose at first, so as to avoid confusion, that the metal to be produced is of the harder kind.

"The Furnace. — The object of greatest importance during the whole of the operation is to keep oxidation as low as possible in the bath. For this reason the furnace must, indeed, be kept as hot as possible, with a good solid body of flame; but there should be only just enough air admitted to promote thorough combustion.

"The Initial Bath. — This must be made of pig iron containing from six to nine per cent. of manganese. Spiegeleisen is probably the most convenient form of pig; but, as spiegel with this percentage may not be at hand at all times, the bath may be formed by taking a richer spiegel, say twelve to fourteen per cent. manganese, and diluting it with one-half ordinary pig containing no manganese. . . . The weight of the initial bath, in proportion to that of the whole charge, varies according to the conditions under which the heat is made. We may say, generally, that eleven per cent. of the whole is an average quantity. Every open-earth melter knows that it is impossible to determine in advance the exact quantity of pig wanted for the operation. The temperature of the furnace has much to do with it. The nature of the refining material has also a great influence. If a specially pure product is required and the softening materials used are very fine puddled blooms, nearly free from carbon and manganese, the initial bath must necessarily be larger, as well as richer in manganese; it may in this case reach fourteen per cent. of the whole charge. The materials for the initial bath are always charged cold. . . .

"The Softening or Refining Materials. — Soon after the bath is completely melted the refining materials are successively added in small lots of about 450 pounds each. These are invariably preheated, as charging them cold and frequently would tend to keep down the temperature of the bath. . . .

"The materials used in this second period of the operation are chosen with reference to the quality required in the finished product. They may be good Bessemer open-hearth scrap, fountains from previous castings, puddled bars or directs blooms. Materials inferior to these would correspondingly lower the quality of the product. . . . The proportion of refining materials to the whole charge averages seventy-eight per cent. . . .

"Slag Tests. — Spiegeleisen is used for the initial bath, because the manganese it contains, being the most oxidizable of all the materials present, will remove oxygen that may be present in the bath, and will intercept oxygen that tends to enter it; so that the more manganese there is in the slag the less oxygen there will be in the metal below. Oxide of iron tends to make a slag black; manganese turns it light olive or ash-green, and the different tints between these two extremes give to the practiced eye an exact idea of the state of the oxidation of the bath. . . .

"Metal Tests before the Final Additions. — The slag test gives no indication of the physical state of the metal, which is an equally important guide in the operation. When, therefore, the operator has reason to believe that the metal is approaching the point of sufficient softening or purification, he makes the following tests: A ladleful of metal is taken from the furnace and cast into a round ingot about three inches in diameter and one and one-fourth inches thick. The ingot is knocked out of the mold as soon as set, and flattened under a special steam hammer, at its original heat, into a disk about seven inches in diameter and three-eighths inches thick. . . . From bending and fracturing these disks the operator can judge of the state of his metal with great nicety, and has at hand all the necessary elements to remedy any unfavorable tendency likely to develop during the operation. . . .

"The Final Additions. — These consist of a special pig containing both silicon and manganese, and also an additional quantity of manganese introduced in the shape a fifty or sixty six per cent. Mn ferromanganese. A part of these ingredients is taken up by reactions which prevent the formation of blow-holes: the remainder is left in the metal to impart to it certain physical qualities. The usual charge consists of eleven per cent. of special pig having the following composition:

Mn, ...	3.50
C, ...	3.00
Si, ...	4.20 to 4.60.
P, ...	0 10

" . . . The proportion of ferromanganese used varies from 1 to 1.8 per cent. of the total charge. . . .

"The special pig is charged hot. While it is melting a marked change takes place; the bath, which up to that time had bubbled about as much as in the ordinary pig and scrap operation, becomes gradually more and more quiet until its surface is smooth and scarcely broken by small and widely-scattered bubble. When the special pig is nearly all melted the ferromanganese is thrown in hot. The bath is then rabbled vigorously for about a minute, and casting takes place immediately."

BLOW HOLES.— It is commonly supposed that blow-holes in castings are due to carbonic acid gas disengaged during the operation of casting. This is only true to a very limited extent, especially where the steel contains 0.1 per cent. or more of silicon. Herein lies the cause of the many failures connected with the manufacture of steel castings. The manufacturers had been led to believe that it was only necessary to add a few pounds of ferrosilicon to their steel, and, presto! all the castings would be solid. Practical experience has proved the fallacy of this idea. Blow-holes in steel which has been properly melted, and to which has been added sufficient ferrosilicon, are almost entirely due to the high melting point of low-carbon steel, or rather to the rapidity with which the metal chills. This is proved by the fact that the lower ends of castings which have been fed from the bottom by means of a runner are always solid, while the blow-holes, when such exist, are always on top. Out of the thousands of castings we have made, I have never yet seen a single one with blow-holes where the gate joined the casting. The metal does not remain fluid long enough to allow the air and other gases that are mechanically carried into the mold to escape.

If water from a faucet passes through a tube, it carries the air along with it. If we could instantly congeal the water, the resulting ice would be full of holes. So it is with steel, only more so, since the molten metal is not nearly as fluid as water. As a consequence of the metal meeting the relatively cold mold, by the time the metal reaches the top of the mold it is very much less fluid, in fact, almost pasty, against the sides, and solidifies instantly without further provocation. If there are any corners, the air is confined in them, and in its efforts to escape through the pastry mass, furnishes (as a cooling agent) the last requisite necessary to solidify the metal. The air is thus imprisoned, and the casting defective. What is necessary, therefore, for a perfect casting in the above case — or, indeed, in any case — is a free circulation of the metal. If the mold can be obtained full of fluid metal, the resulting casting will be solid — that is, free from blow-holes. It may have a hole in the center due to shrinkage, but such holes are entirely distinct from the blow-holes, as will be explained below, when I come to speak of shrinkage. The difficulty connected with blow-holes, as will be seen by an inspection of the 2,000 pound cast-steel roll before you, we have almost entirely overcome by putting on top of the casting a rising head from two to three feet high. By this means we have been able to make 6,000-pound steel rolls without a single blow-hole or flaw of any kind, and and now we rarely lose a casting of this simple type. The long riser is effective in two ways — first, it carries from the casting proper the sluggish metal which has been cooled in its passage through the mold, and allows the mold to be filled with hot fluid metal; and, second, the ferrostatic pressure of a column of iron three feet high is equal to about ten pounds to the square inch. This pressure has a tendency, of course, to force the metal into all the corners and make it solid. It also prevents in a measure shrinkage troubles, and appears to give to steel castings that solidity for which they are noted, giving them a density of 7.8, almost equal to that of a forging.

SHRINKAGE.— The second serious trouble encountered by the steel foundryman is shrinkage. This presents a difficult and troublesome problem, which has not as yet been fully solved. It is almost impossible to make certain large, thin, complicated castings of steel. Shrinkage troubles are caused by the immense contraction of cast steel, which frequently amounts to $\frac{5}{16}$ inch per foot, and to the hard, dry sand molds which it is necessary to use in order to prevent the white-hot metal from destroying the mold. There are five different ways of attempting to remedy this evil: 1. By changing the chemical constitution of the steel. 2. By stripping the castings as soon as poured. 3. By mechanical pressure. 4. By large rising-heads. 5. By care in molding.

CHEMICAL CONSTITUTION.— A change in the chemical constitution, by increasing the manganese and diminishing the silicon, will nearly always have the desired effect. This renders the metal more fluid and lowers its melting point.

STRIPPING.— A large number of castings can be saved from tearing apart or cracking when cooling by simply opening the flasks immediately after pouring, and covering the casting with sand.

MECHANICAL PRESSURE.— We have been able to save quite a number of difficult castings by means of mechanical pressure. For example, at one end of a flask, and immediately at the end of the molding, a small iron plate is placed. This plate is attached to a screw which can be turned from the outside of the flask. The arrangement is admirably adapted for castings large at both ends and small in the middle.

RISING-HEAD.— A large rising-head prevents shrinkage-cracks by the pressure it exerts and by feeding the metal to points where shrinkage is taking place.

MOLDING.— Many castings can be saved from shrinkage-cracks by an intelligent molder. It would be useless for me to enter into details on this subject. Suffice it to say that every pattern is a study; and it is only by an intelligent application of the knowledge already gained that it is possible now to make castings that a few months ago it would have seemed ridiculous to attempt.

SHRINKAGE-HOLES.— Shrinkage-holes in castings are exactly similar to the phenomenon called "piping" in crucible steel. They are very troublesome and difficult to prevent, although they rarely affect the value of a casting, coming as they do in the center. They are caused, of course, by the metal chilling before the immense shrinkage occurs. Then when the contraction does take place on all sides, but away from the center, there is no more fluid metal to run into the space thus made vacant.

PHYSICAL AND CHEMICAL PROPERTIES.— The most important chemical difference between cast steel for casting and ordinary open-hearth or Bessemer steel is in the amounts of silicon they contain. Many eminent authorities maintain that silicon is a hardener, and increases, therefore, the tensile strength, like carbon (although in a lesser degree); but I have not found this to be the case in my experiments. On the contrary, I have always found it to diminish the tensile strength, and when above 0.5 per cent. to destroy almost entirely the elongation or ductility, making the metal very red-short and brittle when cold. It may have been that the silicon in the steel that we tested was present as silicic acid, but this could hardly be the case in samples made by the crucible process in black-lead pots. Such steel made from the best Bessemer muck bar, to which had been added sufficient ferrosilicon to make over 0.5 per cent. of silicon in the steel, only showed a tensible strength of from 40,000 to 50,000 pounds per square inch in perfectly solid test bars, whereas the same mixture with less silicon (but higher manganese, however) invariably gave higher tensile strength. The only explanation that I can suggest, which will at all account for the exactly opposite conclusions of the above-mentioned eminent authorities, is that it is probable that silicon exists in steel both as combined and as graphitoid silicon. In the former case it might act like combined carbon and be a hardener; in the latter it would act like graphite, and undoubtedly would be at least indirectly — or, so to speak, negatively — a softener.

Another important difference is the comparative wide limits between which the carbon, silicon, and manganese may vary in castings without affecting to an important degree the physical results. Such wide variations in steel rails or plates are now quite unknown. The influence of carbon on steel is better known than that of any other substance which enters into its composition. No one, however, so far as I am aware, has done anything more than formulate the general law that tensile strength increases with the carbon, other things being equal. I have made the interesting observation that this increase is almost exactly 1,000 pounds for every 0.01 per cent. of carbon. That is to say, assuming 0.01 per cent. of carbon to be a unit of carbon, then if to 45,000 pounds (the tensile strength of pure wrought iron) we add as many thousand pounds as there are units of carbon we shall be able to make a very close approximation to the tensile strength. Boiler-plate steel, for example, has about 0.15 of carbon, and 15,000 + 45,000 = 60,000 pounds, or about the tensile strength of boiler-plate steel. Rail steel has about 0.30 carbon, and 30,000 + 45,000 = 75,000 pounds, or about the tensile strength of rail steel. Again, crucible steel contains from 0.50 to 0.85 carbon, from which numbers we get in the same way 95,000 and 130,000 pounds respectively, which include the range of tensile strength of various kinds of tool steel. Still again, a sample of spring steel showed 1.0 carbon; its tensile strength should therefore be 145,000 pounds. Its actual tensile strength, as tested at Altoona, was 143,000 pounds.

Of course this law only holds good where other things are equal. An undue amount of one or all of the other foreign substances that enter into the composition of steel, or unusual physical conditions, would change the results entirely. It may be of value, however, as an indication that, when steel with a known amount of carbon does not possess a certain tensile strength, then the other substances entering into its composition are present in undue proportion, or it must have been made under unusual physical conditions. The above law is not applicable to castings, where the presence of so much silicon affects in a notable degree the tensile strength derived from a given amount of carbon, and the physical properties are also affected by the fact that the metal has not been worked. Manganese plays an exceedingly important and valuable part in the manufacture of steel castings. Low-carbon steel, to which has been added about 0.3 per cent. of silicon, is very pasty, and can be poured without chilling into the largest castings only. Manganese will correct this trouble to a great extent, although somewhat at the expense of softness and ductility. The castings, however, as we have seen above, are more apt to be solid and less liable to crack in the molds, the metal being much less red-short. We must remember, in studying the physical characteristics of steel castings, that we are dealing with a material that has not been worked in any way, either by the hammer or rolls. I give below the results of a few chemical and physical tests.

Test No.	Carbon.	Silicon.	Manganese.	Tensile Strength	Elongation in 2 inches, per cent.
3	0.11	0.49	0.61	63,000	12
4	0.23	0.19	0.43	68,000	12
6	0.38	0.39	0.25	55,000	9
29	0.27	0.38	0.39	70.000	8
120	0.28	0.26	0.38	64,000	7 05

I also give the analyses and tests of the Terrenoire metal: *

Charge No.	Carbon.	Silicon.	Manganese.	Tensile Strength.	Elongation per cent.
2,078 } 2,262 }	0.26	0.26	0.41	{ 66,500 { 68,000	12.8 13.8
18	0.317	0.30	0.48	80,700	14.8

The physical tests in both cases were made on the raw metal; annealing about doubles the elongation without greatly affecting the tensile strength. It will be seen from the above tables that the steel made by the Standard Steel Casting Company compares favorably with that of Terrenoire, which is the best cast steel of which we have any records. The steel in the case of the last three tests in Table I was not made for the purpose of developing the highest possible elongation.

Notwithstanding the excellent results that have been obtained at Terrenoire and other places on the Continent, I am convinced, after a careful study of the subject, that the highest attainable physical qualities in a casting can only be secured by compression. That is to say, although we are now able to make perfectly solid, soft, strong steel castings having a reasonable amount of ductility, the solidity is obtained at the expense of the ductility. Now if we were able to retain this ductility to its greatest possible extent, a casting would be of far greater value than a forging. This can be secured by compression or by no-silicon steel, if consumers could be educated to use steel with blow-holes. A case in point is the forged-steel shaft of the Dolphin. A shaft cast to its shape under compression would never have broken under the same test. Even an ordinary steel casting would have been far superior to that shaft, for the metal would at least have been solid and free from that spongy unworked condition due to heating up and cooling down, and to the insufficient power of the hammer to properly work the metal.

There is a popular fallacy in this country that steel castings can be made in England and on the Continent without any trouble from blow-holes. But the *Mechanical World* of February 7, 1884, speaking of Mr. Alfred Davy's process, says: "It Mr. Davy opens up to iron founders a means of making either steel or iron castings with little more than iron-foundry plant, he will confer a benefit on the engineering profession. Perhaps he can also show the users of his patents how to make sound steel castings. If so, much will have been done, for those much to be desired articles are yet a rarity even in the most advanced establishments."

THE average or mean density of the matter of which the earth is composed is between $5\frac{4}{10}$ and $5\frac{6}{10}$ greater than that of water.

THE electric resistance of most fine metals decreases regularly where the temperature is lowered. From recent experiments it seems likely that at 200° C., or 328° Fahr. below zero, the resistance would be very slight.

THE most rapid piece of artesian well boring of which we have any record is fifty feet of five inches diameter in a day of eleven hours.

THE number of passengers transported in the year 1884 by all the American railroads was, according to *Poor's Manual*, 334,814,529, the average distance traveled by each passenger being $26\frac{24}{100}$ miles, and the amount received per mile per passenger was $2\frac{356}{1000}$ cents.

* From Mr. Holley's paper, already cited.

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The Locomotive.

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A Dangerous Mud-Drum.

A very disastrous explosion of a mud-drum occurred but recently in one of our large cities, by which five persons lost their lives, and some twelve others were scalded more or less severely, all being employees who were at work in proximity to the boilers with which the exploded mud-drum was connected.

The boilers, of the flue type, were in a battery of four, each forty-two inches in diameter and twenty-four feet long. Natural gas was the fuel used. The steam-drum and connections were above the boilers, and the mud-drum connections to the bottom of the boilers were made as such commonly are where this form of boiler is used. They are plainly shown by the illustrations, and as such details appear to be of secondary importance in this case, the foregoing brief description is thought to be sufficient.

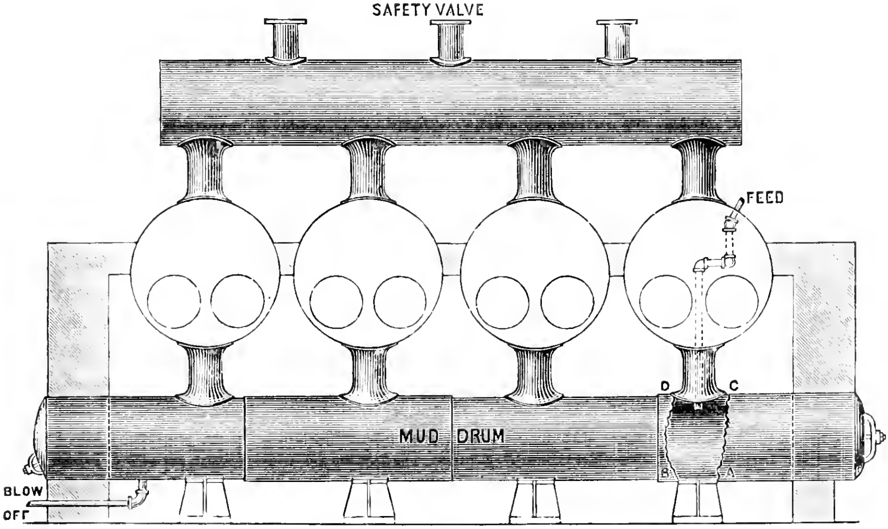

Fig. 1.

In connection with these boilers there was an open heater, into which two of the mill engines exhausted. The feed-water, after passing through this heater, was pumped into one of the outside boilers through a patent feed-water heater largely used in that locality, which may be described as a pipe placed in the boiler above the water-line, so that the feed traverses a considerable distance exposed to the temperature of the interior of the boiler before it is discharged.

In this case the feed attachment was upon the top of the boiler, upon the second course of shell plates, and the connecting pipe extended nearly to the front head, then curving by an elbow it returned to the back end and dropped down between the flues of the boiler, it discharged through an open-ended two-inch pipe at the mouth of the lower neck connection to the mud-drum, a distance of some forty-five feet from its place of entrance, as will be made apparent by reference to Fig. 2.

The mud-drum which exploded was built in March, 1884, of iron one-quarter of an inch thick, and replaced another drum that had been in service under the same battery of boilers for a period of over seven years.

In the early part of February, 1885, about ten months after the new drum was put in service, it was noticed by an inspector of this Company that there were some patches of internal corrosion upon the drum; not sufficient in amount to weaken it, or to cause any apprehension on the inspector's part, and a policy of insurance was issued, limiting the load upon the safety-valves to 100 lbs. per square inch.

In the latter part of the same month (February, 1885), the county inspector and his deputy made their annual inspection, and issued a certificate certifying to the safety of the boilers and attachments for one year, at a steam pressure not exceeding 110 lbs. per square inch, in conformity to a law governing the inspection of steam boilers in that locality.

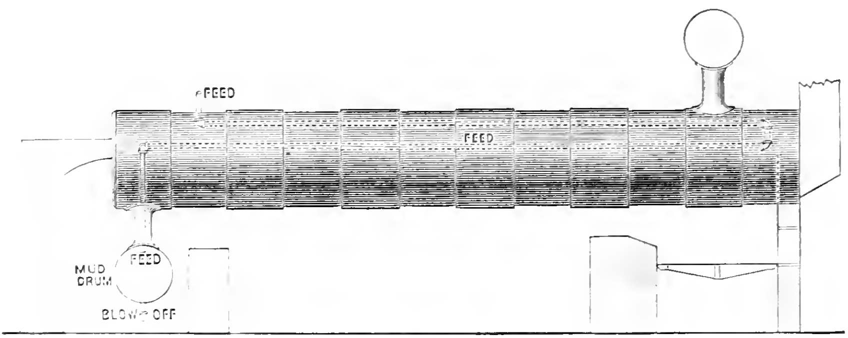

FIG. 2.

In May, 1885, another inspection was made by this Company, and the drum found to be in about the same condition as previously found, the depth of the corrosion at that time not exceeding one sixteenth of an inch thick. This was a common experience with mud-drums in that district, and there was nothing developed by that inspection out of the ordinary course, that might cause any apprehension on the part of an inspector.

On Oct. 2, 1885, this drum exploded under a steam pressure of 100 lbs., with disastrous effect, as previously described, and it was found that a portion of the plate upon the bottom part of the drum, immediately beneath the outlet of the feed discharge-pipe, and over the stand, had wasted away from its former thickness of one-quarter of an inch to less than one-sixteenth of an inch. This thinning covered an area of about one hundred square inches; but the dangerously thin part immediately beneath the feed discharge was of much smaller dimensions. As this part rested upon the stand, it was difficult to detect it by a hammer test, and it is very doubtful if a hydrostatic test would have revealed it either, (?) for the stand beneath would have re-enforced and prevented the buckling of the weak part of the plate.

The explosion was probably caused by the fracture of this thin plate in a longitudinal direction. This stripped off a piece of the lower part of the drum, which straightened out and turned up on each side. The effect of the escaping contents of the drum and boilers through the opening thus provided, would be to raise the boilers off their supports. The end of the drum being bricked in the wall, momentarily resisted this movement: but the end of the drum was torn off nearly on line with the wall, and projected some fifty feet, and the walls of the setting thrown down. The steam connections were broken, and the mill instantly filled with steam and scalding water. The fractures will be better understood by reference to Figs. 1 and 2.

It was customary to wash out each battery of boilers in the mill once in three weeks. This was done under the supervision of the chief engineer, a very competent and experienced man. He stated this duty was last performed less than three weeks before the explosion, and that he saw no indications of weakness at that time.

An examination of the unruptured portion of the mud-drum made immediately after the explosion, showed considerable internal pitting and corrosion of the shell and heads, though not sufficient at any of these places to appreciably weaken the structure, while its external surface was remarkably free from leaks or defects, and the glazed finish of the plate was scarcely disturbed.

Upon some of the adjacent boilers there were mud-drums put in at about the same time as this one which had exploded, and there was some solicitude felt lest they might be in the same dangerous condition. They were carefully examined and tested at once, and found to be in good condition. It was evident now that whatever the cause might be that so dangerously weakened the exploded drum, it was confined to this one battery of boilers, for the arrangement of boilers and attachments were alike in other respects than the feed, which, on the exploded battery, was different from the others.

An examination of the boilers and the mud-drum of the exploded battery failed to show the presence of grease, or other substance that might account for such a remarkable wasting of the plate in so short a time. There was a sight-feed lubricator upon each of the two engines that exhausted into the heater from which the boilers received their feed. This would prevent the use of a wasteful quantity of oil; but the quality of the oil used there had never occasioned us trouble elsewhere. Nor was there probable cause, after a careful examination, for believing that it had anything to do with this case, though a cause of much trouble in many other cases.

It had often been found that a feed discharging against the plates of a boiler had occasioned a wasting of the plates. This would probably vary in intensity according to the character of the water and temperature of the feed. If fine sand or dirt were present it would cut the surface of the plates acted upon still more rapidly, and after the skin of the iron had been penetrated, the work of destruction might be expected to proceed with great rapidity. But we should not look for sand or dirt in sufficient quantity to be harmful in the city water with which these boilers were supplied, and the fact that the previous drum had lasted over seven years under precisely the same conditions, as we were informed, and that many other boilers in the same locality use the same feed attachment, would seem to justify the belief that this arrangement of feed, though objectionable, is not always dangerous unless combined with the other destructive elements.

The dangerous weakening in the same boiler or some parts of a plate, by pitting and corrosion, while other parts or the adjacent plates are untouched, is plausibly explained as due to structural differences in the plate, and may have been an important factor in this case.

The facts upon which the foregoing is based were developed at the coroner's inquest. The jury selected by the coroner to hear this case were of more than average intelligence, two of their number being practical engineers. The investigation was patiently conducted, with an evident desire to learn all the facts, and extended over a period of nearly three weeks. Their verdict attributed the explosion to the rupture of the mud-drum, and censured the county inspector, the deputy county inspector, and the chief engineer of the mill, for not detecting the corrosion which caused the explosion.

Before closing this article it may not be amiss to say a few words about mud-drums, although we have written and said so much on this subject at different times, that much of it may be a repetition. Readers of the LOCOMOTIVE will bear testimony to the fact that we have little faith in mud-drums, for that useless appendage (as we deem it) does not accomplish the purpose for which it is used, while it is a source of danger and expense, and whatever need may have existed for such an attachment when it was first introduced, can be accomplished, so far as stationary boilers are concerned, in a safer, cheaper, and better way to-day by other means.

But we are well aware that in some parts of the country a steam boiler without a mud-drum attached is considered incomplete, and is regarded with little favor. To those who hold this belief, we would suggest that the use of such drums may be made safer by attaching them in such a way as to permit a thorough examination at all times.

Boilers with mud-drums should be supported by hangers or wall-brackets, according to circumstances, and never by stands beneath the drum; and the blow-off should be in the bottom of the drum at its lowest point, so that it may be effectually drained through the blow-off pipe. The feed should not enter the mud-drum. It is much safer and better to introduce it on top of the boiler, or at the water-line, through the front or back heads. But in any case this work should be done under the supervision of an inspector, who will make suitable provision for running the pipes properly, and discharging the feed at the safest place.

Our inspectors condemn a large number of mud-drums every year. We have sometimes felt that our assured regarded us as being too critical in this matter. But we knew that we were right. Some remarkable experiences have been related to us by steam users of mud-drums that they had sometimes used until decayed to a mere shell. We regarded such an experience as being particularly unfortunate for them, if it afterwards caused them to take dangerous risks,— risks that might end in an appalling disaster.

Inspectors' Reports.

OCTOBER, 1885.

The summary of the work done by the inspectors of the company during the month of October last shows 3261 inspection trips; 6455 boilers visited; 2143 boilers thoroughly examined, both internally and externally; and 602 tested by hydrostatic pressure; 4064 defects were reported, of which 598 were considered dangerous, and led to the condemnation of 48 boilers. Our usual statement of defects is given below:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment.	380	51
Cases of incrustation and scale,	541	26
Cases of internal grooving,	26	6
Cases of internal corrosion,	185	44
Cases of external corrosion,	371	67
Broken and loose braces and stays,	55	26
Settings defective,	164	21
Furnaces out of shape,	206	17
Fractured plates,	140	66
Burned plates,	117	26
Blistered plates,	314	24
Cases of defective riveting,	274	20
Defective heads,	46	10
Serious leakage around tube ends,	555	96
Serious leakage at seams,	173	16
Defective water-gauges,	124	8

Nature of defects.	Whole number.	Dangerous.
Defective blow-offs,	46	11
Cases of deficiency of water,	20	10
Safety-valves overloaded,	34	13
Safety-valves defective in construction,	68	10
Pressure-gauges defective,	221	30
Boilers without pressure-guages,	4	0
Total,	4,064	598

We are glad to see that the very important question of riveting is beginning to receive the attention from boiler-makers that it deserves. Very few years ago boiler-makers, almost without exception, were riveting their plates up in exactly the same manner that it was done fifty years ago. The pitch for every thickness of plate was about two inches, and it was the same for both single and double riveted joints. We have long urged that this practice was wrong, both theoretically and practically, but were met by the boiler-makers with the ancient argument that it was impossible to make a tight joint with pitches of over two inches; and as to double riveting, why, two rows of rivets were of course twice as strong as one row. This is true, as far as the rivets were concerned, but when one row is stronger than the plate section left after punching the holes, the utility of the second row is evidently more apparent than real.

As to the impossibility of making tight joints with rivets spaced over two inches apart, we can only say, let those who have tried the wider pitches decide the question. We will, however, give the testimony of two foremen, boiler-makers, one of whom is at the head of the boiler-shop of the largest locomotive-building establishment in the world, and the other at the head of a large iron works in New England. They both agree upon the point that where a wide pitch is used, it is not only easier to *make* a tight joint, but it is easier to keep it tight under the conditions of every-day use. To the truth of this latter statement we can bear witness ourselves. We can also add that, in the last-mentioned shop, where we inspect and test by hydrostatic pressure all the boilers sent out, we find invariably tighter joints on new work when the pressure is applied than we do anywhere else. At this shop the pitch for longitudinal double-riveted seams in five-sixteenths and three-eighths plate is about 3¼ inches. The riveting is all "button-set." Many boiler-makers will claim that good work cannot be done with the "sett"; but, with all due respect to their skill and experience, we must say that when a man makes such a statement he simply pleads ignorance, or his own want of skill. In conclusion, we will simply say that the intelligent use of the table of proportions of riveted joints given by us on page 102, Vol. III, of the Locomotive, will enable a boiler-maker to make better work at a *less cost* than he can do by blindly adhering to the practice of half a century ago.

Boiler Explosions.

OCTOBER, 1885.

Iron Works (110).—Shortly after 3 o'clock A.M., October 2d, the mud-drum of a battery of boilers at the Solar Iron Works of Clarke & Co., on Thirty-sixth street, Pittsburg, Pa., exploded with disastrous effect. The night turn had just been relieved by the day force when the explosion occurred, and that portion of the works in the vicinity of the boilers was filled with a cloud of steam; seventeen persons were scalded, of whom five have since died.

Locomotive (111).—The boiler of the locomotive drawing the Long Branch express train, which left Camden at 4 o'clock, exploded near Brown's mills, N. J., October 3d, fatally scalding the engineer, John Curtis, and injuring the fireman. Other persons are reported injured.

LOCOMOTIVE (112).—The boiler of locomotive No. 284, on the Philadelphia & Reading railroad, which was drawing a coal train through the coal-yards at White Haven, Pa., burst October 5th, blowing the engine to pieces and hurling heavy pieces of iron a great distance. The engineer, Samuel Swartwood, was severely hurt. The conductor was also injured.

PLANING MILL (113).—The boiler in C. B. Tylor's planing mill, at Circleville, Ohio, exploded October 9th, demolishing the mill, a large three-story brick, and seriously injuring the engineer and several other persons. Loss on building and machinery, $5,000 ; insured for $2,500 against fire, but as this was a boiler explosion the loss will be total.

——————— (114).—John Starr, fireman, was killed, and Thomas Nichols fatally injured at Tascumbia, Ala., October 13th, by the explosion of a boiler.

SAW-MILL (115).—The boiler of C. M. Bennett's saw-mill on the Pine Ridge, forty-five miles east of Fresno, Cal., exploded October 15th, killing the engineer, Parson Bennett, brother of the owner of the mill. This is the third fatal accident that has occurred in the mill in three months. Bennett's head was blown completely off.

GAS WELL (116).—A terrible explosion occurred at Greenville, Mercer county, Pa., October 19th. Andrew Hillig was drilling a natural gas well, when the boiler exploded with terrible force, killing Henry Post, aged 65 years, and seriously wounding several others. Fragments of boiler iron dashed through a barn standing near, almost completely wrecking the structure. Windows in the vicinity were shattered by the concussion, and pieces of the boiler were picked up 500 feet from the scene of the explosion.

STEAM-TUG (117).—The boiler of the tug *Admiral D. Porter*, burst Sunday, October 18th, scalding Thomas Arfinetta badly, and William Kirbly so badly that he died.

SAW-MILL (118).—The boiler in the steam saw-mill of J. A. Quackenbush, near Ridgeville, S. C., exploded at daylight, October 20th, killing two men and one boy. Three others were terribly scalded, and one is missing.

DREDGING MACHINE (119).—The boiler of a dredging machine, at work in Stonington Harbor, Stonington, Conn., exploded October 23d, instantly killing Captain Henry Sheffield, of the steam yacht *Firefly*, and injuring Thomas Colbert, Grove White, and Stephen R. Burdick. White and Burdick are badly scalded, but they not thought to be fatally injured. Colbert, besides being scalded, is cut about the head, and his injuries are regarded as serious. At the moment of the explosion Captain Sheffield was stepping from the dredge to his yacht. His body was shockingly mutilated.

KAOLIN WORKS (120).—The boiler of Manly's Kaolin works, near Brandywine Summit, Pa., exploded about 7 o'clock A. M., Oct. 26th, and the engineer buried in the wreck.

COOPER SHOP (121).—The mud-drum of the boiler in the Cincinnati Cooperage Company's works at Riverside, Ohio, blew out with terrible force October 28th. George Stanley, aged 23, the engineer, was badly burned about the face and body. William Coleman, 20, colored, received similar injuries, and will probably die, and Anderson Bush, colored, was badly, but less severely injured than the others. They were all taken to their homes at Sedamsville, Ohio. Stanley and Bush will probably recover. Cause of the explosion is unknown.

STEAMER (122).—The boiler of the steamer *Miles* exploded at Duluth, Minn., October 29th, and engineers Hickey and Rooney were scalded to death by escaping steam.

LAUNDRY (123).—A steam-drum in Robert & Robert's laundry, at 324 West Twenty-sixth street, exploded October 30th. A number of young women employed in the laundry were scalded by the escaping steam before they could get to the street. The following were taken to the hospital more or less badly injured: Mary Herrick, 16 years old; Minnie Callan, 15; Kate Murphy, 15; Ethel Grazer, 16; Margaret Bowers, 16; and William Dooley, 18.

The Locomotive.

HARTFORD, DECEMBER, 1885.

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.

With this number closes the sixth volume of the Locomotive in its present form. The past year has been, on the whole, an uneventful one for the country. The manufacturing interests have been fairly prosperous, and the outlook for the future is very promising. While no boom has been experienced in any department of business, there has been during the past few months a substantial improvement, which is manifest by a better feeling all around. The bottom of the industrial depression has been reached, the shrinkage in values has reached its limit, and from this time onward, we may reasonably look for steady improvement in all departments of business. Let us hope that we may be spared a "boom," with its inevitable reaction.

The Locomotive has endeavored during the past year as during the preceding years of its publication, to give its readers the benefit of our varied experience in the care and management of steam boilers. We are constantly watching the behavior of all kinds of steam boilers, running under a great variety of conditions. We believe our experience is broader than that of any other corporation or individual, and the information thus gained to be of correspondingly greater value, both to boiler owners, and their engineers, and other employees. The results will be cheerfully given in the future, as in the past, for the benefit of our patrons.

The manufacturers of the country have been more than usually fortunate during the past year in the matter of boiler explosions. Few very destructive ones have occurred, and the loss of life has been unusually light. The iron manufacturers have been especially fortunate. We note also almost an entire absence of these terrible disasters on our western river steamers.

It is to be hoped that this year will not prove an exceptionable one in this respect. Let us hope that the record will be better and better with each succeeding year. This will surely be so, if those in charge of steam plants exercise the requisite prudence, and educate themselves in their important specialty.

It is unfortunately true that there has been in the past, a great deal of superstition in the make-up of the ordinary engineer. Various fallacies have obtained so firm a foothold in their belief that many precautions that would otherwise have been taken, have been neglected. These fallacies and superstitions have generally taken the form of some theory of explosion over the conditions of which man had no control. We are glad to see that this is passing away, and that the fact is beginning to be recognized that boiler explosions, like all other accidents, are *always* due to defective material, weak construction, ordinary deterioration, or carelessness in management. When these facts become generally recognized, then and only then can we look for effective precautions to be taken to prevent them.

An examination of the financial resources of the Hartford Steam Boiler Inspection and Insurance Company, made during the past summer by A. R. McGill, the Insurance Commissioner of Minnesota, and J. J. Brinkerhoff, the Examiner for Illinois, shows the condition of the company to be in every sense satisfactory. It had on the 10th of August, $527,194.55 of good interest-paying assets, and, aside from its capital stock of $250,000, but $172,561.55 of liabilities. The investments of the company have all proved to be excellent, and the management has shown rare skill and ability in keeping the losses down to a minimum. This is due largely to the company's thorough system of inspection, by which the expenses are limited in a large measure to the preventive department. An investigation by outside examiners was deemed advisable, on account of adverse reports circulated in the Northwest by an unscrupulous competitor, but the report now made public will completely silence such an unworthy attack.—*Scientific American.*

We would call especial attention to the paper in another part of this issue, by Mr. Samuel Webber, on the *Frictional Resistance of Shafting in Engineering Establishments.* Mr. Webber has had a very broad experience in connection with the subject he writes upon, and may justly be considered the highest authority thereon.

Carelessness in the Boiler-Room.

"Familiarity breeds contempt" is an old saying, and it is unfortunately true that it holds good in the boiler-room. In this case it would be wise to add to the old saw, "and contempt breeds trouble," for many accidents may be traced to the carelessness in the management of boilers which naturally follows long connection with them. Especially is this apt to be the case when a man has been so fortunate in his management of a boiler-plant for a long time as to have had no serious trouble with it.

It is customary with some mechanics to test new boilers, or old ones which have undergone repairs, by simply subjecting them to a high steam pressure. Why any intelligent person should do this passes our comprehension. If a boiler is *known* to be strong enough to sustain a certain pressure, there is no earthly reason to subject it to that pressure. If it is not absolutely certain that it *will* safely sustain any given pressure, then it is the height of folly, and it incurs a risk that no man can afford to take, to apply that pressure in such a manner that, in the event of the boiler not proving strong enough to sustain it, an explosion will inevitably occur.

During the past year we have a record of at least three explosions, all attended by loss of life and great destruction of property, from this cause. The danger in such cases is usually greatly increased by caulking the seams, rivet-heads, etc., where leaks exist while the boiler is under pressure.

Another dangerous practice is the caulking of joints in steam pipes while pressure is on. If pipes or fittings are corroded, as they very frequently are in such cases, there is danger that the chisel or caulking tool may be driven through the pipe. In such a case the sudden escape of steam is more than liable to seriously scald the workman. Quite recently, in a neighboring city, a workman was so seriously scalded in this manner that he died from his injuries. The practice is a very dangerous one, and should never be allowed. Of a similar nature to the above, and one which should be as strongly discountenanced, is the practice of screwing up man-hole, hand-hole, and similar plates while boilers are under steam, to stop leakage. A great many accidents have been caused in this manner. A few years ago a battery of three horizontal tubular boilers were fired up, and on raising steam the joint of one of the man-hole plates was found to leak quite badly. Instead of letting down the steam and repacking the joint, a wrench was applied, and the attempt was made to stop the leak by screwing up on the bolt. This proving insufficient, a long piece of pipe was slipped over the handle of the wrench, and more force applied. The immediate result was the fracture of the man-hole frame, the explosion of the boiler, the destruction of about $10,000 worth of property, and the loss of three lives.

Only a few months ago a similar accident occurred in a large city in one of the Middle States, but in this case the boiler was of the sectional type. A cap covering the end of one of the water-tubes began to leak, and two men, armed with a 24-inch monkey-wrench, attempted to stop the leak by screwing up the nut on a $\frac{7}{8}$-inch bolt, with 100 pounds of steam on the boiler. Result: one man killed, and two others badly scalded.

Several bad accidents have also happened through the carelessness of men who have tried to take off man-hole and similar plates while boilers were under steam. This may appear incredible, but it is nevertheless true. Only a short time ago one of our inspectors, while making quarterly visits in a neighboring city, entered a boiler-room, and found a man trying to remove a man-hole plate with twenty pounds of steam on the boiler. He had removed the nut from the bolt, and was trying to drop the plate (in this case the boiler was provided with an internal man-hole frame) into the boiler. He had just begun the job, and the plate, owing to the great pressure on it, had fortunately so far resisted his efforts to dislodge it. It may be inferred that he had a pretty loud call to "get down off that boiler," and very fortunate for him it was, too.

A few months ago a very bad accident occurred in a rubber works, where two men attempted to remove the head from a vulcanizer before shutting off the steam. These vessels consist of a cylindrical shell, and the goods to be vulcanized are put in at one end, and the opening closed by a circular plate or door, which is bolted to a flange on the end of the cylinder. After the men had removed some of the bolts, the steam pressure proved to be too great for the remaining bolts to withstand, and the head was blown out with great force, killing them instantly, and damaging the building and machinery to a considerable extent.

This list of accidents might be continued almost indefinitely, but we think we have said enough to call the attention of those interested to the fact that too much care cannot be exercised in the management of steam apparatus of all kinds. Eternal vigilance is the price of safety, and it is much easier and more practical to avoid accidents by the constant exercise of the greatest care than it is to dodge the fragments when an explosion occurs.

A Long Felt Want Supplied.

It has come at last. *Low water* has been *patented*, and hereafter any fireman or engineer allowing his boiler to get empty, infringes on U. S. Letters Patent, No. 329,446, dated November 3, 1885, and of course renders himself liable to prosecution and a claim for heavy damages. The damage to the boiler of course takes care of itself.

A brilliant genius "out West" has actually patented a "new and useful improvement in Processes of Treating Steam-Boilers for Preventing Fractures and Explosions," which improvement (?) consists in firing up a steam boiler while it is empty, heating it white hot if necessary and allowing it to cool gradually. The claim put forth by the inventor is, that when boiler plates become crystalized, through long use, this annealing process will restore them to their original condition, or, if the plates of the boiler, when originally made, were crystalized, the boiler will be materially bettered by the treatment.

This is really a great advance in boiler engineering. Of course no one wants to render himself liable to prosecution, so hereafter the firemen will keep a sharp lookout for his water-level, and see that it does not get so low that the patented process of "treating" the boiler will begin to operate. If this is done through carelessness, we hope the inventor will promptly be on hand with his claim for damages.

The inventor states that fuel containing *sulphur* should not be used in carrying out the operations of this "process." He evidently intends to make so much money out of it before he dies, that it will not be necessary for him to continue in the business after his death.

He also states that the customary inclosing walls constitute a suitable furnace or box for the application of the necessary heat to the boiler. He neglects to inform us whether his patent covers the setting of boilers up in brick-work or not: we presume it does.

He also informs us that his application is based upon a long series of tests with "actual steam boilers," both single ones and in batteries. He says at least one hundred boilers have been subjected under his personal superintendence, to his patented treatment. If this is so, he must have been an awfully careless fireman. We should dislike very much to have him fire a boiler for us.

The Frictional Resistance of Shafting in Engineering Establishments.

BY SAMUEL WEBBER, LAWRENCE, MASS.

A PAPER READ BEFORE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

A paper on the above subject, recently presented to the Society of Mechanical Engineers, seems to give an impression with regard to the amount of power actually consumed in overcoming said resistance, which differs widely from the results of the experiments of the writer of the present paper.

The reason for this discrepancy is to be found in the assumption made in the previous paper that indicator cards, taken with all the machine belts running on the loose pulleys of the machines, are a correct representation of the power absorbed by the shafting.

This is to be denied *in toto*, as the loose pulleys are only a part of the machine placed on it for the convenience of the operator, to avoid the delay and annoyance, and possible danger, of throwing the belt off and on the driving pulley on the shaft, every time that the machine is to be stopped and started again, and is in no sense a part of the shafting. When the machine is in operation the loose pulley is not in use, but the power is taken from the shaft to the machine by the machine belt, which latter is merely an accessory to the machine itself, which cannot be operated without it, while the shafting can be.

The writer knows that this method of taking indicator cards to ascertain the power consumed by the shafting, with the belts running on the loose pulleys, has been the usual and common one, but it is none the less erroneous, as it only arises from the unwillingness of the mill-owners or operatives to take the time and trouble necessary to throw the machine belts off for a few moments entirely while the indicator cards are being taken.

This amount of power consumed by the machine belts running on the loose pulleys, will average in a cotton mill fully 10 per cent., varying from 5 or 6 per cent. in the spinning-rooms to 18 or 20 per cent. in the weaving-room. This 10 per cent. is in this manner charged to the shafting, making an average, as given in the paper referred to, of 25.9 per cent. in a large number of mills for shafting and engine, which should not be over 16 per cent. in a properly shafted mill, and which is even much less than that in mills of modern construction, if the machine belts are thrown off before taking the indicator cards, a method of getting at the matter which has been accomplished by taking a Saturday afternoon for the purpose.

This 16 per cent. should be divided as follows: Engine 6 per cent.; shafting and belting 10 per cent., including in the latter all counter belts, and everything except the small belts actually driving the machines, to which their power, as has been said, should be charged, as they can neither be operated, nor their power weighed without them.

A number of years since, the writer had occasion carefully to weigh and determine the power consumed in a large cotton mill, which had just been entirely rebuilt and fitted with new shafting by one of the most judicious engineers in New England, and although the shafting was not of quite so small a diameter or run at so high a speed as has since been often adopted, it was very well arranged, and would serve as at least a fair example of good average dimensions, and not much heavier than I should advise to-day, taking into account the necessary stiffness to resist *transverse* strain, when belts were liable to be led from it at any convenient point to reach the different machines, rather than limiting it to the diameter sufficient to bear the *torsional* strain only.

The summary of the total power required by the machinery was 744.22 horse-power, and in making up the account of the whole, 10 per cent. was allowed for the shafting, but subsequently the latter was calculated, as a whole, from weighings which I had made of a large part of it, assuming that which I had not weighed to require the same power in proportion to its diameter and velocity. These calculations gave a total of about 62 horse-power, or only 8.3 per cent., instead of 10 per cent., and have been fully confirmed by many subsequent experiments.

The spinning-room in this mill contained 198 throstle frames of 128 spindles each, requiring at least 1.5 horse-power each, or 297 horse-power in all, and 12 filling winders and 13 spoolers, requiring also 21.75 horse-power, or a total of 318.75 horse-power. These machines were placed in ten parallel rows, lengthwise of the mill, and were driven by two lines of main shafting, each driving a set of machines direct, and two other sets to either side by counter shafts, each of which drove two machines. This made twenty-four short counters driven from each shaft.

The main shafts were each as follows: One length of 10 feet 4 inches, $4\frac{1}{8}$ inches diameter, receiving the main belt; then divided equally to the right and left in lengths of 16 feet each, 80 feet of $2\frac{7}{8}$ inches diameter, 32 feet $2\frac{5}{8}$ inches, 48 feet of $2\frac{3}{8}$ inches, and 32 feet of $2\frac{1}{8}$ inches; in all 202 feet 4 inches each. The countershafts were each 8 feet 6 inches long and $2\frac{1}{8}$ inches diameter, and the velocity of the whole was 216 revolutions per minute.

The required power to carry this shafting by dynamometer measurement was, for each main line, 1.587 horse-power, and the co-efficient of friction was only .0334. For each set of four counters, with their counter belts, the power was .357 horse-power, and the co-efficient of friction was .0413. The total power, therefore, for each system, was,

Main line	1.587 H. P.
Six sets counters, four @ .35, ...	2.142 "
or	3.729 H. P.
which multiplied by two, gives, ...	7.458 H. P.

as the total for the room, or only 2.34 per cent. of the power required for the machinery.

Now this is the extreme light point, as the spinning-room requires the least shafting, and uses the most power in the machinery of any room in a cotton mill. In a weaving-room for print cloths, the power for the shafting is about 20 per cent. of that required for the looms, or about the same as that absorbed by the machine belts running on the loose pulleys.

Having positively settled this fact in this mill, weighings were afterward made in other mills of a sufficient portion of the shafting to enable me very closely to compute the total, which I have only once or twice found to exceed 10 per cent., which basis I have therefore taken as a safe one to use in computations of the power required to operate a cotton mill.

As an illustration of the closeness of an estimate made on this basis, I was called upon some years since to decide upon the size of turbine required to replace an old-fashioned breast-wheel in a mill where every inch of water-power was of value.

Dynamometer weighings gave me as the power required for the machinery, ...	214.24 H. P.
Adding 10 per cent. for the shafting, or	21.42 H. P.
gave a total of	235.66 H. P.

as the horse-power required.

One of the sizes of the Swain turbine, which was the most economical wheel in the use of water which I then knew, was guaranteed to give 240 horse-power under the available head of eleven feet, and as this wheel had been very thoroughly tested by both Mr. Mills and Mr. Francis, I advised the mill-owners to put in this size of wheel, though apparently a very close fit for the required power, for, as above said, every inch of water was of consequence. The wheel was put in, and to the great delight of owners, when the water was let on, and the machinery put in full operation, there was still a part of the last tooth in the gate rack of eight teeth left unhoisted.

A similar operation, in another mill, a couple of years later, with the same turbine, gave equally satisfactory results.

At both of the last two mills spoken of, the shafting was old, and in excess of the amount which would be used to day for the same machinery. Soon after making the first one of them, I was called upon to weigh the power used by one of the new mills at Fall River, which I did, and was told that my result did not agree with Mr. Bacon's cards from the indicator, of which I knew nothing until my test was completed. I said that I did not include the engine, for which at least 5 per cent. should be added.

Mr. Bacon's cards gave a total power, 470.57 horse-power; my weighings of the machinery only gave 408.94 horse-power, to which I had added 10 per cent. for shafting, making a total of 449.83 horse-power. This I then increased to 15 per cent. for "engine and shafting," making an addition of 20.45 horse-power more, and giving a total, 469.91 horse-power, or a variation of less than one horse-power in the two results, with the estimate of 15 per cent. for the engine and shafting.

Indicator cards taken by me at one of the later mills in Fall River, when the machine belts were all thrown off from the driving pulleys on a Saturday afternoon, when it could be conveniently done, gave me only between 12 and 13 per cent. of the total for engine and shafting, and I am fully convinced by these and other experiments that 15 per cent. for "engine and shafting," or 10 per cent. for "shafting *only*," is an ample allowance to be made for a cotton mill in good running order, as they are now constructed.

While I thus dissent from the writer of the paper referred to, in regard to the data upon which it is based, I agree with him fully in the conclusions he draws in regard to undersized shafting and over-tight belts. For more friction in the bearings will be caused by springing of a flexible shaft than would be due to the necessary excess of diameter to make it sufficiently rigid to resist flexure from the strain of the belts, nor is the substitution of steel for iron any material improvement in this respect.

From a series of elaborate experiments, made by Mr. Jas. B. Francis, C. E., of Lowell, for the Merrimac Manufacturing Company, in 1866, and published by him in the *Journal of the Franklin Institute* for April 1867, he deduces the fact that while a two-inch iron shaft, "subject to no transverse strain other than its own weight," would admit of a distance between bearings of 15.46 feet, a steel one would only admit of 15.89 feet, although the diameter necessary to resist torsion need be only 0.855 for steel to 1. for iron.

In my early recollections of mill-shafting, over forty years since, cast-iron shafts, of a cruciform section, on which wooden drums or cylinders were built up, reaching from beam to beam, were still in use, although wrought-iron shafts and cast pulleys were being substituted. The first formula I remember, for the diameter of wrought-iron shafts, was given by Buchanan in his "*Mill-work and Machinery*," and was—

$$D = \sqrt[3]{\frac{110 \times H.\ P.}{R}}$$

This formula Mr. Francis still retained, after the experiments referred to, as a good one for jack shafts, or first movers, and for the first length of lines, receiving the pull of the main belts, computing the factor of safety, or power of resistance above the breaking strain to be 15.58. For transmitting lines he reduced this co-efficient of 100 to 50, and for light countershafts supported close to the bearings to 33, and, since the introduction of "cold-rolled shafting," I have found the latter co-efficient to answer perfectly for transmitting lines, although I prefer to keep close to the original formula for first movers, to resist the transverse strain without flexure, and when the bearings are from eight to ten feet apart, as is the usual condition in cotton and woolen mills, do not advise the use of any shafting much less than 2″ diameter, unless for the very last length of a line or for such light power as is required for knitting or sewing machines. Even in cases where the beams are ten feet apart, it is well to use an intermediate hanger near the pulley, if any amount of power is to be taken off. I have seen a 2¼-inch shaft, at 250 revolutions per minute, where about four horse-power was taken from it midway between beams ten feet apart, so "*buckled*" by the strain that I could not bear my hand on it near the pulley, and in other cases have found the co-efficient of friction doubled in the same manner, when testing with the dynamometer.

While the above observations apply more particularly to cotton and woolen mills, still the same principle will hold good in all cases, and in the case of machine shops, where the percentage of shafting to the power consumed by the machine tools is much greater, the last countershafts, with their loose pulleys, are always sold with, and form a part of, the machine itself, and the power for these should be charged to the machine and not to the shafting.

Coiling Copper Tubes.

A stand in the North Gallery of the Middle Court caught the eye by the fine collection of coiled copper tubes it displayed. These were the manufacture of Muntz's Metal Company, Limited, of Smethwick, and derived an additional interest from the fact that they were produced by a new process. The ordinary method of bending copper pipes to helical or spiral form, is to fill the straight length with resin, lead, or sand to prevent it from becoming flattened under treatment, and then to coil it upon a drum of the appropriate shape. After the pipe has received the required figure, the core is melted or shaken out as far as possible, but when it is of resin or lead, a portion of it always remains to contaminate the liquid when the coil is employed as a condenser. The pipes shown at the exhibition were, however, perfectly clean and bright inside, for they were bent on a metal mandrel a trifle larger than themselves, so that in passing through them it acted as a die to draw and polish the interior surface. The method of manufacture is as follows: A straight length of pipe, which is usually seventy feet long, is laid on a drawbench, and has inserted into it a solid mandrel rather less in diameter than itself, and curved at the end for about ninety degrees, to the desired radius of the coil. The curved portion may be of a slightly larger diameter than the interior of the pipe, or it may be enlarged in places to draw the interior surface. The other end of the tube does not rest directly against the drawback of the drawbench, but some loose tubular packing pieces are interposed between the two, so that the pipe may be coiled up to its extremity. The mandrel passes through the drawback, and is connected to the drawing apparatus, by which it is forcibly moved forward through the tube, while the latter is held stationary at one end. At the other end, however, the tube is obliged to curl up to allow the passage of the curved core through it, the result being that as the mandrel advances, the pipe is bent into a helix which rolls itself along the bench until it finally slips off the end of the core, and is complete.

When the coil is to be an involute, the apparatus is somewhat modified. The arrangement of the tube, mandrel, and drawback, is the same as before, but the bench is made very narrow, its width being only equal to the diameter of the pipe. The tube, instead of being allowed to form its own figure, is wound on a drum with deep flanges. The length of this drum is only equal to the diameter of the pipe, so when one convolution has been laid upon it, the second is obliged to mount upon the first, the third on the second, and so on, the drum rolling meanwhile along the bench, and being guided by its flanges. The body of the drum is of a spiral form, so that the second convolution is led over the first without any sudden bend. In making a conical coil the drum is of a conical form. As the tube is coiled on the drum by the action of the curved end of the mandrel, which is bent to the smallest radius of the coil, the drum rolls along the bench, and in addition to its rolling motion, has a motion at right angles to the direction of the tube being coiled. The packing pieces and the drawback are the same as in the previous arrangements. By the use of other drums different figures can be produced, the drums being capable of being taken to pieces when required. — *Engineering.*

The Panama Canal.

Dr. Arthur Gore returned recently from a trip through the United States of Colombia. Referring to the Panama Canal, he says that since the failure of the company to receive a new loan a spirit of demoralization seems to have settled down upon the whole enterprise. Nothing of any consequence is being accomplished at present.

Workmen are being discharged right and left, and auction sales of mules, carts, and other property are of frequent occurrence. It is said the Sub-Director-General intends to remove his headquarters to Colon, and that the Grand Hotel, built by the canal company, is to be sold. Nearly all the merchants of Panama hold "canal paper," as it is called, and the larger owners are feeling very blue over the prospect in store for the enterprise. Dr. Gore is satisfied that the whole proceeding has been worked by egregious frauds from the beginning, and for the $120,000,000 already expended, there is nothing to show in the way of a canal but a superficial scratch in the hard mass of volcanic rock through which it was proposed to cut a passage. Large sums of money have been spent in the construction of residences for officers, houses for workmen, hospitals, shops, tool-houses, etc., nearly all of which were built by contractors who have bled the country most unmercifully. Some very handsome buildings and grounds now mark the line of the canal at the various points where it was thought best to begin operations. Gazing on these palpable evidences of extravagance, the French residents remark, "*C'est magnifique, mais ce n'est pas le canal*" [it is magnificent, but it is not the canal]. The surveyors' stakes were supplied under contract for $25 a piece, and all the other preliminary arrangements have been made on a scale and at a cost that would bankrupt a company with anything less than the "wealth of Ormus, and of Ind" at its back. — *N. Y. Sun.*

OBSCURE HEAT. — At the Albany meeting of the National Academy of Sciences, Prof. Langley reported on the progress of remarkable researches with the balometer, by which he has so greatly extended our notions of the invisible spectrum. This time he dealt with the lunar spectrum, and estimated the heat derived from the unillumined moon. Rosse had estimated the temperature of the moon's surface as from 200° to 500° Fah. By studying the moon at its full, with a rock-salt prism obtained only after repeated failures, and which from its nature had already required repolishing seven times, each time necessitating a new determination of its constants, he had succeeded, on repeated occasions, in securing a spectrum which showed two curves — one according with that previously obtained in the infra red region beyond the visible portion of the solar spectrum, clearly due to reflection, and another, lying entirely beyond that, as clearly due to the moon itself, and revealing its real temperature. This, as shown by studying the spectrum of frigid masses, is colder than the temperature of melting ice.

By comparing the mean of the spectra obtained in summer with that of those obtained in winter, it is evident that a much greater amount of heat is obtained from the moon in winter than in summer. This may simply be due to the greater amount of aqueous vapor in our own atmosphere in the summer as contrasted with the winter clarity. By directing the balometer to the zenith and the horizon, the temperature of space has also been measured by direct experiment for the first time, and the amazing transparency of our earth's atmosphere to radiation of the earth's heat revealed; for his experiments show that our atmosphere transmits the earth's heat more readily than the sun's. — *The Iron Age.*

Knife Handles.

"Did you ever wonder what knife handles are made of?" asked a dealer in fancy woods the other day as he hauled out a shapeless block from his store of spoils from many tropical forests. "Outside of bone and tortoise-shell and pearl, so called, which every one recognizes, the majority of knife handles are made out of a close, fine-grained wood, about the name and pedigree of which 9,999 out of every 10,000 persons are ignorant. It is known to the trade as cocobola wood, and it comes in large quantities, millions of pounds a year, from Panama. It is of special value for knife handles because of its close texture, freedom from knots and flaws, and consequent disinclination to split. Many well-known kinds of wood require varnishing and polishing and filling of crevices before they attain the beauty for which they are famous. Of course that sort of thing can't be done in the case of knife-handles, and something must be used which doesn't require fixing up. Cocobola is rarely used for cabinet-making, because, being a gummy wood, it doesn't glue well. The same qualities that make it of use in the manufacture of knife-handles render it valuable for the making of wind instruments, like the flute. It comes to us in chunks, not in strips and planks like other woods. Sometimes these pieces will weigh 500 and 600 pounds, but generally much less than that. It costs 2½ cents a pound now, but before freights went down, and the Isthmus was opened up so thoroughly, it used to cost double that price." — *Boston Journal of Commerce.*

Cement for Iron. — A correspondent of the *English Mechanic* says that he used the following recipe with the greatest success for the cementing of iron railing-tops, iron-grating to stoves, etc., and with such effect as to resist the blows of a sledge hammer. Take equal parts of sulphur and white lead with about a sixth of borax; incorporate the three so as to form a homogeneous mass. When going to apply it, wet it with strong sulphuric acid and place a thin layer of it between the two pieces of iron, which should then be pressed together. In five days it will be perfectly dry, all traces of the cement having vanished, and the iron will have the appearance of having been welded together. — *Boston Journal of Commerce.*

The *Microscope* describes a pretty experiment. Upon a slip of glass put a drop of liquid auric chloride or argentic nitrate, with half a grain of metallic zinc in the auric chloride, and copper in the silver. A growth of exquisite gold and silver ferns will form before the eye.

The *Mechanical Engineer* of November 28th, gives its readers four superb cuts of the engines and boilers of the U. S. Twin-screw Cruiser *Chicago*, with a long and valuable descriptive article concerning the same. The single article alone is worth more than the yearly subcription price.

The current number of the *Journal of the Franklin Institute*, contains the concludin installment of Messrs. Gately and Kletzech's article on Cylinder Condensation in Steam Engines. Every engineer should read this paper. It is of very great value.

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