HARTFORD STEAM BOILER ★ INSPECTION AND INSURANCE CO. ★

HARTFORD, CONN.

The Locomotive.

PUBLISHED BY THE

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

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NEW SERIES.

Vol. XIII.

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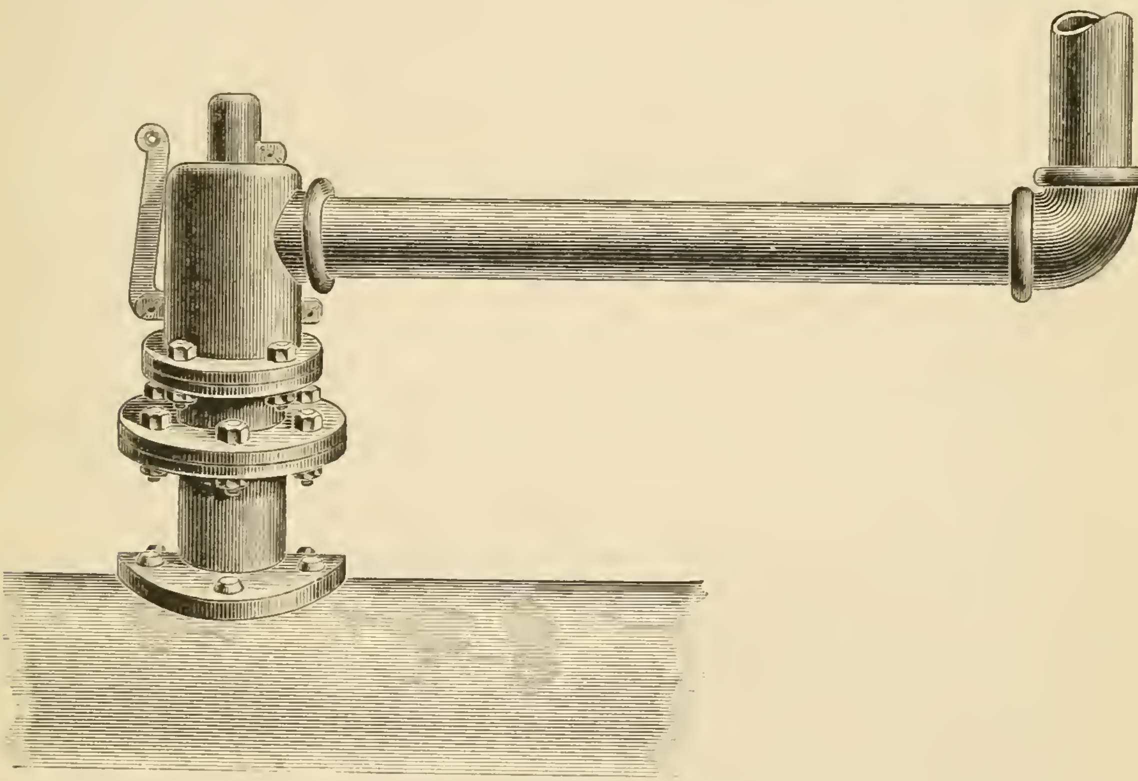
Dangerous Pop-Valves.

The pop-valve is coming into pretty general use on stationary boilers, the chief objection to it, we believe, being its expense. It responds quickly when the steam pressure exceeds the working limit, and, being direct acting, it has no levers that can get cramped, and the only way it can get fast is by the valve adhering to its seat, which is not likely to happen if it receives proper attention. Moreover, the pop-valve can be



A Dangerous Arrangement.

locked up, so that irresponsible persons cannot tamper with it or change the pressure at which it is set.

There is one feature about the pop-valve, however, which may make it dangerous. In many cases a waste-pipe is attached to the escape opening in the manner shown in the cut, the horizontal pipe being, say, four feet long, and the vertical pipe long enough to direct the outflow of steam upward, or perhaps long enough to pass through the roof so as to discharge out of doors. Usually no adequate support is provided for the waste-pipes that are put on in this manner, such support as there may be being intended only to relieve the valve-casing of the weight of the pipe. Now, when the valve blows off, the escaping steam rushes upward through the escape pipe, and creates a downward reaction that brings a severe strain on the outside casing of the valve. Suppose, for example, that the waste-pipe is four inches in diameter, and that the pressure at which the boiler blows off is 100 pounds per square inch. The area of a four-inch pipe is 12½ inches, and a reactionary pressure of 100 pounds per square inch acting on this area would give a total downward reaction of 1,250 pounds. This, acting at the end of a four-foot lever (*i. e.*, the waste-pipe), would bring an enormous strain on the casting that forms the outside of the valve; and it should be borne in mind that this casting is all that holds the valve together, so that if the casting should fail under the strain, the entire valve would be blown from the boiler, and in a few moments the entire contents of the boiler would be blown out. The result would probably be that the boiler would be burned before the fire could be drawn, to say nothing of the likelihood of scalding employés. Several accidents of this kind have come to our attention recently, and we do not doubt that others will continue to happen unless this arrangement of the waste-pipe is discarded. To appreciate the danger fully, one only needs to be on the top of a boiler arranged in this way, when the valve blows off.

It might be objected that the full head of steam is not realized at the end of the waste-pipe, and that the strain on the casting would therefore be materially less than is indicated above. In reply to this we may say that even if the reactionary pressure is but 50 pounds to the square inch, the total reaction in a four-inch pipe will be 625 pounds, and this, if the pipe is four feet long, will bring a bending moment on the casting of the valve of $4 \times 625 = 2{,}500$ foot-pounds, which is quite sufficient to endanger the casting if there should happen to be a flaw in it, and to bring on the bolts that fasten the casting to the neck below, a strain that is greater than they can stand with safety.

If this form of attachment is to be used at all, the outer end of the pipe should have a substantial support, capable of safely bearing a weight of a ton or so; and some method of draining the pipe should be provided, in order that it may not fill with water and set back into the valve. The valve is provided with a drip opening, it is true, but it is well to incline the waste-pipe downward and put an opening in it near the elbow (at the right-hand end in the cut), in order that any water in it may pass off freely without running back through the valve-casing.

We advise that the waste-pipe from safety-valves, if any be used, should be a simple, straight piece of pipe, without elbows and dipping slightly downward, so that water may run out freely. We also advise that the waste-pipe should open *in the boiler-room*, unless the available space is so small as to make this impracticable. We have known of a number of accidents that were caused by the freezing up of the outer ends of waste-pipes discharging out of doors. If the boiler-room is small, however, and the valve is large, it may be dangerous to blow off in the room, for pop-valves blow so suddenly that there is danger of the fireman being scalded, unless there is a large free space to blow into. Numerous fatal accidents have been caused in this way.

Setting a pop-valve under working pressure is always a dangerous proceeding. A safe way to set such a valve is to adjust it when the steam pressure is far below the blowing-off point, and test it by bringing the steam pressure up to the point at which it is desired to blow. A further adjustment is made the next time the pressure is down, and after several attempts made in this way, the valve may be brought to the desired blowing-off point. This process is a long and tedious one, and the same degree of safety and accuracy may more quickly be attained by filling the boiler with hot water and adjusting the valve under water pressure, which may be done without danger.

Inspectors' Reports.

OCTOBER, 1891.

During this month our inspectors made 6,018 inspection trips, visited 11,667 boilers, inspected 4,717 both internally and externally, and subjected 689 to hydrostatic pressure. The whole number of defects reported reached 10,664, of which 938 were considered dangerous; 46 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	862	52
Cases of incrustation and scale,	1,512	78
Cases of internal grooving,	94	14
Cases of internal corrosion,	462	40
Cases of external corrosion,	694	58
Broken and loose braces and stays,	118	27
Settings defective,	267	24
Furnaces out of shape,	377	6
Fractured plates,	239	74
Burned plates,	163	26
Blistered plates,	283	12
Cases of defective riveting,	2,168	107
Defective heads,	83	30
Serious leakage around tube ends,	1,891	215
Serious leakage at seams,	409	27
Defective water-gauges,	318	28
Defective blow-offs,	118	27
Cases of deficiency of water,	18	7
Safety-valves overloaded,	47	14
Safety-valves defective in construction,	88	33
Pressure-gauges defective,	387	27
Boilers without pressure-gauges,	6	6
Unclassified defects,	60	6
Total,	10,664	938

Boiler Explosions.

NOVEMBER, 1891.

THRESHING MACHINE (204). The boiler of W. S. Holcomb's threshing machine exploded, on Nov. 2d, near DeSmet, S. D., and two men, Horace Holcomb and Ed. Garland, were killed, and several others of the crew were badly injured. Holcomb came from Iowa and had worked only one day.

SAW-MILL (205). The boiler of J. A. Stemerd's saw-mill, situated eight miles northwest of Kildare, Tex., burst on the morning of Nov. 3d, instantly killing the fireman and severely scalding several others. The explosion was heard many miles, and was said to have stopped a clock three and one-half miles off.

THRESHING MACHINE (206). By the explosion of a threshing machine boiler, which occurred four miles west of Sanborn, N. D., on Nov. 3d, Ed. Thompson, the engineer, was blown five rods, and fatally hurt. Albert Thompson, feeder, had his right arm blown off and was otherwise injured. It is doubtful if he can live. Ed. Swartout, fireman, was badly scalded.

Fire Engine (207). The board of fire commissioners of New Orleans, La., proceeded to Milneburg on Nov. 4th, to test the steam engine of Milneburg No. 1. After the fire had been started and the engine was in working order, the spectators near by were startled at the sudden explosion of the boiler with a steam pressure of seventy pounds. Commissioner F. Barker, one of the most energetic members of the board, was slightly injured about the body, and Fireman Edward Joseph escaped with a severe shock.

Portable Engine (208). A portable boiler and engine that was fired up, on Nov. 5th, near Tokio, O., to try a new shingle saw, blew up and killed two men who were running the machinery, and badly wounded another. Several narrowly escaped injury. It is claimed that three gauges of water were in the boiler at the time of the explosion.

Planing Mill (209). On Nov. 6th, the boiler in M. E. Tonkey's planing mill and sash and door factory, Sundridge, Ont., blew up, demolishing the building and machinery, and injuring a number of men. The boiler was blown through the building and about 80 feet into the air, landing 175 yards from the factory. James Turnhall, engineer, was driven through two partitions. Both legs were broken, and he was terribly scalded. William Cassidy, carpenter, had a leg and arm broken by falling machinery. . Several others were scalded, but not seriously.

Saw-mill (210). On Nov. 7th, a boiler exploded in the mill of Manning Bros., about six miles south of Marienville, Pa., and about one-half of a mile from the Maple Creek Lumber Co.'s mill. The setter, Elmer Botzer, was the only one who sustained any serious injury, he having a leg, both arms, and three ribs broken. The boiler was carried under the mill, and only stopped when it struck the breast of the dam. Some of the flues were blown fully two hundred feet, and the engine was thrown from its place. The entire mill is damaged, so that it will have to be rebuilt. This is the second explosion that has occurred in that vicinity within three weeks.

Steamer (211). The *Marion A.*, a small steamboat, exploded her boilers on Nov. 7th, at Renton, near Seattle, Wash., but fortunately no one was injured. Two boats, the *Marion A.* and the *Renton*, run on Lake Washington from the end of the Rainier car line to Renton. For some time past there has been a bitter rivalry existing between the crews of the boats. The *Renton* claimed to be the faster boat, and the *Marion A.* disputed this claim. In the morning the captains determined to settle the dispute once for all, so, when they both set out for Renton, it was under a full head of steam. The *Renton* was loaded with passengers, but the *Marion A.* had only three besides her crew. For a time the contest appeared to be an equal one, but the *Renton* soon began to forge ahead. A half mile from the dock at Renton, the *Renton* was 350 yards ahead. Her passengers were wildly cheering and waving handerchiefs at the persons on board the *Marion A.*, when they were horrified to see the *Marion A.* apparently stop for a moment, and then the whole top of the boat seemed to be flying through the air. An instant later they heard the dull, heavy sound of the explosion. The *Renton* put back to the scene of the disaster as soon as possible, and to everyone's surprise found that no one had been injured. Captain Grant of the *Marion A.* is said to have admitted that the *Marion A.* was carrying 220 pounds of steam, or seventy pounds more than usual, when the explosion took place.

Rendering Tank (212). A rendering tank exploded on Nov. 7th, in the pork-packing establishment of Mowry & Barnes, on Lock street, on the north side of the Erie Canal, Syracuse, N. Y. The roof and entire side of the lean-to were blown away, and the tow-path was blocked, for a time, with the débris. Fortunately nobody was seriously hurt.

Oil Well (213). On Nov. 7th, a boiler exploded at the Liberty Oil Company's new well, McDonald, Pa. The dome and a portion of the wreckage were thrown through a house, killing a child, and injuring three other people. The dome then struck another house near by, carrying away a gable, and landing in the street half a mile or so from its starting point.

Saw-mill (214). William and Henry Thomas were killed on Nov. 10th, by the explosion of a saw-mill boiler, near Vendora, Mercer county, Ohio.

Saw-mill (215). The boiler of the saw-mill running in connection with the phosphate factory, at Paradise Fort, thirty miles from Gainesville, Fla., exploded, on Nov. 10th, blowing out the entire end of the factory, and otherwise wrecking the building. Three white men were terribly scalded, besides sustaining other injuries. Mr. Pardee, engineer in charge, had his shoulder dislocated, is internally injured, and but little hope is entertained for his recovery. Mr. Osteen, who was assisting the engineer, had an eye blown out. Mr. Tilden, carpenter, was also badly, if not fatally, burned.

Threshing Machine (216). A threshing machine engine exploded with terrific force, while at work four miles south of St. Hillaire, Minn., on Nov. 12th. Four men were injured. The owner of the machine, Mr. Ames, and the engineer, cannot live. Nothing is left of the engine but one bull-wheel.

Colliery (217). On Nov. 12th, at the Oakdale colliery, near Hazleton, Pa., operated by G. B. Markle & Co., a boiler exploded with fatal results. Andrew Wastah, the fireman, was terribly scalded, and John Hecker was killed outright. Hecker was loafing in the boiler-house, his home being in Ebervale. The unfortunate man was frightfully scalded and burned by the fire from under the boiler. The boiler that exploded was a new one. It went up through the roof like a shot, taking part of the boiler-house with it.

Wire Works (218). On Nov. 16th, one of the five boilers in the Ashley Wire Co.'s works, Joliet, Ill., exploded, instantly killing the fireman, Frank McSwain. The building, which is an immense one, was wrecked from end to end, with a loss estimated at $75,000. The cause of the explosion is unknown.

Residence (219). By the explosion of Thomas Kirk's steam-heating boiler in the cellar of his beautiful residence, at Watertown, Pa., on Nov. 18th, Mr. Kirk was badly injured. Portions of the boiler went through two floors, two ceilings, and the roof, causing damage amounting to $3,000.

Locomotive (220). On Nov. 18th, near Greenwood, S. C., an engine on the Georgia, Carolina & Northern road, in charge of Engineer Tom Argo, was destroyed by the bursting of the boiler. Argo escaped with a few bruises and scratches, but Fireman Robert Allen was pinned down where the steam and hot water scalded him terribly, so that he died a day or two later.

Residence (221). The steam-heating apparatus in the residence of Capt. Davenport, 1319 18th street, Washington, D. C., exploded on Nov. 19th. The house was just built, and had been furnished in handsome style. It was badly damaged. Capt. Davenport was an officer on one of the vessels that were driven ashore by a hurricane in the harbor of Samoa.

Saw-mill (222). The boiler of Fenton & Frampton's saw-mill, Newcastle, Pa., exploded Nov. 19th, and four workmen were seriously injured, two of whom, Wm.

Duberry and Charles Wilson, are not expected to recover. Wilson, who was fireman, was blown 70 feet by the force of the explosion, and had one leg and one arm broken, and was terribly scalded. The other two men, Clifford Fenton and J. Stafford, were burned about the head and face, but will recover. The building was demolished. A piece of the fly-wheel crushed in the roof of James Hannon's building, 500 feet away, but fortunately no one was injured. The explosion was caused by the supply pipes freezing in the night.

RESIDENCE (223). By the explosion of a heating boiler, on Nov. 20th, on Corey street, Spring Street Station, Boston, the windows of a dwelling-house were broken, the plastering was knocked down, and the lower floors were thrown up. A little child and its mother, who were in the house at the time, escaped without injury.

SAW-MILL (224). On Nov. 20th, at Mento, Ga., forty-five miles below Chattanooga, a saw-mill boiler exploded instantly, killing two young sons of the proprietor, T. P. Battens. A sawdust wheeler had his leg broken, and Mr. Battens had an arm broken in two places. Portions of the boiler were thrown 300 feet.

IRON WORKS (225). On Nov. 23d, a boiler exploded in the Lochiel Iron Works, Harrisburg, Pa., in the blooming department. The explosion played general havoc in the mill, and destroyed all other boilers in close proximity. Jacob Rettinger, aged 34, the fireman, was the only one injured.

LOCOMOTIVE (226). On Nov. 27th, a locomotive belonging to the Cleveland, Akron & Columbia Railroad Company exploded a mile south of Akron, O. The locomotive was badly wrecked. The body of Engineer John Byron was found 600 yards south of the track, while that of his fireman, George Parker, was hurled 200 feet north. Both had been instantly killed.

SYNAGOGUE (227). A heating boiler exploded in the basement of a Jewish synagogue, in Des Moines, Iowa, on Nov. 29th, doing the edifice considerable damage. The explosion occurred early in the morning, and nobody was hurt.

EDITORIAL ROOMS (228). A small explosion occurred in Chicago, on Nov. 30th., in the editorial rooms of the *Abend Post*. A portion of the steam-heater blew off, narrowly missing a few reporters, and tearing down the ceiling of an adjoining room.

PLANING MILL (229). The boiler in the planing mill of Dunn, Washburg & Randall at Lodi, Texas, exploded, on Nov. 30th., killing Jake Bickham and W. S. Warner, two white employes.

The Horse-Power of Boilers.

It has become an almost universal practice to rate boilers by the amount of work they are supposed to be capable of doing, so that the expressions "80-horse-power boiler," and "100-horse-power boiler" have become familiar to every one. There are numerous objections to rating boilers in this way, but no distinctly better way has yet been proposed. It would be more exact to rate them in accordance with their diameters, lengths, and number and size of tubes; but one serious objection to this would be, that such a rating would have no meaning whatever except to specialists who knew from experience what boilers of the various sizes are capable of doing in practice.

The strongest and chief objection to the use of the word "horse-power" in connection with boilers, is that it is very indefinite, and may mean any one of a great variety of things. The work done by a boiler depends very largely upon the engine used with it; so that the horse-power of a boiler used in connection with an engine taking steam full stroke would be one thing, and it would be quite another thing if the engine cut off at one-quarter or one-fifth stroke. Again, it depends largely upon the type of engine used; for two engines may each cut off at the same point, and yet one may be more economical than the other, and the performance of the boiler will appear better with the better engine. Then, again, the pressure at which steam is carried, the design and workmanship of the setting, and the proportions of the flue and chimney, all exert a great influence on the performance of the boiler, for a poor draft or a faulty setting may cause a really good boiler to make a poor showing.

These points were well brought out in a discussion before the American Society of Mechanical Engineers in 1885. In discussing a paper on the subject Mr. Kent gave some interesting examples of the confusion to which the rating of boilers by horse-power may lead, three of which are given below. "CASE A. A mill owner having boilers and engines each of which he called 120 horse-power, has an accident with his boilers; thinks them not worth repairing, and telegraphs to a boilermaker, 'For what price will you sell me two of your sixty horse-power boilers?' Receives price and telegraphs: 'Ship at once.' Boiler manufacturer writes accepting order, and sends also a regular printed form of specification, in which he agrees to furnish two sixty horse-power boilers, and states in parenthesis, 'horse-power equals thirty pounds of water evaporated,' and particularly describes the boilers as having drums of such and such dimensions, tubes of a certain number, length and diameter, and grate surface of specific dimensions. Boilers are delivered and set to work, and mill owner soon telegraphs, 'Boilers will not furnish steam enough to run mill: send expert to find out the trouble.' Expert goes, reports that he has tested the boilers and finds that they are developing 160 horse-power on the basis of thirty pounds of water evaporated being equal to a horse-power, and says that the trouble is that the engines are calling for more than 120 horse-power of steam. Thinks the engine is a wasteful one. Mill owner not satisfied, calls in engine expert who indicates engines, finds them developing only 120 horse-power, but from the shape of the indicator cards, estimates that the engines are using more than forty pounds of steam per horse-power per hour: condemns the engine as being of wrong type for the service; recommends purchase of a modern automatic cut-off engine. Mill owner buys new engine and all trouble ceases. The two new boilers easily furnish sufficient steam to run it: thus far the question of fuel consumption has not entered into the matter at all, the whole question is one of horse-power for measuring the work done and as a measure of the size of the boilers by which they are rated; but by watching the coal bill, the mill owner finds that with the new combination of new boiler and new engine he is saving thirty per cent. of the fuel used with the original combination. This fuel consumption, however, is a matter wholly foreign to the question of horse-power. Boiler-maker now demands payment of his bill; payment is refused on the ground that the new boilers were not sixty horse-power each; expert sent again to straighten matters out: mill owner says to him, 'My old boilers were only sixty horse-power each; here they are out in the yard, measure them for yourself; and they run my mill satisfactorily. Your new boilers would not run my mill, therefore I hold that they were not sixty horse-power boilers. By your failing to deliver two sixty horse-power boilers which I had ordered, you have put me to the expense of buying a new engine. You have caused my mill to be stopped for several weeks, and, instead of paying you for these boilers, I ought to sue you for damages.' Expert says, 'When we accepted your order for boilers, we gave you a detailed specification of exactly what we proposed to furnish you; we furnished you exactly what we said we would do; and, I may say further, we furnished you exactly what we have been selling for sixty horse-power boilers for the last twelve or fifteen years. These boilers are known in the trade regularly as sixty horse-power boilers, and they already develop by actual test eighty horse-power each. We will make no discount on our bill, and you must pay every dollar of it, or stand suit.' The man paid the bill without suit."

"CASE F. Another 150 horse-power boiler, mill owner reports does not furnish steam enough to run the mill. 'How much coal are you using?' he is asked. 'Not using coal at all; using shavings and refuse lumber. I supposed the old boiler I had to be of smaller capacity than yours, and had no trouble with it, and yours cannot be the horse-power it was sold for.' Expert sent and finds a contracted flue between the boiler and the chimney; secondly, a hood over the chimney, which acts as an obstruction to the draft, rather than a help to it; and, thirdly, that the furnace under the boiler is not of sufficient size to burn the shavings properly. Recommends change of these three faults in the order named. The contracted flue is enlarged and the hood taken off the chimney, and satisfactory results follow without making any change in the furnace. Here, again, the question of fuel economy had nothing to do with the problem; in fact, the fuel consumption was of no importance whatever. The character of the furnace under the boiler was such that the shavings were being distilled, and converted into gas and sent up the chimney in that form, rather than being properly burned."

"CASE H. (A hypothetical case.) A party writes to four boiler-makers for specifications and estimates for a 100 horse-power boiler, of their regular make. The specifications submitted may be tabulated as follows:

Maker.	Horse-Power. Builders' Rating.	Square Feet. Heating Surface.	Square Feet. Grate Surface.	Ratio of Heating to Grate Surface.	Price.	Price per Square Foot of Heating Surface.	Price per Horse-Power.
A	100	1,500	37.5	40 to 1	$1,500	$1.00	$15.00
B	100	1,200	30.	40 to 1	1,260	1.05	12.60
C	100	1,200	40.	30 to 1	1,320	1.10	13.20
D	100	1,000	40.	25 to 1	1,200	1.20	12.00

Would-be purchaser is puzzled. A's boiler costs the most, but it is the cheapest per square foot of heating surface. D's costs least but is the dearest per square foot of heating surface. B's and C's boilers approximate to D's in entire cost, but to A's in cost per square foot of heating surface, and they differ widely in extent of grate surface. All the makers define a horse-power as a guaranteed evaporation of thirty pounds of water per hour, but all say that their boilers will evaporate twenty-five or fifty per cent. more, if driven. Would-be purchaser has heard that the question of horse-power of boilers is an unsettled one, and thinks he would like to see how the horse-power of these four boilers compares when some scientific rule is applied to it. He hears of two rules proposed involving the rate of combustion of fuel under the boiler, and presented before this society. These are, (1) A horse-power is equivalent to thirty-five pounds of water evaporated per hour from and at 212° Fah., when the rate of combustion *is not less than* ten pounds of ordinary coal on each square foot of grate surface. (2) A horse-power is equivalent to forty pounds of water evaporated per hour from and at 212° Fah., with a rate of combustion of *not more than* four-tenths pounds of good ordinary coal per square foot of heating surface. After learning further that one pound of 'good ordinary coal' may be expected to evaporate nine pounds of water, he applies these two rules to the specifications, with the following results:

		By rule 1.	By rule 2.
A's boiler,	called 100 H. P.	*Not less than* 96 H. P.	*Not more than* 150 H. P.
B's "	" 100	" " " 77	" " " 120
C's "	" 100	" " " 103	" " " 120
D's "	" 100	" " " 103	" " " 100

While he is cogitating over these curious results without getting any clearer idea of the relative horse-power of the four boilers, A, B, C, and D appear and urge their respective claims. A is told, 'Your boiler costs too much.' A replies, 'I am giving you more boiler than any of my rivals, fifteen square feet of heating surface per horse-power. It is the cheapest per square foot of heating surface, and has the proper proportion of grate surface to give you both capacity and economy. It is the most economical of fuel, because it has the largest surface to absorb the heat.' B is told, 'If A's boiler is 100 horse-power, yours is not. You don't give enough heating surface nor enough grate surface.' B then 'runs down' A's boiler, shows that a large portion of its heating surface is badly placed, and therefore inefficient; that it consists of small tubes closely placed together, which will soon get covered with scale and cease to absorb heat. 'A gives forty square feet of grate, to be sure,' says B, 'but the gas passages are so contracted that his draft will be choked and he cannot get any more coal burned, nor any more horse-power, out of his forty square feet of grate surface than I can out of my thirty.' C is also told that his boiler is smaller than A's, and he replies as B did. Then he is told that his boiler is higher priced than B's. 'Yes,' replies C, 'but he doesn't give you so much grate surface, and therefore the capacity of his boiler is limited. I can get thirty per cent. more horse-power out of my boiler than B can out of his.' D is told that his boiler is entirely too small for 100 horse-power — only ten square feet of heating surface per horse-power. 'True,' he answers, 'but I place every square foot where it does good service, and I can easily keep it all clean, so that it will do as much work as A's fifteen square feet.' 'Well,' says the mill-owner, 'your price is too high — $1.20 per square foot of heating surface, while A's price is only $1.00.' 'Certainly,' replies D, 'for A's heating surface is only small tubes, while mine is large tubes and shell, costing more to build. I give you more grate, also, than A, and plenty of draft, which A doesn't give; and therefore I can guarantee to develop fifty horse-power more than A can, in case you need to drive your boiler at any time above its rating.'" The outcome of the talk is, that D's boiler is bought, and twenty pounds of coal are burned per square foot of grate per hour, or 800 pounds per hour in all, the water evaporation being six pounds per pound of coal, or 4,800 pounds per hour in all, making the boiler 160 horse-power, if we allow thirty pounds of water per hour to each horse-power. "As the rate of combustion per square foot of heating surface is eight-tenths lbs., or double the maximum allowed in rule (2), that rule cannot be applied; or, if it is applied on a *pro rata* basis, the horse-power might be called sixty. As the rate of combustion is double the *minimum* of rule one, that rule will apply, and the horse-power developed called 137. Now, shall this boiler be rated at 160, 60, or 137 horse-power?"

We have quoted Mr. Kent rather fully, because his remarks show up the difficulties of the case very clearly, and make it plain that it is by no means easy to give a rule for the horse-power of a boiler, nor even to define the expression "horse-power," when used in connection with a boiler. If the boiler to be rated is in use, the definition adopted by the centennial committee is as good as any for estimating the nominal horse-power of a boiler. According to this definition or rule, a horse-power is the evaporation of thirty lbs. of water per hour, under a steam pressure of seventy lbs. to the square inch, and with feed water at 100° Fah., or its equivalent. This estimate was adopted by the committee after an exhaustive examination of many boilers, and it was considered that the power computed by this rule is about what will be realized in ordinary good practice. With a defective setting or chimney, less power will be realized; and if everything is in perfect condition, and a good modern automatic cut-off engine is used, 30, 40, or 50 per cent. more power may be realized.

If the boiler is new, or has never been tested, the heating surface is the best guide to a knowledge of what it will be capable of doing. If the boiler is well designed and properly set, two pounds of water should be evaporated for each square foot of heating surface, so that, on the centennial committee's basis, fifteen square feet of heating surface should be allowed per horse-power; and in estimating the horse-power of a boiler, the external surface of that portion of the shell which is exposed to the fire should be estimated, and to this, expressed in square feet, should be added the area of the tubes, and of such portions of the heads as are exposed to the direct heat. The sum should then be divided by fifteen, and the result is the nominal horse-power of the boiler. This rule is not absolute, but, like all other rules, it has exceptions. With the most approved settings, and with well managed fires, the evaporation is greater than that estimated above, and we find that in such cases twelve square feet of heating surface will evaporate the quantity of water required for a horse-power. In some exceptional cases the requisite heating surface is even less than twelve square feet, but we do not use less than twelve unless we have satisfied ourselves, by careful experiment upon similar boilers, similarly set, that we may do so fairly. On the other hand, if the boiler or the setting is poorly designed, or the draft imperfect, or the fires badly handled, more than fifteen square feet may be required. There is no such thing possible as an absolute rule for the horse-power of a boiler, and the rule we have given above merely represents what, in our experience, a given boiler, well designed, may be expected to do under ordinary circumstances.

The Pacific Cable.

The following letter, from one of our western inspectors, contains interesting information concerning the sounding expedition that has been nearly completed by the *Albatross*.

San Francisco, Jan. 4, 1892.

Mr. J. M. Allen, *President*,
Hartford, Conn.,

Dear Sir: — On January 1st, I visited Captain Z. L. Tanner, Commander, G. C. Calkins, Executive and Navigating Officer, and Mr. Hunt, Chief Engineer, on board of the *Albatross*, which returned to San Francisco on Dec. 31st, from the survey of the route of the proposed Pacific cable to Honolulu. The present survey was begun on Oct. 11, 1891, the starting point being Moss Landing, in Monterey Bay, Cal. After sounding 830 miles, a return trip was made to San Francisco for more fuel. On Nov. 4th the *Albatross* again left San Francisco, proceeding directly to the point where soundings had been discontinued, and the work was resumed.

On the outward survey work was commenced at Moss Landing, in Monterey Bay, and a west-southwest course was taken out of the bay to sea. Then a southwesterly direction was followed, on as near a direct line to Honolulu as could be steered, the course being parallel with the survey made by the *Tuscarora* in 1874, and about 134 miles to the west. Soundings were taken every five miles on the outward survey, and in some places every mile or two. It was found that from Moss Landing to sea there was a gradual increase of depth, along the bottom of what was anciently a river bed, and which consists of a soft mud, which makes it entirely feasible to lay the cable from that point.

The average depth of the ocean along the route followed was 2,500 fathoms. The first obstruction encountered was a small mountain true west from Mt. Belknap, and distant about 130 miles. Here there was a gradual shoaling from 2,800 fathoms to 2,014 fathoms. Two similar mountains, about equidistant between Mt. Belknap and Honolulu were encountered, but in neither case would they interfere with the safety of the cable. The greatest depth measured was 3,186 fathoms, which was found in latitude 31° 54′, longitude 136° 44′.

In making the soundings the ship was brought stern to the sea, as the reel is located on the stern of the vessel; and the engines were reversed, to keep the ship as nearly stationary as possible. The sounding shot, weighing sixty pounds, is attached to the trip hook, and this is secured to a short piece of line. The cup and self-registering thermometer are fastened to the line above the shot, and the line is secured to a tempered steel sounding wire, 0.028 of an inch in diameter. The sounding wire will stand a strain of from 200 to 220 pounds, the average strain at which it broke, on three occasions during the survey, being 207 pounds.

The drop is made at the rate of 600 feet per minute, and after bottom is reached and the shot has been released, the apparatus is hauled in at the rate of 600 feet per minute, *plus* the speed of the ship, which, after the shot is released, is at once started ahead at the rate of two miles per hour, which speed is gradually increased to six or eight miles per hour as the wire is drawn aboard. It is intended that the strain on the wire in winding in shall not exceed 96 pounds, but it has run as high as 120 pounds when some obstruction has been met. It is noticed that if the shot is slightly uneven, or has what are termed "fins" by foundry men, — that is, slight projections where the flask did not unite it evenly, — quite a difference is perceptible in deep soundings in the speed with which the shot sinks, this difference often amounting to ten seconds in 100 fathoms.

The sediment or specimen brought up in the cup is turned over to the scientist of the expedition, who carefully examines it with the microscope. After leaving the shore and its influences, the bottom of the ocean is found to be almost entirely covered, and to a considerable depth, with the remains of minute animal life. Should any lava or sand or grains of quartz be detected, it is considered certain that a submarine mountain is near. Then soundings are taken more frequently until the nature and extent of the obstruction are determined. During the whole of the present survey no "live" lava (or lava which had apparently been recently thrown out) was found. This indicates pretty clearly that at the present time no volcanic action is taking place along the route that the *Albatross* followed.

At the Hawaiian end a gradual shoaling from sea to land was noted, and at Waikiki, four miles south of Honolulu, where it is proposed to land the cable, a mud and coral bottom was found. On account of coral reefs and a shallow bottom, a suitable landing could not be made at Honolulu, but no trouble will be found at Waikiki.

While the *Albatross* was near Honolulu half a day was devoted to deep sea dredging for specimens of fish, with the Beam troll. Captain Tanner also enlisted the services of the fishermen in Honolulu, and desired them to obtain any rare specimens that they could. About 100 varieties were obtained, twenty-five of which were new to science. These were carefully preserved, and will be forwarded to Washington.

On the return survey a line was run to the *east* of the *Tuscarora* survey, distant about 130 miles. Soundings were carried on along this route for 1,450 miles, when, on account of the poor quality of coal obtained at Honolulu, it was found necessary to discontinue the work, and the *Albatross* came to San Francisco for a fresh supply of fuel. It is intended to finish the remaining 640 miles of soundings at once. Up to the time work was suspended nothing unusual had been found on the return trip. The depth was about the same as along the outward survey, and it was found that by making slight detours any of the mountains encountered could be passed on even soundings.

During some soundings that were taken about nine years ago, some glass spheres about eight inches in diameter and half an inch thick were sunk until a pressure of 2,600 pounds per square inch was obtained, and when they were again taken on board it was found that water had forced itself through the glass and compressed the air within to less than one-third of its original bulk, the other two-thirds of the space being filled with water. The water remains in the spheres to this day, undiminished in volume after over eight years of constant exposure to the atmosphere in all climates.

Commander Tanner extended every courtesy to me, and wished to be kindly remembered to you and yours, with the compliments of the season.

Respectfully yours, J. B. Warner, *Inspector*.

The Locomotive.

HARTFORD, JANUARY 15, 1892.

J. M. ALLEN, *Editor.* A. D. RISTEEN, *Associate Editor.*

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*

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Papers that borrow cuts from us will do us a favor if they will mark them plainly in returning, so that we may give proper credit on our books.

THE twelfth volume of the *Transactions of the American Society of Mechanical Engineers*, embracing the Richmond and Providence meetings, is at hand. It is the first volume that has appeared since the decision was made to have the transactions bound by the society. The wisdom of the new plan is abundantly evident, for the present volume is a beautiful book, and will be ornamental to our shelves as well as profitable to our minds.

WE desire to extend our sincerest thanks to the Hartford Fire Insurance Company for the large and beautiful steel engraving of Landseer's famous "Monarch of the Glen" that they have kindly presented to us. The plate was engraved especially for the Hartford Company, at great expense, by Messrs. John A. Lowell & Co. of Boston. It is an unusually fine piece of work, and would make an acceptable addition to any drawing-room.

The Hartford Company also issues a neat and appropriate souvenir booklet giving some account of the life of Landseer; and the two together form a very creditable offering, of which the "Old Hartford" may fitly be proud.

MR. C. J. H. Woodbury, Vice-President of the Boston Manufacturers' Mutual Fire Insurance Company, has kindly sent us an article from his own pen on *Fire Hazards from Electricity*. It originally appeared in the *Electrical Engineer*, and is now reprinted in pamphlet form. The article bears evidence of much careful study and thought, and, it is needless to say, is full of instruction. One paragraph is especially interesting, as containing Mr. Woodbury's views on a much-discussed question. "In case of fire," he says, "the press frequently ascribe the results to electrical wires purely on presumption, without any evidence to establish the fact. Furthermore, in many instances such allegations are made when the known facts or weight of presumptive evidence indicate a contrary cause. It has been fully established by the experience of the past twelve years that a well-installed electric lighting plant is the safest method of illumination."

We have also to thank Mr. Woodbury for various clippings and other evidences of remembrance.

ONE of the new names in practical engineering chemistry is that of paranitrophenol, and it may yet play an important part in a certain specialty. As is well known, water containing magnesium chloride is injurious to boilers, as the salt dissociates with the production of hydrochloric acid which attacks the plates, and though, in large installations, where systematic purification of the feed-water can be adopted, this evil is preventable, in most cases the treatment in vogue consists in adding soda ash to keep the contents of the boiler alkaline; an excess of the soda, however, is wasteful, as well as otherwise objectionable, and it becomes desirable to ascertain readily when the water in the boiler ceases to contain alkali and needs a further supply. Dr. Goldberg has found that the sodium salt of paranitrophenol is entirely unaffected by the salts commonly present in feed-waters — the claim being that it is possible, by introducing a sufficient quantity into the boiler, to judge of the alkalinity or acidity of its contents at any given moment by merely blowing the water out of the gauge glass and allowing it to refill. To give a distinct yellow color — the evidence of alkalinity — to the water so that it may be seen in the small quantity of water in the gauge glass, about thirty to fifty grammes per cubic metre are requisite. It is remarked that, though the high price of the article is a bar to its general use at present, still, as its successful application is not dependent on its purity, a crude variety could doubtless be produced much more cheaply. — *N. Y. Sun.*

We have received a pamphlet giving the details of the proposed excursion of the American Society of Mechanical Engineers to San Francisco, which leaves New York on Wednesday, May 4th. Special trains of vestibuled Pullman palace cars are to be provided, including sleeping cars, dining cars, and composite cars. The transportation will be under the direction of Messrs. Raymond & Whitcomb, and among the places to be visited are Chicago (with a visit to the Exposition grounds), Manitou Springs, the Garden of the Gods, the Royal Gorge, Marshall Pass, Tennessee Pass, Glenwood Springs, Castle Cañon and Castle Gate, the Cañons of the Rocky and Wahsatch Mountains, Salt Lake City, Sacramento, Monterey, San Francisco, Portland, Tacoma, Seattle, Minneapolis, St. Paul, and Niagara Falls. There will also be side trips to the Yosemite Valley, the Yellowstone National Park, and to Southern California. The expense of the trip ranges from $240 to $398, from New York to New York, and from $210 to $368 from Chicago to Chicago, according to the particular excursion chosen. Four such excursions are open to the tourist. The circular gives full accounts of the various routes, and copies of it may be had by applying to William H. Wiley, Treasurer of the Society, 53 East 10th Street, New York; or to F. R. Hutton, Secretary, 12 West Thirty-first Street, New York.

Every member who can do so should go on this excursion, as it promises to be a most enjoyable one.

The Origin and Home of Cholera.

The following graphic description of the home of Asiatic cholera occurs in Dr. Floyd Davis's recent work on *Potable Water*. It was written by Dr. D. B. Simmons, chairman of the Yokohama Foreign Board of Health.

"The drinking-water supply of India is derived from wells, so-called 'tanks' or artificial ponds, and the water-courses of the country. The wells generally resemble those in other parts of Asia. The tanks are excavations, made for the purpose of collecting the surface water during the rainy season, and storing it up for the dry. Necessarily they are mere stagnant pools. The water is used not only to quench thirst but is said to be drunk as a sacred duty. At the same time, the reservoir serves as a large washing-tub for clothes, no matter how dirty nor in what soiled, and also for personal bathing and ablution. Many of the water-courses are sacred, notably the Ganges, a river sixteen hundred miles long, in whose waters it is the religious duty for millions, not only of those living near its banks, but of pilgrims, to bathe and to cast their dead. The Hindoo cannot be made to use a latrine. In the cities he digs a hole in his habitation; in the country he seeks the fields, the hillsides, the banks of streams and rivers, when obliged to obey the calls of nature. Hence it is that the vicinity of towns and the banks of the tanks and water-courses are reeking with filth of the worst description, which is of necessity washed into the public water supply with every rainfall. Add to this the misery of pilgrims, their poverty and disease, and their terrible crowding into the numerous towns which contain some temple or shrine, the object of their devotion, and we can see how India has become and remains the hot-bed of the cholera epidemic. In the United States official report the horrors incident upon the pilgrimages are detailed with appalling minuteness. W. W. Hunter, in his *Orissa*, states that twenty-four high festivals take place annually at Juggernaut. At one of them, about Easter, forty thousand persons indulge in hemp and hasheesh to a shocking degree. For weeks before the car festival in June and July, pilgrims come trooping in by thousands every day. They are fed by the temple cooks to the number of ninety thousand. Over one hundred thousand men and women, many of them unaccustomed to work or exposure, tug and strain at the car until they drop exhausted, and block the road with their bodies. During every month of the year a stream of devotees flows along the great Orissa road from Calcutta, and every village for three hundred miles has its pilgrim encampments. The people travel in small bands, which at the time of the great feasts actually touch each other. Five-sixths of the whole are females; and ninety-five per cent. travel on foot, many of them marching hundreds and even thousands of miles, a contingent having been drummed up from every town or village in India by one or another of the three thousand emissaries of the temple, who scour the country in all directions in search of dupes. When those pilgrims who have not died on the road arrive at their journey's end, emaciated, with feet bound up in rags and plastered with blood and dirt, they rush into the sacred tanks or the sea, and emerge to dress in clean garments. Disease and death make havoc with them during their stay. Corpses are buried in holes scooped in the sand; and the hillocks are covered with bones and skulls, washed from their shallow graves by the tropical rains. The temple kitchen has the monopoly of cooking for the multitude, and provides food which, if fresh, is not unwholesome. Unhappily, it is presented before Juggernaut, thus becoming too sacred for the minutest portion to be thrown away. Under the influence of the heat it soon undergoes putrefactive fermentation; and in forty-eight hours much of it is a loathsome mass, unfit for human food. Yet it forms the chief sustenance of the pilgrims, and is the sole nourishment of thousands of beggars. Some one eats it to the very last grain. Injurious to the robust, it is deadly to the weak and wayworn, at least half of whom are suffering from some form of bowel complaint when they reach the place. Badly as they are fed, the poor wretches are worse lodged. Those who have the temporary shelter of four walls are housed in hovels built upon mud platforms about four feet high, in the center of each of which is the hole that receives the ordure of the household, and around which the inmates eat and sleep. The platforms are covered with small cells, without any windows or other apertures for ventilation; and in these caves the pilgrims are packed, in a country where, during seven months out of the twelve, the thermometer marks from eighty-five to one hundred degrees Fahrenheit. Hunter says that the scenes of agony and suffocation enacted in these hideous dens baffle description. In some of the best of them, thirteen feet long by ten broad and six and a half high, as many as eighty persons pass the night. It is not, then, surprising to learn that the stench is overpowering, and the heat like that of an oven. Of three hundred thousand that visit Juggernaut in one season, ninety thousand are often packed together for a week in five thousand of these lodgings. In certain seasons, however, the devotees can and do sleep in the open air, camping out in regiments and battalions, covered only with the same meagre cotton garment that clothes them by day. The heavy dews are unhealthy enough; but the great festival falls at the beginning of the rains, when the water tumbles in solid sheets. Then lanes and alleys are converted into torrents or stinking canals, and the pilgrims are driven into the vile tenements. Cholera invariably breaks out. Living and dead are huddled together. In the numerous so-called corpse fields around the town as many as forty or fifty bodies are seen at a time; and vultures sit, and dogs lounge lazily about, gorged with human flesh. In fact, there is no end to the recurrence of incidents of misery and humiliation, the horrors of which, says the bishop of Calcutta, are unutterable, but which are eclipsed by those of the return journey. Plundered by priests, fleeced by landlords, the surviving victims reel homeward, staggering under their burdens of putrid food wrapped up in dirty clothes, or packed in heavy baskets or earthenware jars. Every stream is flooded, and the travelers have often to sit for days in the rain on the bank of a river before a boat will venture to cross. At all these points the corpses lie thickly strewn around (an English traveler counted forty close to one ferry), which accounts for the prevalence of cholera on the banks of brooks, streams, and rivers. Some poor creatures drop and die by the way; others crowd into the villages and halting-places on the road, where those who gain admittance cram the lodging places to overflowing; and thousands pass the night in the streets, and find no cover from the drenching storms. Groups are huddled under the trees; long lines are stretched among the carts and bullocks on the roadside, their hair saturated with the mud on which they lie; hundreds sit on the wet grass, not daring to lie down, and rocking themselves to a monotonous chant through the long hours of the dreary night. It is impossible to compute the slaughter of this one pilgrimage. Bishop Wilson estimates it at not less than fifty thousand. And this description might be used for all the great Indian pilgrimages, of which there are probably a dozen annually, to say nothing of the hundreds of smaller shrines scattered through the peninsula, each of which attracts its minor hordes of credulous votaries. So that cholera has abundant opportunities for spreading over the whole of Hindustan every year by means of many huge armies of filthy pilgrims, and the country itself well deserves the reputation it universally possesses of being the birthplace and settled home of the malady."

Druggists have their troubles, too. They are supposed to be doctors, and people rush in to get something to stop the pain in their back, or to arrest a boil or prevent a felon, or to put them asleep or keep them awake. The clerks have to look up addresses in the directory, personally advise about cosmetics, and always be ready to please lend me a pencil a minute, or to won't you let me have a bottle, please? or a box, or a cork, or some string. Then postage stamps! Oh, goodness, yes! The girl looks so impatient that the drugman thinks she has an awful pain and leaves a prescription he is compounding. "No," she says, "I want a stamp." He says, "We don't sell them." She, timidly, "Haven't you some private ones you could let me have?" He grudgingly produces two. She gives him five cents, and as he fumbles for change she says, "Let me have another stamp instead. He hasn't a one-cent stamp, but he sees she has an extra cent so he gives her another two-center. She takes it, but doesn't give him the cent. Then she says, won't you please lick a stamp for her, because of her veil. Next she is afraid it will need two stamps, and won't he weigh it for her. It does need two, and won't he please lick the other. Then she says she thought she bought three stamps. He thought so, too. She looks so unhappy about it that he gives her another. She hands him a cent, reminding him that there was a cent change on the nickel. He is in that state of mind by this time that he doesn't know a soda-water fountain from a load of hay. She says, "Thank you so much." The next customer to whom he sells soda coughs up a two-cent stamp, and wants to know what sort of beverage that is, anyhow. Yet some people who are not druggists think life is hard." — *N. O. Times-Democrat.*

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The Locomotive.

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The Bursting Pressure of Cylindrical Boilers.

Several correspondents have recently asked for an explanation of the rule for finding the bursting pressure of boiler shells. The following article is offered as a general answer to all of these inquiries.

Figure 1 shows an end view of such a shell, with the thickness purposely exaggerated. Let us assume that when the shell bursts it will separate along the line *AB*, so as to come apart in the manner indicated in Fig. 2. Now, although the steam pressure acts perpendicularly to the curved shell at every point, as indicated by the arrows, yet, so far as blowing the two halves of the boiler apart is concerned, the *effect* is the same as though the steam pressure acted vertically against a flat plate equal to the boiler in length, and equal in width to the diameter of the boiler. To make this plain let us

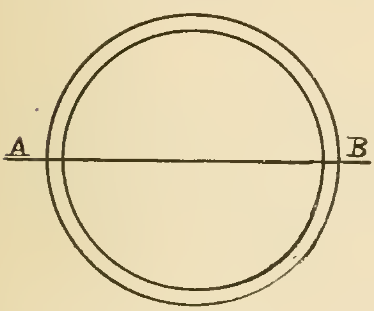

FIG. 1.

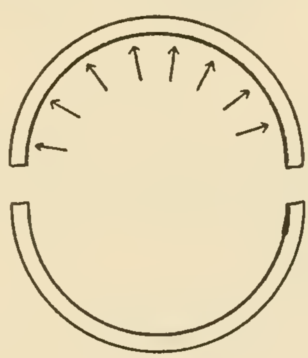

FIG. 2.

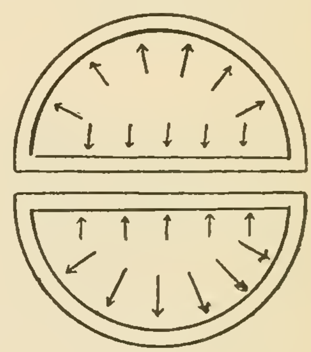

FIG. 3.

THE BURSTING PRESSURE OF CYLINDRICAL BOILERS.

consider Fig. 3, which shows each half of the boiler with a flat plate welded to it along its open side. Now it is a matter of common experience that a structure like one of these halves will not move upwards or downwards when steam is admitted to its interior. That is, if it were put on a pair of scales the pressure of the steam against its inner surfaces would not make it weigh less or more than before. It follows, therefore, that the total *upward* pressure of the steam against the shell is precisely equal to the total *downward* pressure against the flat plate; the greater area of the curved shell being exactly compensated by the obliquity of the pressure against it.

Let us now consider Fig. 4. The total *upward* pressure of the steam against the upper half of the shell is equal, as we have seen, to the pressure against a flat plate such as that shown in the cut, extending across the middle of the boiler. That is, it is equal to

Pressure per sq. in. × area of flat plate.

But the area of the flat plate is equal to the length of the boiler multiplied by its diameter; so that the total upward pressure, tending to blow off the upper half of the boiler, is equal to

Pressure per sq. in. × *diameter* × *length.*

This upward force is resisted by the strain on the boiler shell, as indicated by the arrows at *A* and *B*. The total strain on the shell is equal to the strain on one square inch of sectional area multiplied by the number of square inches of sectional area that would be broken across if the boiler should burst. The area of the fracture along each side of the boiler would be

Thickness of boiler × *length of boiler,*

and since there is one such strip on each side of the boiler, the total area broken across would be

2 × *thickness* × *length,*

and therefore the total strain at *A* and *B*, tending to hold the boiler together, is

2 × *strain per sq. in. of section* × *thickness* × *length.*

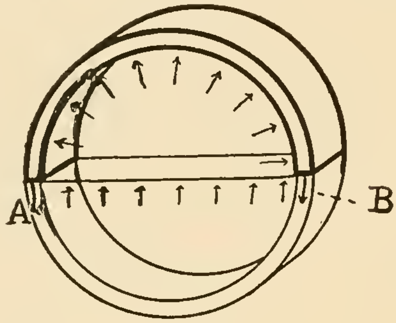

FIG. 4.

So long as the boiler does not burst, the force tending to blow it apart must be exactly equal to the force tending to hold it together; so that

Pressure per sq. in. × *diameter* × *length* = 2 × *strain per sq. in.* × *thickness* × *length.*

This is equivalent to saying that

Pressure per sq. in. × *diameter* = 2 × *strain per sq. in.* × *thickness.*

And this, again, is equivalent to saying that

Pressure per sq. in. × *radius* × 2 = 2 × *strain per sq. in.* × *thickness.*

That is,

Pressure per sq. in. × *radius* = *strain per sq. in.* × *thickness.*

Now, when a boiler bursts it does so because the strain on the shell has become equal to the tensile strength of the material; so that in this case our last formula becomes

Bursting pressure × *radius* = *tensile strength* × *thickness.*

This is the ordinary rule for finding the bursting pressure of a cylindrical boiler, except that it is usually expressed in the following slightly different manner:

$$\textit{Bursting pressure} = \frac{\textit{tensile strength} \times \textit{thickness}}{\textit{radius}}.$$

The bursting pressure of a boiler shell, therefore, is found by multiplying the tensile strength of the material in pounds per square inch, by the thickness of the shell in inches, and dividing by the radius in inches.

In this demonstration we have assumed the shell to be a solid sheet of metal, without joints. In practice the strength of a boiler is reduced exactly in proportion to the strength of its longitudinal joints, so that we must multiply the result obtained by the foregoing rule by the decimal representing the efficiency of the joint. (The question of the efficiency of joints has been so frequently and fully considered in THE LOCOMOTIVE that it is not necessary to discuss it in this place.) The foregoing formula therefore becomes

$$\textit{Bursting pressure} = \frac{\textit{tensile strength} \times \textit{thickness} \times \textit{efficiency of joint}}{\textit{radius}}$$

which means that in actual boilers we find the bursting pressure by multiplying the tensile strength of the material by the thickness of the plate *and by the efficiency of the joint*, and then dividing by the radius.

In conclusion we shall give a few numerical examples of the use of the foregoing formula and rule.

EXAMPLE 1. What is the bursting pressure of a steel boiler (tensile strength 55,000 lbs.), 48 inches in diameter and $\frac{5}{16}$ inch thick, with single riveted longitudinal joints whose efficiency is 56 per cent.? ANS. The radius of this boiler is 24 inches, so that the rule gives

Bursting pressure $= 55{,}000 \times \frac{5}{16} \times .56 \div 24 = 401$ lbs. per sq. in.

EXAMPLE 2. What is the bursting pressure of a steel boiler (tensile strength 55,000 lbs.), 60 inches in diameter and $\frac{3}{8}$ inch thick, with double riveted longitudinal joints whose efficiency is 70 per cent.? ANS. The radius is 30 inches, and the rule gives

Bursting pressure $= 55{,}000 \times \frac{3}{8} \times .70 \div 30 = 481$ lbs. per sq. in.

EXAMPLE 3. What is the bursting pressure of a steel boiler (55,000 lbs. tensile strength), 66 inches in diameter and $\frac{3}{8}$ inch thick, with triple riveted longitudinal joints whose efficiency is 75 per cent.? ANS. The radius of this boiler is 33 inches, and the rule gives

Bursting pressure $= 55{,}000 \times \frac{3}{8} \times .75 \div 33 = 469$ lbs. per sq. in.

EXAMPLE 4. What is the bursting pressure of a steel boiler (tensile strength 55,000 lbs.), 72 inches in diameter and $\frac{3}{8}$ inch thick, with double welt butt longitudinal joints whose efficiency is 87.5 per cent.? ANS. The radius is 36 inches, and the rule gives

Bursting pressure $= 55{,}000 \times \frac{3}{8} \times .875 \div 36 = 501$ lbs. per sq. in.

After we have found the bursting pressure, the safe working pressure may be found by dividing the bursting pressure by a suitable factor of safety. We consider 5 to be the best factor of safety when all things are considered, though we sometimes allow $4\frac{1}{2}$ when the workmanship is known to be first-class, and the materials of which the boiler is made have been carefully selected and tested. With a factor of safety of 5, the safe working pressures in the foregoing examples are as follows: Example 1, $401 \div 5 = 80$ lbs.; in Example 2, $481 \div 5 = 96$ lbs.; in Example 3, $469 \div 5 = 94$ lbs.; and in Example 4, $501 \div 5 = 100$ lbs.

Inspectors' Reports.

NOVEMBER, 1891.

During this month our inspectors made 6,605 inspection trips, visited 12,847 boilers, inspected 4,708 both internally and externally, and subjected 646 to hydrostatic pressure. The whole number of defects reported reached 11,419, of which 1,021 were considered dangerous; 41 boilers were considered unsafe for further use. Our usual summary is appended:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	864	47
Cases of incrustation and scale,	1,502	110
Cases of internal grooving,	83	14
Cases of internal corrosion,	413	28

Nature of Defects.	Whole Number.	Dangerous.
Cases of external corrosion,	704	48
Broken and loose braces and stays,	131	29
Settings defective,	320	24
Furnaces out of shape,	347	7
Fractured plates,	250	56
Burned plates,	197	36
Blistered plates,	322	12
Cases of defective riveting,	2,625	136
Defective heads,	99	18
Serious leakage around tube ends,	1,912	249
Serious leakage at seams,	474	42
Defective water-gauges,	284	28
Defective blow-offs,	131	28
Cases of deficiency of water,	32	23
Safety-valves overloaded,	66	32
Safety-valves defective in construction,	45	11
Pressure gauges defective,	461	26
Boilers without pressure gauges,	7	7
Unclassified defects,	150	10
Total,	11,419	1,021

DECEMBER, 1891.

During this month our inspectors made 6,969 inspection trips, visited 13,220 boilers, inspected 4,780 both internally and externally, and subjected 586 to hydrostatic pressure. The whole number of defects reported reached 11,036, of which 995 were considered dangerous; 48 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	775	66
Cases of incrustation and scale,	1,225	58
Cases of internal grooving,	110	18
Cases of internal corrosion,	466	32
Cases of external corrosion,	736	60
Broken and loose braces and stays,	126	46
Settings defective,	196	22
Furnaces out of shape,	389	23
Fractured plates,	233	50
Burned plates,	218	35
Blistered plates,	280	13
Cases of defective riveting,	2,433	65
Defective heads,	93	26
Serious leakage around tube ends,	2,043	285
Serious leakage at seams,	404	22
Defective water-gauges,	312	46
Defective blow-offs,	114	29
Cases of deficiency of water,	17	12

Nature of Defects.	Whole Number.	Dangerous.
Safety-valves overloaded,	48	17
Safety-valves defective in construction,	79	25
Pressure-gauges defective,	408	32
Boilers without pressure-gauges,	1	1
Unclassified defects,	330	12
Total,	11,036	995

Summary for the Year 1891.

During the year our inspectors made 71,227 visits of inspection, examined 137,741 boilers, inspected 57,312 boilers, both internally and externally, subjected 7,859 to hydrostatic pressure, and found 526 unsafe for further use. The whole number of defects reported was 127,609, of which 10,858 were considered dangerous. A summary of the work by months is given below, and the usual classification by defects is likewise given.

Summary by Months.

Month.	Visits of inspection.	Number boilers examined.	No. inspected internally and externally.	No. tested hydrostatically.	Number condemned.	Number of defects found.	Number of dangerous defects found.
January,	5,953	12,513	4,577	521	48	10,719	925
February,	5,231	9,484	3,296	618	31	10,140	677
March,	6,086	12,195	4,389	780	51	11,227	903
April,	5,509	10,706	4,341	641	40	9,933	951
May,	5,265	10,418	4,939	721	63	11,142	984
June,	6,044	11,405	5,106	703	33	11,196	1,110
July,	6,177	11,997	6,585	732	49	12,007	906
August,	5,644	10,398	4,697	619	43	9,236	626
September,	5,726	10,891	5,177	603	33	8,890	822
October,	6,018	11,667	4,717	689	46	10,664	938
November,	6,605	12,847	4,708	646	41	11,419	1,021
December,	6,969	13,220	4,780	586	48	11,036	995
Totals,	71,227	137,741	57,312	7,859	526	127,609	10,858

Summary of Defects for the Year 1891.

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	9,651	522
Cases of incrustation and scale,	15,695	676
Cases of internal grooving,	1,003	150
Cases of internal corrosion,	5,031	311
Cases of external corrosion,	8,486	557
Defective braces and stays,	1,713	531
Settings defective,	3,162	319
Furnaces out of shape,	4,099	215
Fractured plates,	2,482	672
Burned plates,	2,320	354

Nature of Defects.	Whole Number.	Dangerous.
Blistered plates,	3,462	129
Defective rivets,	28,100	1,097
Defective heads,	976	232
Leakage around tubes,	23,565	2,867
Leakage at seams,	4,822	400
Water gauges defective,	3,536	424
Blow-out defective,	1,378	303
Cases of deficiency of water,	209	114
Safety-valves overloaded,	675	193
Safety-valves defective,	804	242
Pressure gauges defective,	4,687	374
Boilers without pressure gauges,	82	82
Unclassified defects,	1,671	94
Total,	127,609	10,858

In order to exhibit the growth of the company's business we append a summary of the work of its inspectors from 1870 to 1891, inclusive. The years 1876 and 1878 are omitted, because the data that we have at hand for those years are not complete. The

SUMMARY OF INSPECTORS' WORK SINCE 1870.

YEAR.	Visits of inspection made.	Whole number of boilers inspected.	Complete internal inspections.	Boilers tested by hydrostatic pressure.	Total number of defects discovered.	Total number of dangerous defects discovered.	Boilers condemned.
1870	5,439	10,569	2,585	882	4,686	485	45
1871	6,826	13,476	3,889	1,484	6,253	954	60
1872	10,447	21,066	6,533	2,102	11,176	2,260	155
1873	12,824	24,998	8,511	2,175	11,998	2,892	178
1874	14,368	29,200	9,451	2,078	14,256	3,486	163
1875	22,612	44,763	14,181	3,149	24,040	6,149	216
1877	.....	32,975	11,629	2,367	15,964	3,690	133
1879	17,179	36,169	13,045	2,540	16,238	3,816	246
1880	20,939	45,166	16,010	3,490	21,033	5,444	377
1881	22,412	47,245	17,590	4,286	21,110	5,801	363
1882	25,742	55,679	21,428	4,564	33,690	6,867	478
1883	29,324	60,142	24,403	4,275	40,953	7,472	545
1884	34,048	66,695	24,855	4,180	44,900	7,449	493
1885	37,018	71,334	26,637	4,809	47,230	7,325	449
1886	39,777	77,275	30,868	5,252	71,983	9,960	509
1887	46,761	89,994	36,166	5,741	99,642	11,522	622
1888	51,483	102,314	40,240	6,536	91,567	8,967	426
1889	56,752	110,394	44,563	7,187	105,187	8,420	478
1890	61,750	118,098	49,983	7,207	115,821	9,387	402
1891	71,227	137,741	57,312	7,859	127,609	10,858	526

figures, so far as we have them, indicate that the work during these years was in good accordance with the regular progression observable in other years. Previous to 1875, it was the custom of the company to publish its reports on the first of September, but in this year the custom was changed and the summaries were made out up to January 1st, so as to agree with the calendar year. The figures given opposite 1875, therefore, are for the sixteen months beginning September 1, 1874, and ending December 31, 1875.

The increase in the work of our inspectors during the past year is well shown in the following short table:

Comparison of Inspectors' Work During the Years 1890 and 1891.

	1890.	1891.
Visits of inspection made, - - - - -	61,750	71,227
Whole number of boilers inspected, - - -	118,098	137,741
Complete internal inspection, - - - -	49,983	57,312
Boilers tested by hydrostatic pressure, - - -	7,207	7,859
Total number of defects discovered, - - -	115,821	127,609
" " dangerous defects, - - -	9,387	10,858
" " boilers condemned, - - -	402	526

The following table is also of interest. It shows that our inspectors have made nearly two-thirds of a million visits of inspection, and have, in all, made over a million and a quarter of inspections, in the course of which nearly a million defects were discovered and pointed out to the owners. Of these defects, over an eighth of a million were considered dangerous:

Grand Total of the Inspectors' Work Since the Company Began Business, to January 1, 1892.

Visits of inspection made, - - - - - - -	639,991
Whole number of boilers inspected, - - - - -	1,268,129
Complete internal inspection, - - - - - -	482,205
Boilers tested by hydrostatic pressure, - - - - -	86,749
Total number of defects discovered, - - - - -	962,757
" " dangerous defects, - - - - -	130,654
" " boilers condemned, - - - - -	7,128

Boiler Explosions.

December, 1891.

Saw-mill (230). Pope & Pulley's mill near Hornersville, Mo., was destroyed by a boiler explosion on Dec. 1st. There were eight men at work in the mill, and three of them were killed, — Curtis Long, Lee Clark, and William Riley. William Pope, who stood with Long, Clark, and Riley in front of the boiler when the explosion occurred, was hurled between two logs and pinioned there, but was not fatally injured. Three other men had just left the spot where the boiler made the worst havoc. The cause of the explosion has not been ascertained. The gauge showed only eighty pounds of steam.

Zinc Works (231). An over-heated boiler in the Passaic Zinc Works, near the Hackensack, exploded in Jersey City on Dec. 1st. A tramp giving his name as Thomas

Norris, who had crept in beside the boiler to sleep, was severely scalded about the legs. The explosion was terrific. The foundation of the building was shaken, and many panes of glass shattered. Norris was removed to the city hospital. The building was damaged to the extent of $200.

SAW-MILL (232). A terrific and fatal boiler explosion occurred at Benjamin Huffman's saw-mill, on Big Buffalo, Braxton county, W. Va., on Dec. 2d. There were about one hundred pounds of steam on at the time, and the fireman, sawyer, and other hands about the mill were busy mending a belt which had broken. The only person very close to the boiler at the fatal moment was Charley Rhea, who had come from the lumber yard and was standing in front of the furnace, warming himself. The boiler was hurled forty or fifty feet, and rocks, boards, and other missiles were thrown in every direction. Young Rhea was instantly killed, but the other hands escaped without injury, except a few slight bruises and a general shaking up. The unfortunate young man, Rhea, was about eighteen years of age.

PAPER MILL (233). The large boiler in the Fort Madison paper mill, Fort Madison, Ia., exploded with terrible force on Dec. 4th, wrecking the mill. Three operators, Stephen Buckner, Barney Menke, and Henry Neier, were so terribly injured that it is feared they will die. The mill is so badly wrecked that operations will be suspended for the winter.

MINE (234). Mine No. 1, operated by the Mount Olive Company, situated about a mile north of Mt. Olive, Ill., was the scene of an accident on Dec. 5th, as a result of which two men are dead, and several others seriously injured. The men went into the boiler house to keep warm, when a flue blew out of one of the boilers, and they were deluged with boiling water and steam. Tom Roach and Otto Schenck, both miners, were terribly scalded, and both died in great agony. Preston Maybell and August Riegol were severely scalded, the former probably fatally.

SAW-MILL (235). J. W. Couston's saw-mill, six miles north of Colliersville (near Memphis, Tenn.), was wrecked, on Dec. 7th, by the explosion of the boiler. Two men were killed, and the mill, valued at $2,000, was wrecked. The force of the explosion was such that a twelve-foot pipe was blown into the heart of a white oak tree.

PLANING MILL (236). By the failure of a mud drum in Kreinheder & Flierl's planing mill, Buffalo, N. Y., on Dec. 8th, three men were badly scalded. The mill sustained no damage. Dec. 8th was a bad day for planing mills in Buffalo, for on that day a severe dust explosion occurred in Lee, Holland & Co.'s mill on Court street, by which one man was killed and four injured.

AGRICULTURAL ENGINE (237). On Dec. 8th, the explosion of a boiler on the place of Major Frank L. Anderson, at Reidville, Ga., caused the death of a young man named Wm. Burnett, and fatally scalded Benj. Anderson, a son of Major Anderson. The boiler was an old one, having been used for about twenty years. The two young men were oiling some part of the engine when the explosion occurred with a noise that could be heard several miles. Burnett was blown thirty feet and fell against a bank. He was fearfully bruised and scalded, and died in two hours.

SAW-MILL (238). The boiler of Chapman's saw-mill, three miles from Otterville, Mo., exploded on Dec. 9th, killing Engineer Henry Jennings, and fatally injuring Sterling Coe, who has since died. Jesse Wilson was also slightly injured.

LUMBER MILL (239). The boiler in Stonebraker's lumber mill, Fredericksburg, Va., exploded, on Dec. 10th, wrecking the building and killing Engineer Tyson. Two small boys named Hudson were badly injured, one of them fatally so. A Mr. Saunders was hurled forty or forty feet, but fortunately he landed on a pile of sawdust, so that he escaped serious injury.

Starch Factory (240). A disastrous boiler explosion, which, fortunately, was unattended by loss of life, occurred, on Dec. 10th, at the starch factory of Wiesendanger & Narome, corner of Eighth and San Pedro streets, Los Angeles, Cal., completely wrecking the building. It was a two-story brick structure, one of the most substantial of the kind in the city, and was erected seven years ago at a cost of $12,000. The boiler, which was second-hand, was purchased in 1884, and was carefully tested when the starch factory was started up, and appeared to be in good condition. A few minutes after the last of the employes went to supper that evening there was a terrific explosion, and the large horizontal tubular boiler sailed through the wall like a cannon ball, landing on the sidewalk. The neighboring residence of R. G. Weyse, who owned the building, was partially shattered, and Otto Weyse, who was in his bed, had a narrow escape. An inspection of the remains of the boiler shows that the sheets on the bottom were reduced to the thickness of an eighth of an inch.

Threshing Machine (241). The boiler of a threshing machine exploded on Dec. 12th, on the farm of Ezekiel Boyce, two miles southwest of Mayville, a village near Detroit, Mich. Two men were killed, and one was seriously injured, and the barns were destroyed by fire. The property loss is estimated at $1,200.

Brick Works (242). A boiler exploded, on Dec. 12th, in a brick-works near the village of Irondale, O. The engineer escaped uninjured, but Oscar Campbell, a boy of 15, was killed. The works were almost demolished, and the tracks of the Cleveland & Pittsburgh road were blocked for some time with the débris.

Drilling Well (243). The boiler at Mellon & Gartland's well, northeast of Oakdale, Pa., exploded on Dec. 14th. The largest section of the boiler struck and completely wrecked the kitchen of a house near by in which thirty men were sleeping. Nobody was hurt.

Feed Mill (244). On Dec. 17th, a boiler exploded in Elliot Perkins's feed mill, in Holland, near Toledo, O. The explosion resulted in the instant death of the engineer, Adams, and Floyd Perkins, son of the proprietor. Mr. Elliot Perkins and another son were also badly injured, but not dangerously. The mill was damaged to the extent of about $1,200.

Saw-mill (245). Three persons were killed outright, one mortally wounded, and two others badly injured by the explosion of the boiler in the saw-mill of A. Collett, Ridgeville, Ind., on Dec. 17th. The boiler was a large one and apparently in good order. It had three gauges of water, and started up under the usual amount of steam, running both saws. At 7.30 a belt ran off, and the engineer went to shut down the engine and throw on the belt when the explosion occurred, and, as all in the building were killed at once, it will never be known how it happened. The mill is a total wreck.

Paper Mill (246). On Dec. 18th, a safety-valve failed in the boiler-room of the Taggart Paper Mill, near Carthage, N. Y., severely scalding Frank Wood, John Spicer, Joseph Douay, Joseph Wood, Jr., and Frank Wood.

Saw-mill (247). The boiler of Farland Bros.' saw-mill, twelve miles from Neillsville, Wis., exploded on Dec. 19th. One man, Geo. McCormick, was killed, and several others were seriously injured by the flying pieces and escaping steam.

PORTABLE BOILER (248). A boiler used by some stone contractors near the new Baldwin Theatre, on St. Louis street, Springfield, Mo., exploded, on Dec. 19th, killing Engineer Philip Davis, Assistant Engineer Robert Baer, and George Crews.

LOCOMOTIVE (249). On Dec. 19th, a locomotive exploded in Little Rock, Ark. The engine was dismantled, and the engineer and fireman were slightly injured.

SAW-MILL (250). A boiler exploded in Blither's saw-mill, Catskill, Colo., on Dec. 21st, while the men were at dinner. The loss is estimated at about $10,000. Not a vestige of boiler or machinery remains.

BARBER SHOP (251). On Dec. 21st, a heating boiler exploded in Christopher's barber shop, on Pike street, Seattle, Wash. Nobody was hurt, and the damage was only about $250.

PAPER MILL (252). A terrific boiler explosion occurred, on Dec. 21st, at the Waidlow, Thomas & Co. paper mill in Middletown, O., wrecking the brick boiler-house, and badly damaging one side of the mill. Fireman David McChesney was badly scalded and bruised, but, it is thought, will recover; while Geo. Lawrence, son of the superintendent of the mill, was also severely scalded about the face and body. A part of the machinery was badly broken and damaged.

SAW-MILL (253). The boiler at Wm. McCoy's mill, eight miles south of Richmond, Ind., blew up, on Dec. 28th, killing Isaac Taylor, the engineer. Four other men had narrow escapes. The boiler is said to have been condemned for two years.

PORTABLE BOILER (254). By the explosion of the boiler of a rock-crusher in Rome, Ga., on Dec. 30th, two men, Will Brown and Henry Dean, were dangerously hurt, and several others were slightly injured.

Summary of Boiler Explosions for the Year 1891.

Our usual summary and classified list of the boiler explosions that have taken place during the past year is presented herewith. So far as we have been able to learn, the total number of explosions was 257, against 226 for 1890 and 180 for 1889. In several instances more than one boiler has exploded at the same time. Where this has been the case we have counted each boiler separately, as in previous summaries since 1887, believing that by so doing we can give a fairer conception of the amount of damage done during the year. It is difficult to make up an accurate list of the killed and injured, as in many cases the newspaper reports (upon which we largely depend in making up our monthly lists) are rather indefinite. We have carefully examined the accounts of each explosion, however, and have done our best to make the summary as fair as possible.

We are pleased to say that, although the number of explosions was large, the loss of life appears to have been smaller than for any year since 1886. The number of persons injured was 371, against 351 in 1890, 433 in 1889, 505 in 1888, 388 in 1887, and 314 in 1886.

It should be understood that this summary does not pretend to include *all* the explosions of the year. In fact, it probably includes but a fraction of them. Many accidents have undoubtedly happened that were not considered by the press to be sufficiently "newsy" to interest the general public; and many others have, without question, been reported in local papers that we do not see.

Classified List of Boiler Explosions in the Year 1891.

CLASS OF BOILER.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1. Saw-mills and other Wood-working Establishments, . .	5	9	5	3	7	3	6	4	4	4	8	10	68
2. Locomotives, ...	3	3	...	3	...	1	3	2	1	3	2	1	22
3. Steamships, Tugs, and other Steam Vessels, ...	1	2	1	...	4	1	3	2	...	2	1	...	17
4. Portable Boilers, Hoisters, and Agricultural Engines, . .	...	...	1	...	1	3	5	8	4	5	5	3	35
5. Mines, Oil Wells, Collieries, ...	1	1	8	3	2	1	...	...	2	1	2	2	23
6. Paper Mills, Bleacheries, Digesters, etc., ...	1	3	...	...	...	...	...	...	...	1	...	3	8
7. Rolling Mills and Iron Works, ...	...	1	...	...	5	3	1	1	...	3	2	...	16
8. Distilleries, Breweries, Dye-Works, Sugar Houses, and Rendering Works, ...	1	...	1	...	1	...	2	1	1	1	1	...	9
9. Flour Mills and Grain Elevators, ...	1	2	1	1	...	...	1	...	...	1	...	...	7
10. Textile Manufactories, ...	2	2	1	...	...	...	1	...	...	...	...	...	6
11. Miscellaneous, ...	6	3	1	4	4	2	2	5	3	5	5	6	46
Total per month, ...	21	26	19	14	24	14	24	23	15	26	26	25	257
Persons killed (total, 263), " "	23	36	11	7	21	22	23	13	19	36	20	32	
Persons injured (total, 371), " "	28	43	31	10	27	25	45	31	15	52	34	30	

The Population of the Earth.

An interesting article on this subject appears in the *Popular Science Monthly* for January. The results of elaborate study of this subject, by Drs. Supan and Wagner, are as follows:

Territory.	Square Miles.	Population.	To 1 Sq. Mile.
Europe,*	3,756,860	357,379,000	94
Asia,†	17,530,686	825,954,000	47
Africa,‡	11,277,364	163,953,000	14
America,§	14,801,402	121,713,000	8
Australia,‖	2,991,442	3,230,000	1
Oceanic Islands, ...	733,120	7,420,000	10
Polar Regions, ...	1,730,810	80,400	..
Total, ...	52,821,684	1,479,729,400	..

* Without Iceland, Nova Zembla, Atlantic Islands, etc. † Without Arctic Islands. ‡ Without Madagascar, etc. § Without Arctic regions. ‖ The continent and Tasmania.

The Locomotive.

HARTFORD, FEBRUARY 15, 1892.

J. M. Allen, *Editor.* A. D. Risteen, *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. (Any volume can be supplied.)

Papers that borrow cuts from us will do us a favor if they will mark them plainly in returning, so that we may give proper credit on our books.

We have received the *Annual Report* of the Chief of the Bureau of Steam Engineering for the year 1891, issued by the Navy Department.

It was an old New England judge who once interrupted a lawyer in the midst of a spread-eagle speech by saying: "Mr. ——, I wish you would take a few feathers from the wings of your imagination and put them in the tail of your judgment." — *Ex.*

The magnificent new screw ferry-boat *Bremen*, belonging to the Hoboken Ferry Company and running between Hoboken and New York, made her trial trip on Tuesday, Dec. 1st. In connection with this trip the ferry company issued a neat pamphlet briefly recounting the history of ferry-boat building during the past few years, and giving particulars of the design and tests of the *Bremen*, the *Bergen*, and the *Orange*. It is illustrated by two suggestive cuts, showing the boats in use in 1804 and 1891.

Messrs. John Wiley & Sons send us a copy of Dingey's *Machinery Pattern Making*. Most of the matter contained in the book appeared originally in the *American Machinist*, but it has been thoroughly revised by the author, and its present form makes it very handy for reference. It is fully illustrated and beautifully printed. Mr. Dingey is a practical pattern-maker and draughtsman, and his work has a peculiar value because it comes from a man engaged in the business. Too much of our literature is written by men who have had but little actual experience in the matters of which they treat.

Mr. W. C. Bruce, engineer in charge, writes to say that the accident at the Cerealine Company's works, reported among the boiler explosions in our October issue (No. 141), was not a boiler explosion. We make the correction with pleasure. "The accident spoken of, says Mr. Bruce, was the bursting of a small steam trap while the man, John Wagner, was tightening up the flange bolts. One of the bolts broke, causing the others to give way also. The man did not lose his sight, and is now at work again." (We are indebted, for the misinformation that led us to class this accident among boiler explosions, to the Chicago *Inter-Ocean* of August 3, 1891.)

We have received from Messrs. John Wiley & Sons, of 53 East Tenth street, New York, a copy of the second part of Dr. R. H. Thurston's *Manual of the Steam Engine.* The first part of this work appeared a short time ago, and was noticed in The Locomotive. It was devoted to the structure and theory of the steam engine, and discussed its history, structure, philosophy, and theory. Chapters on thermodynamics, compounding, jacketing, superheating, and efficiencies were also given, so that it formed a comprehensive treatise on the principles underlying the operation of the engine. The present volume is devoted to the design, construction, and operation of engines, and contains chapters on design, on valves and valve motions, on regulation, governors, fly-wheels, and inertia effects, on construction and erection, on operation, care, and management, on tests, on specifications and contracts, and on finance, costs, and estimates. The book contains nearly a thousand pages. It is clearly written, and in some respects we consider it the best thing that Professor Thurston has yet published. The chapter on finance is especially worthy of attention. The typography is excellent, and the illustrations are numerous and good.

We have received from the author, Professor Johann Radinger, a copy of the third edition of his treatise *Ueber Dampfmaschinen mit hoher Kolbengeschwindigkeit* ("On Steam Engines with High Piston Speed"), published in Vienna by Carl Gerold's Sohn. Herr Radinger has for years been professor of machine design in the Hochschule in Vienna, and he is one of the highest living authorities on this subject. The first edition of this book was published as long ago as 1870, so that in preparing the present edition extensive revision was necessary, in order to bring it down to date. Herr Radinger's work is carefully and logically arranged, and his method of treating his subject reminds one of Rankine's style, except that it is more lucid, perhaps, than the illustrious Scotchman's. Herr Radinger confines himself entirely to the principles underlying the steam engine, and does not consider the matters of detail in which one manufacturer's design differs from another's. His book is a marvel of the printer's art, and the 92 cuts are unusually good. It is a work of which both author and publisher may well be proud.

The Screw Propeller.

By Samuel Nott, C. E.

In these days of high art in using steam power it is interesting to call to mind the day of small things, within the memory of thousands of people now living. I find a few notes on this subject in an unexpected quarter, namely, in Bishop Heber's travels in India, which he made tediously by sail on the sea, by oar, setting-pole, and sail on the rivers, and, on land, by palanquin, horse and elephant, through sections now long traversed by railroads. His notes are the more interesting, because he was a good man and a keen observer, — "a godly gentleman and a great lover of learning," as was said of John Howard, the founder of Harvard College, by one of his contemporaries. Nothing escaped the keen eye and attention of the Bishop. He visited the King of Oude in 1824, and the King talked about steam vessels, speaking particularly of a new way of propelling ships by a spiral wheel at the bottom of the vessel, which an English engineer in his pay had invented; and in a letter dated at Calcutta on December 14, 1825, he says the steamboat long promised from England, the *Enterprise*, is at length arrived, after a passage of nearly four months. Here we have an account of one of the earliest experiments with the screw propeller, made by an East India king living away up in the interior; and of the first steamer by the Cape of Good Hope to India.

The late John Ericsson, whose remains were not long ago borne to his native Sweden by a United States ship of war, in consideration of his invaluable services in the late war, was the man of all others to persevere in making the screw propeller a power throughout the world. Previous to 1839 Ericsson tried unsuccessfully to introduce it in England, and came to the United States. In 1840 the English woke up, and the propeller came rapidly into use in England. In 1841 the *Princeton* was built by our own Government, and was the first vessel with a screw propeller in this country. The introduction of the propeller was slow for ten or fifteen years, but now for more than fifteen years it has been the only mode of propulsion used on sea-going steam vessels and tug boats. There is no more animating and impressive sight in busy harbors and on busy rivers than to see the lively tug-boats darting about, towing the largest ships with ease; and it is hard to realize that even in Boston harbor, for instance, there were no regular tug-boats until, mainly through the continued efforts of John Ericsson, the screw propeller came into general use. Truly, "Peace hath her victories, as well as War."

The Grip.

Speaking of this malady, the *Boston Journal* says: "Professor Nothnagel of Vienna affirms that it is 'distinctly miasmatic in character, and that it is certainly infectious and probably contagious.' He also stated that persons having cardiac affections and those suffering from tuberculosis have most cause to fear a fatal result. As the infectious character of the disease proves that it is produced by spores or germs floating in the air, its prevention and cure are pretty clearly indicated.

"To prevent taking the disease people must take care of their general health. A slight cold, or exhaustion from overwork of any cause, is enough to give the spores their opportunity. When attacked by the feverish chill which almost invariably accompanies the disease, a person should, if possible, keep indoors for a few days, and by inducing free perspiration and using enough quinine to destroy the disease germs in the blood, most persons will escape the worst effects of the grip. But there are some severe cases which demand prompt advice and treatment from a physician.

"The reason why in this, as in other febrile attacks, a person is so weak, is evidently from the fact that the microbes, which are reproduced in the blood by the millions after an attack in a few hours, at once begin to devour the nutritious portion of the blood. And it is only after they are destroyed by some strong antiseptic antidote like quinine, or after they have devoured the best part of the blood, as in a common fever, they die; and then, if the patient has strength enough left to rally, he soon recovers. When putrid water cleanses itself it undergoes a similar process. But as a few of these persistent germs may remain hidden in some portion of the tissues for quite a period, a person must be ready to renew the battle long after he has recovered from the first attack."

IF a man has to wrestle with a lamb chop three hours after swallowing it, his good humor is exhausted. The contest in his body leaves him no strength for the battle with the world. Foreign wars are not so destructive as internal. When things sour on a man's stomach they make him sour with all the world. Some of us need not more a "new heart," according to the gospel, than a new liver, according to physiology.— *Talmage.*

The Wave Theory of Light.

In *Engineering* for Feb. 12th we find an article about Dr. Thomas Young, the physicist, a few extracts from which may be of interest. It is well known that Newton advocated the corpuscular theory of light, because he considered that a body could not cast a shadow, or at least a *sharp* shadow, if light is a wave-motion. The waves, he considered, would flow around an object in the same manner that waves in the ocean flow around a lighthouse, or other obstacle, so that even in bright sunlight we should find only a slight indication of a shadow. A good example of this is afforded by sound. If we are close to a large building we may fail to hear a disturbance on the other side of it; but if we go away from the building a short distance we can hear the noise with increasing loudness and distinctness. This is so because, although the structure casts a sound-shadow, it is a very short one, and the waves speedily flow around it, so that only a short distance away we can hear very well. Newton considered that if the wave-theory of light were true we should notice similar phenomena with regard to light-shadows; but he knew that in total eclipses of the sun it is very dark in places that are in the full shadow of the moon; so that it is certain that even at a distance of 240,000 miles from an object, its shadow may be very black. Newton's argument was a sound one until Dr. Young advanced the theory of *interference* of waves, which, as Sir John Herschel said, "procured for its author a scientific immortality." It follows from Young's theory, that an object may cast a long and very black shadow, even if light is a wave-motion, *provided* the waves are very short when compared with the size of the body casting the shadow. Now the waves of a sound whose pitch is "fundamental C" are about two feet long; but waves of yellow light are so short that it would take about 400,000 of them, end to end, to make an inch. The two are therefore very different, and we see why an ordinary object may cast a dense light-shadow, but a very slight sound-shadow.

Dr. Young's own account of his discovery is as follows:—"It was in May, 1801, that I discovered, by reflecting on the beautiful experiments of Newton, a law which appears to me to account for a greater variety of interesting phenomena than any other optical principle that has yet been made known. I shall endeavor to explain this law by a comparison. Suppose a number of equal waves of water to move upon the surface of a stagnant lake, with a certain constant velocity, and to enter a narrow channel leading out of the lake; suppose then, another similar cause to have existed, another equal series of waves will arrive at the same channel with the same velocity, and at the same time with the first. Neither series of waves will destroy the other, but their efforts will be combined. If they enter the channel in such a manner that the elevations of one series coincide with those of the other, they must together produce a series of greater joint elevations; but if the elevations of one series are so situated as to correspond to the depressions of the other, they must exactly fill up those depressions, and the surface of the water must remain smooth; at least I can discover no alternative either from theory or from experiment. Now, I maintain that similar effects take place whenever two portions of light are thus mixed, and this I call the general law of the interference of light."

The Locomotive.

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On Stayed Surfaces.

In the construction of steam boilers with internal furnaces, it is customary to use stay-bolts to sustain flat surfaces, or to prevent the collapse of curved surfaces when the pressure acts inward upon them. The locomotive boiler is a familiar example of this sort of construction, in which the surfaces to be stayed are flat. Curved surfaces, requiring stay-bolts, occur in the various forms of upright boilers with water-legs around the furnace; and as we have recently been called upon, in a number of instances, to give opinions concerning the safe working pressure allowable on boilers of this class, we propose to explain the problem in the present article, and give the method of computation that is in use in this office.

The cuts represent a water-leg of the kind under consideration, Fig. 1 being a top or

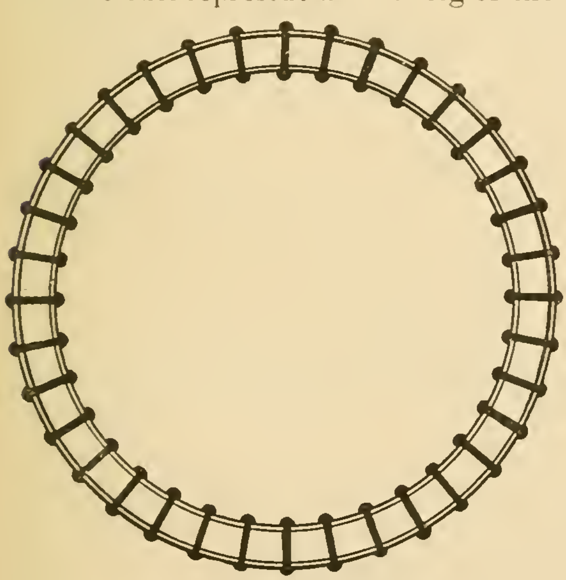

Fig. 1.

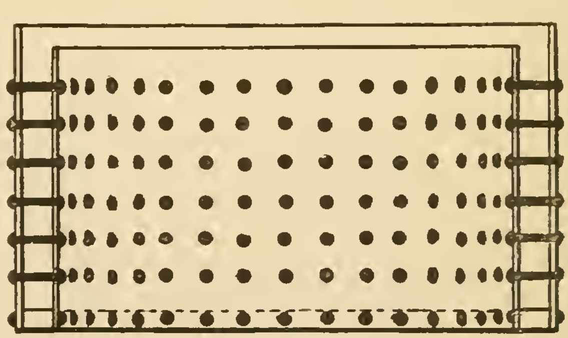

Fig. 2.

A Cylindrical Water-Leg.

plan view, and Fig. 2 a side view or elevation. In Fig. 2 the front half of the water leg has been removed for the sake of clearness.

In considering a structure of this kind, the question immediately arises, whether we should treat it the same as a flat surface, or whether the fact that it is curved will modify the problem materially. This question can only be answered by a mathematical analysis of the distribution of the strains. We have made such an analysis, and without going into the details of the investigation, we may say that the following formulæ result from it. The only assumption that has been made, is that the workmanship is good, so that no undue or extraordinary strain is concentrated at any particular point. The meaning of the letters is as follows:

R_1 = internal radius of external shell.
R_2 = external radius of internal shell.
S_1 = additional tension, per sq. in. of sectional area, on external shell.
S_2 = " " " " " internal shell.
T = tension, per sq. in. of sectional area, on each stay bolt.
t_1 = thickness of outer shell.
t_2 = thickness of inner shell.
A = area of outer shell to which one stay-bolt is allotted.
a = net sectional area of each stay-bolt.
P = pressure of steam, per square inch.

$$T = \frac{PA\ (t_2\ R_1^2 + t_1\ R_2^2)}{aR_1\ (t_2\ R_1 + t_1\ R_2) + t_1\ t_2\ A\ (R_1 - R_2)}$$

$$S_1 = \frac{(PA - Ta)\ R_1}{t_1\ A}, \qquad S_2 = \frac{Ta\ R_1 - PA\ R_2}{t_2\ A}.$$

It should be understood that S_1 and S_2 do not represent the *whole* strain on the shell. They stand for the *excess* of the strains in the curved shell, over and above what they would be if the stayed surfaces were flat.

As a numerical example of the foregoing formulæ, let us consider a case that recently came up in this office. The dimensions were as follows: $R_1 = 39''$, $R_2 = 36''$, $t_1 = \frac{1}{2}''$, $t_2 = \frac{3}{8}''$, and $P = 150$ pounds. The diameter of the stays from the base of the thread was $\frac{7}{8}''$, so that $a = 0.601$; and the pitch of the stay-bolts, from center to center, was $5\frac{11}{16}$ inches in both directions, so that $A = 5\frac{11}{16} \times 5\frac{11}{16} = 32.35$ square inches. Hence,

$$T = \frac{150 \times 32.35 \times (\frac{3}{8} \times 39^2 + \frac{1}{2} \times 36^2)}{.601 \times 39 \times (\frac{3}{8} \times 39 + \frac{1}{2} \times 36) + \frac{1}{2} \times \frac{3}{8} \times 32.35 \times (39 - 36)}.$$

Upon reducing this fraction to its lowest terms, we find that $T = 7{,}552$ pounds per square inch, which is the tension on the stay-bolts. Having found T, we can now calculate S_1 and S_2. We have

$$S_1 = \frac{(150 \times 32.35 - 7{,}552 \times .601) \times 39}{\frac{1}{2} \times 32.35} = \frac{313.8 \times 39}{16.175} = 757.$$

Hence the strain on the outer shell of the curved water-leg exceeds the strain that would come upon a flat surface similarly designed, by 757 pounds per square inch of sectional area.

A similar computation gives us S_2. Thus:

$$S_2 = \frac{7{,}552 \times .601 \times 39 - 150 \times 32.35 \times 36}{\frac{3}{8} \times 32.35} = \frac{2321}{12.131} = 191.$$

That is, the tension on the inner shell exceeds the tension that would come upon a similar flat surface by 191 pounds per square inch of sectional area.

When $P \times A \times R_2$ is greater than $T \times a \times R_1$, the subtraction in the formula for S_2 must be performed the other way, and S_2 must be *subtracted* from the calculated strain on a flat plate, similarly designed. S_1, on the other hand, is always additive, since it is not possible for $T \times a$ to exceed $P \times A$. It also follows from the formulæ above that the tension on the stay-bolts in a curved surface can never *exceed* the tension on the stay-bolts of a flat surface, similarly designed.

It is not our custom to publish formulæ such as those above, but in the present case we considered them essential to a thorough treatment of the problem in hand.

We may remark that they show that the strains in a curved stay-bolted structure like that shown in Figs. 1 and 2 are not materially different from those in flat surfaces similarly designed. This being the case, we see the justice of the United States Government Rule for computing the strength of curved stayed surfaces. This rule, as given in the *Amended Steamboat Rules and Regulations* issued by the treasury department in February, 1891, is as follows: "All vertical boiler furnaces constructed of wrought-iron or steel plates, and having a diameter of over 42 inches or a height of over 40 inches, shall be stayed with bolts *as provided by Section* 6 *of Rule II for flat surfaces;* and the thickness of material required for the shells of such furnaces shall be determined by the distance between the centers of the stay-bolts in the furnace and not in the shell of the boiler; and the steam pressure allowable shall be determined by the distance from center to center of the stay-bolts in the furnace, and the diameter of such stay-bolts at the bottom of the thread." According to this rule, the number and diameter of the stays and the thickness of the plate are to be calculated in water-legs such as that shown in the cuts, in the same manner as for flat surfaces. Section 6 of Rule II, referred to above, reads as follows: "No braces or stays hereafter employed in the construction of boilers shall be allowed a greater strain than 6,000 pounds per square inch of section. . . . And no brace or stay-bolt used in a marine boiler will be allowed to be placed *more* than $10\frac{1}{2}$ inches from center to center on fire-boxes, furnaces, or back connections; nor will they be allowed to be placed at a greater distance than will be determined by the following formulas:

"The working pressure allowed on flat surfaces fitted with screw stay-bolts and nuts, or plain bolts with single nut and socket, or with riveted head and socket, will be determined by the following rule: When plates $\frac{7}{16}$ inch thick and under are used in the construction of marine boilers, multiply the constant 112 by the square of the thickness of the plate in sixteenths of an inch. Divide this product by the square of the pitch, or distance from center to center of the stay-bolts.

"For plates above $\frac{7}{16}$ inch thick, the pressure will be determined by the same rule, except that the constant will be 120.

"On other flat surfaces there may be used stay-bolts with ends threaded, having nuts on the same, both on the outside and on the inside of the plates. The working pressure allowed would be found as follows: Multiply the constant 140 by the square of the thickness of the plate in sixteenths of an inch, and divide this product by the square of the distance between the bolts from center to center.

"Plates with bolts with double nuts and a washer at least one-half as thick as the plate, and a size equal to two-fifths the pitch of the stay-bolts, would be allowed with a constant 200, when riveted to the plates, by the rule as given above. Plates fitted with double angle iron riveted on, with a leaf at least two-thirds the thickness of the plate and a depth at least one-fourth of the pitch, would be allowed the same pressure as determined by the formula for plates with washers riveted on."

While we approve of the Treasury rule first quoted, which states that curved stayed surfaces are to be computed in the same manner as flat ones, we prefer, in calculating the allowable pressure on flat stayed surfaces, to avail ourselves of Mr. D. K. Clark's exhaustive study of the subject, the results of which will be found in the second part of his treatise on *The Steam Engine.** Mr. Clark first investigates flat, unstayed plates, and then applies the results of the investigation to stayed surfaces, which he regards, for

* "The Steam Engine: A Treatise on Steam Engines and Boilers," by Daniel Kinnear Clark, London, Blackie & Son, 1890.

convenience, as equivalent to a multitude of flat, unstayed plates, whose length and breadth are equal to the distance between the rows of bolts.

In his treatment of flat, unstayed plates or heads, he finds that the pressure that will strain such a head to its elastic limit is proportional simply to the thickness of the plate, instead of to the square of the thickness, as is assumed by most writers on the subject. The idea that it is proportional to the square of the thickness seems to have originated in conceiving the head to behave somewhat the same as a beam, supported at each end. But the strain on an unstayed boiler head would seem to be *all tension*, instead of compression on one side and tension on the other, as in a beam; and hence the formula for expressing the bursting pressure of such a head would not necessarily have the same form as that which expresses the breaking load of a beam. Clark's words on this point are (p. 623), "Since the end-plate [of a boiler with a flat, unstayed head] is thrown by deflection into a state of tension throughout its thickness, the resistance to bursting pressure follows the ratio of the thickness simply; not the ratio of the square of the thickness, as is assumed for the most part by writers on the resistance of flat surfaces. The experiments of Sir William Fairbairn on the resistance of quarter-inch and half-inch plates to bulging stress, applied at the center, showed clearly that the resistance increased directly as the thickness. The experiments of Mr. Kirkaldy point to the same conclusion." The formula deduced by Mr. Clark for flat heads appears to agree with experimental data fairly well, so that we may have some confidence in it when he extends it to the consideration of the strength of stayed surfaces.

Continuing, our author says (p. 629), "The flat plate-surfaces of steam boilers are stayed with rows of bolts, pitched, usually, at equal intervals, vertically and transversely, dividing the surface into rectangles or squares. When internal pressure is applied on one face of the plate, it is bulged, and resolves itself into a group of circular or arched segments starting from the stay-bolts, in the manner represented by a tufted cushion. The segments are mitred together like groined arches, and they merge in the elevated interspaces between the stay-bolts. In section, the plate is formed as a series of arches from bolt to bolt. Like a flat end-plate, the stayed-plate is qualified for resisting internal pressure, by assuming a curved form. But, while the flat end-plate [or head] takes the form of a spherical segment, the radical form of the stayed-plate when deflected is cylindrical, or at least approximately cylindrical; and its capability for resistance can be calculated accordingly."

By considering the stayed surface in this way, as an aggregate of small unstayed surfaces, he arrives at the following formulæ, in which p is the pressure that will strain the plates to their elastic limit, t is the thickness of the plate in inches, and d is the distance between two rows of stay-bolts, *in the clear*, — that is, d is the distance between centers, less the diameter of the stay-bolt at the base of the thread.

Expressed in words these rules are, (1) To find the internal pressure that will strain a flat iron stayed surface to its elastic limit, multiply the constant number 5,000 by the thickness of the plate in inches, and divide the product by the distance, *in the clear*, between two consecutive rows of stay-bolts. (2) To find the thickness of an iron plate that will be strained just to its elastic limit by a given pressure, multiply the pressure by the distance, *in the clear*, between the rows of bolts, and divide by the constant number 5,000. (3) To find the pitch of the bolts, having given the thickness of the iron plate and the pressure that is to strain it to the elastic limit, multiply the constant number 5,000 by the thickness and divide by the pressure. The rules are the same for plates of steel or copper, except that the constant number is 5,700 for steel, and 3,300 for copper. (In case the pitches of the bolts are not the same in both directions, the largest pitch is to be used in these rules.)

Formulæ for Ultimate Elastic Strength of Flat Stayed Surfaces.

	Material of Plates.		
	Iron.	Steel.	Copper.
Pressure, ...	$p = 5000 \frac{t}{d}$	$p = 5700 \frac{t}{d}$	$p = 3300 \frac{t}{d}$
Thickness of Plate, .	$t = \frac{p \times d}{5000}$	$t = \frac{p \times d}{5700}$	$t = \frac{p \times d}{3300}$
Pitch of Bolts, . . .	$d = \frac{5000t}{p}$	$d = \frac{5700t}{p}$	$d = \frac{3300t}{p}$

To find the diameter of the bolts, Clark gives the following rule: Multiply the square root of the pressure that will strain the plate to its elastic limit, by the pitch of the stay-bolts *between centers*; then, if the bolts are iron, multiply by .0069: if they are of steel, multiply by .0064; and if of copper, multiply by .0084.* The result is the diameter of a bolt that would just be strained to its elastic limit by the given pressure. The bolts actually used should be larger, for reasons presently to be given. If the pitches are not equal in both directions, the foregoing rule becomes as follows: Multiply the pitch of the vertical rows by the pitch of the horizontal rows (both measured from center to center), and multiply the product by the pressure that will strain the plate to its elastic limit. Extract the square root of the result, and then multiply by .0069, by .0064, or by .0084, according as the bolts are made of iron, steel, or copper. (In all these rules, the "diameter of the bolt" is understood to mean the diameter at the base of the thread.)

The factor of safety to be used for stay-bolts requires the most careful consideration, for we have to provide not only against faulty workmanship and defective material, but against corrosion. Ford, in his excellent little work on *Boiler Making*, bases the strength of stayed surfaces on the *tensile* strength of the bolt instead of the *elastic* strength, and allows a factor of safety of 6; but he recommends placing the bolts nearer together than his formula indicates. The Treasury Department, by limiting the strain on stay-bolts to 6,000 pounds per square inch, fixes the factor of safety at not less than 7½ or 8. Thurston (*A Manual of Steam Boilers*, p. 144) says that stay-bolts "should be given a large factor of safety (15 to 20) to allow for reduction of size by corrosion, from which kind of deterioration they are liable to suffer seriously." We may, perhaps, adopt 10 as a reasonable factor of safety when the calculated size of the bolt is based on the tensile strength of the material. This corresponds to about 5, when, as in Clark's formulæ, the stay-bolt is computed from the elastic limit.

We have now to consider what kind of a joint should be provided on these cylindrical water-legs. To illustrate the mode of procedure, we shall use the example previously given, in which the thicknesses of the outer and inner plates are ½ inch and ⅝ inch respectively, the bolts being ⅞ (= .875) inch in diameter as the base of the thread, and

* This rule occurs on page 631 of the book already cited; but by a printer's error, the decimal points were all put one place too far to the left. (See the example on page 633.) The same errors occur in *D. K. Clark's Pocket Book* (1892), on page 384.

pitched $5\frac{11}{16}$ (= 5.6875) inches apart, from center to center. The distance, in the clear, from one row of stay-bolts to the next, is 5.6875 – .875 = 4.8125 inches, on the outside plate. Rule (1) therefore gives us (using the constant 5,700, because the plates are of steel).

$$\frac{5700 \times \frac{1}{2}}{4.8125} = 592 \text{ pounds per sq. inch,}$$

as the pressure that will strain the plate to its elastic limit. A factor of safety of about 3 should be used in computing the safe working pressure when the *maximum elastic* pressure is given. Hence 592 ÷ 3 = 197 lbs. per square inch would be the safe working pressure, if there were no joints in the sheet. If it is desired to carry 150 pounds of steam, therefore, the efficiency of the joint used on the outside sheet of the water-leg must be at least as great as 150 ÷ 197 = .76. That is, the joint on the outer sheet must have an efficiency of at least 76 per cent. On a half-inch plate this cannot be attained, in practice, with a triple-riveted lap-joint, according to the tables of joints in use in this office. We believe, therefore, that a double-strap butt-joint is the proper thing for the outer shell of a water-leg of this kind. The factor of safety used above in figuring the strength from the elastic limit, corresponds to a factor of about 6 when figuring from the ultimate strength. If, instead of 6, we should use a factor of safety of 5, when figuring from the ultimate strength, or of $2\frac{1}{2}$, when figuring from the elastic limit, we should find that a good double-riveted joint would suffice. Thus, 592 ÷ $2\frac{1}{2}$ = 237 lbs. per square inch, which would be the safe working pressure if there were no joints to take account of. If it is desired to run at 150 lbs., the joint used on the water-leg must have an efficiency at least as great as 150 ÷ 237 = 63 per cent. That is, a carefully designed double-riveted joint would do, though a good triple-riveted one would be better.

We have next to consider the inside sheet of the water-leg. It is $\frac{3}{8}$ inch thick, and is made of mild steel. The distance between two consecutive vertical rows of bolts is less on the inner shell than on the outer one, because the bolts converge towards the center line of the boiler. Calling the inner radius of the inner shell equal to 35.5 inches, the horizontal pitch of the bolts on this shell is found from the proportion

Outer radius of outer shell : inner radius of inner shell : : pitch on outer shell : horizontal pitch on inner shell.

That is,

$$39.5 : 35.5 : : 5.6875 : x.$$

Whence x = 5.112 inches. Clark's rule for finding the strength of stayed surfaces requires us to use the *greater* pitch when, as in this case, the horizontal and vertical pitches are different. But his rule applies to plates without riveted joints; and when there are such joints in the plate, we should use the pitch between the rows that are parallel to the joint. (If the pitch were much greater the other way, we should calculate the strength in that direction also, making no allowance for joints; and we should use the smaller of the two results in determining the working pressure.) Applying the same rule to the inner plate that we applied to the outer one, we have, as the distance in the clear between the stay-bolts, 5.112 — .875 = 4.237 inches. Then

$$\frac{5700 \times \frac{3}{8}}{4.237} = 505 \text{ lbs. per square inch,}$$

which would strain the plate to its elastic limit. Allowing a factor of safety of $2\frac{1}{2}$, this gives 505 ÷ $2\frac{1}{2}$ = 202 lbs. per square inch, as the safe working pressure, if there were no joint. Hence, if it is desired to run at 150 lbs., the joint should have an efficiency of at least 150 ÷ 202 = 74 per cent. According to our tables for $\frac{3}{8}$ inch plates, this would require a triple-riveted lap-joint, though 70 per cent. can be attained with a good double-riveted joint, and, in consideration of the fact that the material of this boiler has an elastic limit equal to 60 per cent. of the tensile strength, the double-riveted joint might perhaps be allowed.

Let us next consider the stay-bolts. The area allotted to each bolt is 5.6875 × 5.6875 = 32.35 sq. in., the total pressure on which is 32.35 × 150 = 4852 lbs. This, with a factor of safety of 10, would require about one square inch of sectional area. The stay-bolts would, therefore, have to be about $1\frac{1}{8}$ inches in diameter at the bottom of the thread, or, say $1\frac{1}{4}$ inches in diameter over all.

We may sum up the results of the computation as follows: For the boiler in question to be perfectly safe at 150 pounds, (1) the stay-bolts should be $1\frac{1}{4}$ inches in diameter, over all, or else they should be pitched nearer together. The factor of safety of 10, used in the foregoing example, is none too large, for stay-bolts made of the best of iron are peculiarly liable to corrosion; and, as a matter of fact, they are usually cut from common bar iron, which may consist largely of hoop-iron and other scrap. The boiler would be materially improved by lessening the pitch of the stay-bolts to say $4\frac{3}{4}$ inches, for this would increase the stiffness of the plates. One-inch bolts would then be amply large. (2) The inside plates should have a well-proportioned double-riveted joint, though a triple-riveted joint would be preferable with the present spacing of the stay-bolts. If the pitch of the stay-bolts were lessened, as indicated above, a good double-riveted joint would be ample for the inside sheet of the water-leg. (3) The joint on the outer plate should at least be triple-riveted if the bolts are pitched as at present. Considering the liability of the stay-bolts to corrode, and the consequences that would follow if the water-leg should fail, we should much prefer to design it, so that it would be capable of withstanding the steam-pressure without any assistance from the stay-bolts. This would call for a triple-riveted butt-strap joint.

In connection with this subject we must once more call attention to riveted joints. The water-leg considered above had a double-riveted joint on the outer sheet, the dimensions of which were as follows: Diameter of rivets, 13-16 of an inch; pitch of rivets, $2\frac{1}{8}$ inches. This joint has an efficiency of only 58.8 per cent. By using one-inch rivets, pitched $3\frac{1}{4}$ inches apart, an efficiency of 67.3 per cent. can be attained in a double-riveted joint. Such a joint caulks well, is stronger, and is cheaper to make. Boiler-makers should give more attention to these points.

Boiler Explosions.

JANUARY, 1892.

LOCOMOTIVE (1). We learn from a Pittsburgh, Pa., paper that a "dinky" engine exploded on the Beck's Run road on Dec. 31st, seriously injuring Alexander Love. Mr. Love says he is sure there was an abundance of water in the boiler; and an examination made on Jan. 1st showed that where the break occurred the plate was not over 1-32 of an inch thick. [We did not learn of this explosion in time to include it in its proper place.]

OIL WELL (2). On Jan. 1st, a large boiler used for pumping oil wells exploded on Blue Lease, two miles west of St. Mary's, O. John Foltz, pumper, was instantly killed, and Wm. Stealts, a bystander, fatally injured. The boiler was torn to pieces, and the boiler house, made of iron, was totally demolished, pieces of iron cutting limbs off of trees 500 feet away. Foltz's neck was broken. He leaves a wife and two small children. The boiler was an old one and considered unsafe. Foltz would have changed towers in ten minutes with Tom Brewer, another pumper. The well belongs to the Riley & Milligan Oil Company, Celina.

Locomotive (3). Engine No. 412 of the Valley route, exploded her boiler at Arkansas City, Ark., on January 2d, just as she was getting ready to hook on to a through freight for Little Rock. The engine was blown to one side of the track, and Fireman Louis Eaton was badly scalded about the arms and shoulders. His wounds are not serious.

Cotton Gin (4). A boiler in the cotton gin of John Dearmon, ten miles northeast of Bonham, Tex., exploded on January 5th, demolishing the building. Dearmon was blown forty feet in the air and terribly mutilated and burned. He cannot recover.

Locomotives (5). A double explosion took place on the New York, Ontario & Western Railroad, on Jan. 6th, at a point about half a mile north of Smyrna. Accommodation train No. 68 collided with a freight engine, running light. The fireman on the accommodation train jumped, but the engineer waited to blow brakes and reverse his engine. It was then too late to jump, and he was killed. At the moment of collision both locomotives exploded, scattering fragments in all directions. The killed are Fred. A. Youngs, Adelbert Cady, and Martin Sheedy, and the injured are Lawrence Hannigan, John Alexander, George Lotheredge, George Paul, and Charles Maxted.

Wire Works (6). Six boilers, in two batteries, at the Braddock wire works, Rankin station, near Pittsburgh, Pa., exploded on Jan. 7th, killing Peter Zimmerman, the engineer, seriously injuring James Carpenter, the fireman, and slightly injuring about a dozen employes. The works were partially wrecked. The cause of the explosion is not known. Zimmerman was struck by a flying piece of boiler plate and almost instantly killed. Carpenter was hurled forty feet by the explosion. He is badly bruised and may be internally injured, but is likely to recover. Perhaps a dozen of the workmen were slightly cut and bruised by flying bricks and timbers. The explosion tore open a natural gas main, which supplied not only the works, but several other factories, with fuel. Part of the roof was blown away and some machinery wrecked.

Lumber Mill (7). The boiler of Caldwell, Milner & Flowers's big lumber mill, at Bolling, Ala., exploded on Jan. 7th, instantly killing Engineer Cooper and four other employes of the company. Besides the killed, four were injured, two of them fatally. The loss is estimated at $30,000.

Manufacturing Building (8). On Jan. 8th, five boilers exploded in the Warren-Springer building on South Canal Street, Chicago, killing Arthur Hall, Patrick Rogers, Addison Busch, John Lee, and Henry Oswald, and seriously, and perhaps fatally, injuring James Siggins. The property loss was estimated at $15,000.

Flouring Mills (9). By an explosion in the Roller Mills at Coleman, Tex., on Jan. 8th, the engineer, E. S. Johnson, was killed. Ed. Johnson, head miller, was badly scalded while trying to extricate the engineer.

Pork-Packing Establishment (10). A boiler in the large pork-packing establishment of A. H. Marsh, at Bridgeport, opposite Norristown, Pa., exploded on Jan. 11th, killing John Shaw and John Myers, fatally injuring Benjamin Shaw, and seriously injuring Thomas Hendron, Eugene Law, William Hillebrecht, William Henwood, Walter Whitman, Oliver Baker, and Jacob Reeme. The factory is literally a mass of ruins, and Mr. Marsh estimates the property loss at $40,000.

Quarry (11). On Jan. 11th, a boiler exploded in the slate quarry of R. R. Jones, at Delta, near York, Pa. William Hazlett was instantly killed and Richard Hughes was seriously injured. The boiler was thrown high in the air, and landed fifty feet from the ruins of the boiler house.

Mine (12). A boiler exploded on Jan. 12th, at the Diamond mine engine house, Mystic, near Ottumwa, Iowa. John Ryan, Samuel Roberts, and Charles Stewart were badly injured, but fortunately nobody was killed. The account says that "the engine house was blown to splinters and the boiler into scrap iron."

Iron Mine (13). A terrific boiler explosion took place at the North Pabst mine, Ironwood, Mich., on Jan. 12th. The hoisting plant, engine house, and mine office were wrecked, one man was killed, and two others were probably fatally injured. John Hughes, a drum man, was blown fifty feet, death being instantaneous. John Carney, a pump man, was being lowered into the shaft when the explosion occurred. The shock broke the cable, Carney falling to the bottom of the shaft into several feet of water. He sustained severe injuries about the head and was unconscious when brought up. Superintendent J. S. Buddle was buried in the ruins. He is not dangerously hurt, but his escape was miraculous.

Mine (14). By an explosion of a steam boiler in the Little Ellen mine in Big Evans gulch, Leadville, Col., on Jan. 16th, Simon Anderson was so badly burned that he died within an hour. Anderson, who was the engineer in the mine, was alone in the boiler room when the explosion occurred. He was horribly mangled and was unconscious when friends reached him. He was carried to St. Vincent's hospital and died shortly after reaching there.

Saw-mill (15). The boiler in Robert Hopkins's saw-mill, at Knoxdale, near Reynoldsville, Pa., exploded on Jan. 18th, killing Mr. Hopkins and a teamster named Kunz. Eli Philips, a saw filer, had one of his hands so badly crushed that amputation was necessary. At the time of the explosion the mill was not running, on account of repairs being made to the belt, and while this was being done the hands had gone out and were having a snow-balling match. One piece of the boiler lodged on a side hill, 600 feet from the mill.

Locomotive (16). Near Oxmoor, seventeen miles south of Birmingham, Ala., a terrible explosion occurred, on Jan. 17th, which cost two men their lives. An engine of the DeBardeleben Coal and Iron Company, leased by McNamara Brothers, when running between Eureka mines and Oxmoor, ran out of water, and the engineer made an effort to reach the tank, half a mile away, as soon as possible. When at full speed the boiler exploded with a tremendous noise, wrecking the locomotive, and blowing Engineer Joseph Hunt and Fireman Bradford into a thousand pieces. The track was torn up and a great hole dug in the ground.

Lumber Mill (17). The boiler of the Kellogg lumber mills at Ceredo, near Huntington, W. Va., exploded on Jan. 18th, killing eight men.

Institution (18). On Jan. 20th, a boiler exploded in an institution in Dunning, near Chicago, Ill. The damage was not great, and no one was seriously hurt.

Locomotive (19). The boiler of Reading engine No. 535 exploded on January 22d, at Cedar street bridge, Philadelphia, Pa., with a terrific report, throwing fire and scalding water in all directions, and endangering the lives of a score of yard employes. The engine, which was one of the largest in use on the road, having ten driving-wheels, had just finished the regular run, and was placed over the ash-pit by the engineer, ready for the yard men to draw the fire. She stood there but a short time when the boiler burst. The heavy wheels kept the track, but the entire superstructure, boiler, cab, and all, went flying through the air, landing against the stone abutment of the bridge over Cedar street. Hundreds of people quickly flocked to the scene. The boiler in its flight broke the electric light wires along Cedar street, and they lay about hissing until the current was turned off. A large tool-house that stood at the end of the bridge was struck by the flying boiler, and knocked into Gunner's Run. The woodwork of the cab that still clung to the boiler caught fire, and the great engine stood on end, directly on the sidewalk, a mass of twisted iron. Fortunately no one was hurt by the accident, but there were many narrow escapes.

Cotton Gin (20). Mr. Gus T. Wright, who owns and operates a steam gin in Lincolnton, Ga., was ginning for Mr. J. L. Crawford, on Jan. 22d, when the boiler of his engine exploded, and instantly killed Bill Tomkins, the engineer, and Sylvester Kennedy, another employe, both colored. Tomkins was literally torn to pieces. Kennedy was struck by pieces of the boiler, and had his neck broken. Messrs. G. T. Wright, J. L. Crawford, and John Durham were slightly injured by the explosion, as was also Bob Hardy, colored. The engine and the boiler were a complete wreck.

Tack Factory (21). A boiler flue collapsed in the tack factory of C. S. Ballou, Haverhill, Mass., on Jan. 26th. Several girls were injured, and the engineer narrowly escaped with his life. The property loss does not exceed $500.

Thresher (22). On January 26th, Lewis W. Neal, residing near Jacksonville, Pa., who is the owner of a steam threshing machine, was firing up preparing to thresh, when the boiler exploded with terrific violence, throwing the fire-box of the boiler into the barn, where the coals set fire to the hay and straw, and the barn, together with all its contents, was destroyed by fire. The unfortunate owner was slightly injured by the explosion.

Locomotive (23). The boiler of a locomotive exploded near St. Clair, Pa., on Jan. 28th, with terrible results. The locomotive was demolished and fragments were sent flying in every direction. Joseph Zeigler, Napoleon Paul, Jacob Turner, William Winterstein, and Harry Sands were killed. Paul's remains were found 300 feet away, in a creek. Turner's body was found 500 feet across the valley, with his head crushed. After several hours' search, the remains of Winterstein were found half way up the mountain, 400 feet above the creek. Zeigler and Sands were thrown up the bank 200 feet, together with the fire-box. Trees were uprooted, and debris line the hillsides.

Church (24). The boiler used to heat the First Methodist church, Pleasant and Ninth streets, Des Moines, Iowa, exploded on Jan. 30th, damaging the building to the amount of $1,500.

A cigar contains acetic, formic, butyric, valeric, and propionic acids, prussic acid, creosote, carbolic acid, ammonia, sulphuretted hydrogen, pyridine, viridine, picoline, and rubidine, to say nothing of cabagine and burdockic acid. That's why you can't get a good one for less than ten cents. — *Ex.*

A Defect Found by Inspection.

A short time ago we were called upon to examine a boiler that had just been repaired. The feed water that had been used in this boiler contained a large amount of lime, and a troublesome scale had formed on the heads, between the tubes. The back head became overheated from this cause, and a serious crack made its appearance, so that it was considered wise to put in a new one. The tubes were cut off and removed, and both heads were taken out and replaced by new steel ones. In order to use the old tubes it was of course necessary to set the new heads nearer together than the original ones, which had been shortened in removal. Somehow or other a mistake was made in measuring them, and, after the heads had been riveted in place they were found to be considerably too far apart. The old tubes were put in, however, the heads being drawn inward by long bolts running through the tube-holes until the old tubes would reach from one head to the other. The tubes were then put in, and were beaded on the back head in the usual manner. On the front head it was not possible to bead very many of them, since most of them would not reach further than flush with the head, and some would not even come as far as that, by a tenth of an inch, the thickness of the head being seven-sixteenths of an inch. They were expanded, however, and the owner was assured by the boiler-maker that the job was all safe.

Having some doubts about it, the owner called in one of our inspectors and requested an examination. The front head was found to be deflected inward about five-eighths of an inch, though it is impossible to say that this deflection was due entirely to the stress set up in drawing the heads together by the bolts, since it is not certainly known that the heads were originally flat. The back head was also deflected inward, so that after the removal of all strain it had a permanent set of about three-eighths of an inch. Upon examining the boiler internally the inspector found that the pins securing the braces to the heads did not come against the ends of the braces by an eighth of an inch, in some places. The braces would therefore be of no use whatever until the heads had bulged out enough to take up the slack in the fastenings.

After looking the boiler over carefully, our inspector put on the man-hole cover and secured the safety-valve and proceeded to test the boiler hydrostatically. The ordinary working pressure was eighty pounds to the square inch, and it was proposed to carry the hydrostatic pressure up to 130 pounds if the boiler would stand it, though the indications were that it would fail before that pressure was reached. At seventy-seven pounds — three pounds less than the usual pressure carried — the front head snapped back into place and the tubes drew out so that a shower of water came out through the holes around them.

If the boiler-maker's word had been taken in this case, and the inspection had not been made, the boiler would have been fired up as usual, and the head would undoubtedly have given way in the same manner as it did under the hydrostatic test. Considerable damage would have resulted, and the fireman and perhaps others would very likely have been scalded. At all events the boiler would have been ruined before the fires could be drawn. We speak of this incident because it is a particularly good illustration of the value of inspection. Most of the defects that our inspectors discover are of such a character that it is not *certain* that accidents would result from them, and we have to be content with saying that accidents would be *very likely* to result. In the present case it is plain that the outcome must have been most serious had the inspection not been made.

The Locomotive.

HARTFORD, MARCH 15, 1892.

J. M. Allen, *Editor.* A. D. Risteen, *Associate Editor.*

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Papers that borrow cuts from us will do us a favor if they will mark them plainly in returning, so that we may give proper credit on our books.

The boiler of the Italian steamer *Calabria*, which left Genoa for Naples on the morning of Dec. 12th, exploded near Genoa, sinking the steamer. Thirty-six persons were on board. of whom twenty-one were drowned.

Our esteemed English contemporary, *Engineering*, speaks of Dr. Thomas Young's first lecture before the Royal Institution, as follows: "His first lecture, which was introductory to the whole course, gave a short account of the work and objects of the Royal Institution, in the course of which he somewhat quaintly gives his views upon the question of what we prefer to call 'the presence of ladies,' but to which he refers as 'the education of females.' In reference to this he says: 'The many leisure hours which are at the command of females in the superior orders of society may surely be appropriated with greater satisfaction to the improvement of the mind, and to the acquisition of knowledge, than to such amusements as are only designed for facilitating the insipid consumption of superfluous time.' And in pointing out one of the special objects of the institution at that time, namely, the improvement of mechanical design and invention, he does so in these words: 'We may venture to affirm, that out of every hundred of fancied improvements in arts or machines, ninety at least, if not ninety-nine. are either old or useless; the object of our researches is to enable ourselves to distinguish and to adopt the hundredth.'"

In the issue of *The Iron Age* for March 3d, we find an interesting article concerning a bill recently introduced in Congress, and which, among other things, provides for a minimum factor of safety of *five* on all steam boilers within the federal jurisdiction. The *Iron Age* objects to this factor, particularly in the case of boilers that are now in operation, and calls attention to the fact that boilers now carrying 100 pounds with a factor of safety of four, would, by the proposed law, be allowed only 80 pounds; and this, it is said, would give rise to serious trouble and expense. But, in our judgment, the very first consideration should be the *safety* of boilers: and our twenty-five years of experience and meditation has satisfied us that a factor of four is not large enough for general use. The boilers designed in this office have a factor of safety of five.

"We have been unable to ascertain who instigated the proposed measure," says the *Iron Age.* Well, we didn't instigate it, but we have never lost an opportunity yet to say that five is the proper factor for general use; and if, in the future, five is to be more widely used, we areglad of it. It will lessen the number of explosions, and promote the public welfare.

Mr. Risley's Experience.

A short time ago, an unusual accident befell Mr. E. W. Risley, who is engineer for Nathan Drucker & Co., in Cincinnati. It being Sunday morning, Mr. Risley undertook to clean out the big boiler under his charge, and with this object he took off the man-hole cover and crawled in. He had finished his work and was about to return, when it occurred to him to turn around and come out head first. He was experienced in such matters and had often turned around inside this boiler before, but this time he got caught in some manner when half-way around, and found that he could neither turn further nor return to his original position. For a quarter of an hour he strugged to free himself, and then realized that it was hopeless to try to get out without help. He shouted for assistance, but nobody heard him. His lamp went out, and he knew that by morning he would very likely be so weak that he could not call out at all, especially as his chest was pressed against his knees so tightly that he could scarcely breathe. In the early morning the fireman would come. He would, doubtless, put on the man-hole cover without thinking to look inside, and would fill up the boiler with water, and Risley would be drowned. These thoughts did not add to the engineer's comfort, as the reader may readily imagine. Thoughts of his wife and three little children came to him, and the boiler seemed to be pressing slowly in upon him from all sides, like the famous "iron bride" of the days of torture. After nightfall, by some happy chance, the engineer unlocked his cramped limbs. How he did it he does not know. He reached the outside air half crazed, and, falling upon the ground, lay there for an hour, entirely exhausted, before he was able to go home.

Crystals.

Crystals are always beautiful objects, and the study of their formation and growth is one of the most interesting branches of science. The word is derived from the Greek word *Krystallos*, which originally meant "quartz," and quartz was the only substance to which the ancients gave the name of "crystal." Quartz was then believed to be ice, rendered permanently solid by the action of intense cold, and hence the propriety of the Greek word given above, which came from *Kryos*, meaning "frost." Nowadays, the word has been extended so as to include all the regular forms that bodies take when they solidify from a state of vapor, fusion, or solution.

"The regular external form of a crystal is its most striking feature, and the only one that, for a long time, was regarded as important or essential. But we now know that this form is only an outward expression of a regular internal structure. If we examine ordinary homogeneous substances which are not crystals, we find that their physical properties, such, for instance, as their elasticity, hardness, cohesion, light-transmission, heat-conduction, etc., are the same in all directions. Thus a piece of glass, when struck, will break with equal readiness along all surfaces, and it will exhibit an equal degree of hardness wherever it may be scratched. With crystals, however, this is not true. In them we find *differences* of elasticity, hardness, cohesion, and other physical properties, which do *not* exist in homogeneous substances that are not crystals. As the result of long study by many eminent observers, the fact has been established that the physical properties of crystals are the same *along all parallel directions*, while, with certain exceptions, *they are different along directions that are not parallel.* This important fact gives us the clue to the essential nature of the crystal: for it implies that both the regular external form, and the distribution of physical properties are alike directly the outcome of some regular internal structure. We may make a glass model of exactly the same shape as a crystal, but it is not a crystal, in spite of its form, because the necessary internal structure is absent."*

The reason why crystals take their characteristic forms, or why they exhibit such curious regularities in internal structure, has not yet been discovered, though some interesting guesses at the truth have been made. We shall have to learn something more about molecules and atoms before the question can be answered satisfactorily. In fact, it is probable that the problem will be solved from the other end, the study of crystals giving us information about molecules, instead of the molecules informing us about crystals.

One of the interesting things about a crystal is, that it retains its power of growth for an indefinite period. If we take one out of a solution in which it is forming, and keep it any length of time, and then put it back in the solution from which it was taken, it will continue to grow precisely as though there had been no interruption. Nature affords us some wonderful examples of this, for she often expends an amazing length of time in building up a crystal. In some cases it is certain that the growth of natural crystals has been suspended for millions of years, to be resumed again when the conditions were suitable, as though nothing had happened. A crystal of quartz, for example, which was formed ages ago by the cooling of melted silica, may be made to grow in our laboratories at the present day, by immersing it in a saturated solution of silica. In nature crystals often show evidences of suspended and renewed growth. Thus we find them with shells of foreign matter arranged concentrically within them. Sometimes, too, a substance that can crystallize in two or more forms will grow in one of these forms until its growth is interrupted, and when the conditions for growth are again favorable, there may be some slight cause of disturbance present that will cause them to gradually assume another form as they increase in size. In such cases there is often a difference in color or transparency in the two parts, that makes the compound character of the crystal distinctly visible.

This power of growth remains, no matter how much the crystal has been modified by exposure to the weather, or from any other cause, provided there is still some small amount of it left unaltered. "Crystals, like ourselves, grow old. Not only do they suffer from external injuries, mechanical fractures, and chemical corrosion, but from actions which affect the whole of their internal structure. Under the influence of the great pressures in the earth's crust, the minerals of deep-seated rocks are completely permeated by fluids which chemically react upon them. . . . As the result of this action, minerals, once perfectly clear and translucent, have acquired cloudy, opalescent, iridescent, avanturine, and 'schiller' characters; and minerals thus modified abound in the rocks that have, at any period of their history, been deep-seated. As the destruction of their internal structure goes on, the crystals gradually lose more and more of their distinctive optical and physical properties, retaining, however, their external form, till at last, when the last of the original molecules are transformed or replaced by others, they pass into those mineral corpses known as 'pseudomorphs.' But, while crystals resemble ourselves in 'growing old,' and, at last, undergoing dissolution, they exhibit

* Williams, *Crystallography*, p. 2.

the remarkable power of growing young again, which we, alas! never do. For it does not matter how far internal change and disintegration may have gone on in a crystal; if only a certain small proportion of the unaltered molecules remain, the crystal may renew its youth and resume its growth. When old and much-altered crystals begin to grow again, the newly-formed material exhibits none of those marks of 'senility' to which I have referred. The sand grains that have been battered and worn into microscopic pebbles, and have been rendered cloudy by the development of millions of secondary fluid cavities, may have clear and fresh quartz deposited upon them to form crystals with exquisitely perfect faces and angles. The white, clouded, and altered feldspar crystal may be enveloped by a zone of clear and transparent material, which has been added millions of years after the first formation and the subsequent alteration of the original crystal."*

There is one other important property of crystals that must be referred to. It is, that crystals possess the power of repairing damage done to them. If a corner be broken from a crystal, or an edge be knocked off, or a hole be bored in it, as soon as the crystal is replaced in the solution in which it was forming, nature proceeds to repair the injury. She puts on a new corner, or a new edge, or she fills up the hole, so that no one would know there had been any break. Ordinarily, this is accomplished while the whole crystal goes on growing as before, the growth at the broken place being more rapid than elsewhere until it has caught up with the rest of the crystal. In the case of alum, however, it is said that if the injuries are not too deep, the crystal "does not resume its growth over its general surface until those injuries have been repaired:" and if this is true in the case of alum, it is doubtless true of many other substances. This repairing tendency is so strong that the original regular surface may all be broken off from a crystal, until a spherical or irregular mass is left; yet, when growth is resumed, all the angles, faces, and edges are restored as before.

These properties remind one forcibly of the phenomena of organic life. Many of the lower organisms can restore parts of themselves that have been lost. Even the lobster, it is said, reproduces lost legs, and among microscopic creatures, the tendency to repair is so marked that sometimes an entire organism may be produced from a small part, accidentally removed from the parent creature.

Interpreting a Dream. — A Dundee navvy, on awakening one morning, told his wife of a curious dream that he had during the night. He dreamed that he saw a big fat rat coming toward him followed by two lean ones, and in the rear one blind one. He was greatly worried over it, and swore that some great evil was about to fall upon him. He had heard that to dream of rats foreboded some dire calamity. In vain did he appeal to his wife, but she could not relieve him. His son, who, by the way, was a bright lad, hearing the dream told, volunteered to interpret it, and he did it with all the wisdom of a Joseph. Said he: "The fat rat is the mon who keeps the public house where ye gang to sae aften, and the twa lean anes are me and me mither, and the blind one is yersel', father." — From *Frank Leslie's Weekly*.

A bold bad man put his head in at the door of a cheese factory. "Has anything remarkable a curd here?" he asked. And then the girls creamed, and the men came out and drove him a whey. — *Druggists' Circular*.

* Friday Evening Discourse before the Royal Institution. Delivered by Prof. John W. Judd, Jan. 30, 1891.

The Locomotive.

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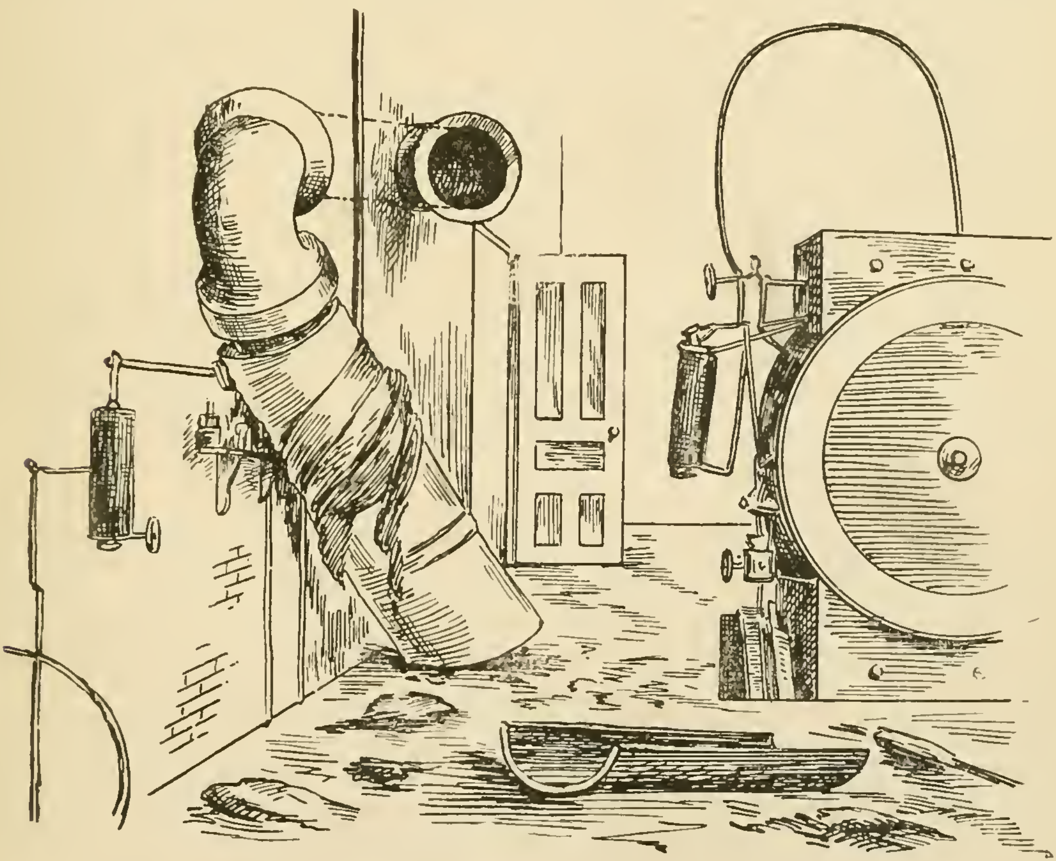
An Accident in an Engine-Room.

A short time ago a serious accident occurred in the engine-room of a New England mill, which was instructive enough to merit wider publicity than it has yet had. The engine is a 1,200 horse power Corliss, and it is supplied with steam by a 14-inch steam main, which enters the room about nine feet above the floor, passing horizontally along the wall for about eight feet, and then turning downward and connecting with a pipe



THE ENGINE ROOM AFTER THE ACCIDENT.

under the floor that supplies the engine from beneath. This main steam-pipe is fed by smaller pipes running into it from each of the ten boilers in the boiler-room, and it is provided with a main stop-valve which is just outside and above the engine-room door, shown in the cut.

The engineer was just starting his engine up in the morning, when, without warning, the eight-foot section of pipe running along the wall (indicated by the dotted lines) burst with a noise like a cannon, and steam at 100 pounds pressure rushed into the engine-room with frightful velocity. The engineer was at the throttle-valve between the two cylinders (to the right of one shown in the cut), and the powerful current of air and steam that rushed against him bore him helplessly across the engine-room, to a door that our artist has not shown. He struck the casing of the door, and succeeded in gaining sufficient footing to jump out instead of being blown out. The ground is twenty feet or more below the door sill, and the engineer says it seemed fully a minute before he landed. His right knee was badly sprained by the fall, but he hobbled around to the boiler-room, and with the assistance of the two firemen, tried to close the main stop-valve over the engine-room door. This was a difficult thing to do in the blinding blast of steam that issued from the engine-room, and the effort proved fruitless. The valve failed to work, and the smaller stop-valves on the individual boilers had to be closed before the draught of steam could be checked.

When the engine-room could be entered it was found that the heat of the steam had unsealed the automatic sprinklers on the ceiling, and a perfect storm of water was pouring down on the engine. The water supply was shut off, and the engine was examined and found to be uninjured, save for some rust that afterwards formed on the wet metal.

The large cast-iron main that had burst was found to be split in halves, lengthwise, and fragments of it lay about the floor. An examination of the large piece shown in the foreground of the cut revealed the cause of the accident. On either side of this piece, where had been the parting of the mould, the casting was defective, and for perhaps four feet on both sides the metal was hollowed and blown, so that there was no union whatever, the casting being held together by a scale of iron hardly a sixteenth of an inch thick in places, and hardly an eighth of an inch thick in most of its length. The upright length of pipe that ran down through the floor was blown over about six feet, so that the joints and valves under the floor were badly twisted and bent. Fragments of the bursted pipe struck and ruined the valve oiler on the cylinder, and a Locke damper regulator on the wall was also broken, the weights belonging to it being strewn all over the engine-room floor. One weight, weighing about ten pounds, was driven across the room and imbedded in the wall, making a hole eight inches deep and a foot in diameter.

The engineer was carried to his home after the accident, and it was found that his injuries, although serious and painful, were not fatal.

The moral of this accident is, that cast-iron ought not to be used for large steam mains carrying heavy pressures. Certainly, such pipes ought not to be used unless they have been thoroughly tested hydrostatically and with the hammer; and our opinion is, that wrought-iron pipes are always much safer and better.

While the failure of this pipe was due to its inherent weakness, accidents of a similar nature are often caused by the pipe being improperly supported. Supports provided for main steam pipes should receive the most careful attention, especially if the pipe is a long one. Steam pipes are exposed to great variations in temperature, and the consequent expansion and contraction is often very considerable, and needs to be properly provided for. Several articles on this subject have appeared in The Locomotive, and some of the forms of hanger that we have found to be satisfactory have been illustrated in connection with them. (See, for example, the issue of August, 1890.)

One of the funniest things that has happened in Greenville for some time was the shooting of a negro last night by a policeman. The cop blazed away at the man and shot him in the elbow, the ball glancing and striking the negro in the cheek. As he spit the ball out he said: "Look heah, white man, you quit dat shootin' at me; fus' thing yuh knows yuh gwinter brake some 'spectable pusson's winder glass." — *Memphis Avalanche.*

Boiler Explosions.

February, 1892.

Locomotive (25). On Jan. 25th a locomotive in charge of Engineer Gotham and Fireman Kreitner, exploded at Newton, Kan. The engine was standing at the east end of the Santa Fé depot platform; the engineer and fireman were out of the cab oiling the engine, fortunately on the opposite side from the part of the boiler that gave way. No one was hurt, though fragments were blown some distance. One portion struck a vestibule car and broke the doors, besides doing other slight damage. [Received too late for insertion in the January list.]

Artesian Well (26). A boiler used in boring an artesian well at the cotton mill in Dallas, Texas, exploded on Feb. 1st. The rotating machinery and massive superstructure were blown to pieces; Ed McDonald, in charge of the machinery, was carried through the air a distance of about seventy yards, sustaining injuries which may prove fatal; about sixty windows in the cotton mill were blown out and that building was set on fire. The superintendent of the mill, aided by his two watchmen and some men employed in boring the artesian well, at once brought to bear on the flames the fire extinguishing apparatus, with which the mill is equipped, and succeeded in saving the mill with no damage to the machinery, and only the loss of about 1,000 yards of cloth. The mill is supplied with water and pressure from its own water tower, and a line of hose runs into every room and is always ready for use. But for this provision and the prompt action of the superintendent and his aids, the consequences of the fire might have been the most disastrous to Dallas that had ever befallen it.

Saw-mill (27). On Feb. 2d the boiler of a threshing engine, owned by H. H. Finroe, and used in running a saw-mill six miles south of Lake Park (near Minneapolis, Minn.), burst and killed two men and injured one other. Torger Nestleby, the sawyer, was struck by the front door of the boiler and killed instantly. Godfred Lien, the engineer, who was standing by the boiler when it exploded, was thrown into the air 50 feet and badly mangled.

Locomotive (28). The boiler of a freight engine on the Chicago & Alton road blew up near Joliet, Ill., on Feb. 2d, with fatal effect. The dead are: Thomas Brandon, fireman, and C. F. Hastings, head brakeman. The only survivor was Dubois Williams, engineer, who had one leg broken and face crushed and scalded.

Fruit Store (29). A boiler explosion in St. Joseph, Mo., on Feb. 3d, partially wrecked G. W. Chase & Son's candy factory and fruit store, on Market Square, and shook the adjoining buildings like a violent earthquake. A man passing the store at the time of the explosion was nearly blown into the street by its force. The boiler is a low pressure one used only for heating the building, and is situated at some distance from the front of the basement, yet the force of the explosion was so violent as to rip up the floor and shatter the heavy glass in front. The fire department quickly extinguished a slight blaze which immediately followed the explosion. Aside from the damage to the building the loss was small. The man in charge is, as usual, accused of criminal carelessness; yet those acquainted with boilers will be slow to accept the charge without some definite evidence. He left the boiler, he says, with little fire and a generous supply of water.

Saw-mill (39). The boiler in L. Luneack & Sons' saw and planing mill, at

Jenera, O., exploded on Feb. 5th, and totally demolished the building. Seven men were at work in the mill at the time, but fortunately all were assisting in rolling a log on the saw carriage. They were on the opposite side of the log from the boiler and escaped without serious injury. George N. Troutman had his left hand mashed by a flying brick.

GRIST-MILL (31). On Feb. 6th, while customers were waiting at Salton's grist mill, five miles south of Paragould (near Little Rock, Ark.), to get their grain ground, the boiler exploded. B. Waugh, Thomas Woods, and James Woods and his son were instantly killed. The boiler was blown 400 feet from the mill.

SAW-MILL (32). The boiler in Merrill Bros. saw and shingle-mill at Clarion, eight miles south of Petoskey, Mich., exploded on Feb. 6th, completely wrecking the mill. John Gregg, an employe, was badly scalded and had his skull fractured. The mill had just shut down, and the saw had been taken to the file-room for repairs, and eight employes went into the file-room to warm themselves. Had they not done so, the chances are that all would have been terribly injured. The file-room was protected by a high bank of logs.

LOCOMOTIVE (33). On Feb. 8th, locomotive No. 183 exploded between Wayne Junction and Nicetown, Pa., on the Bound Brook track of the Philadelphia & Reading railroad. The engine was one of the heaviest made, and had ten driving wheels. At the time of the explosion the locomotive was pushing a heavy train of coal cars to the tracks at Wayne Junction, to be switched to the New York tracks, to which place the coal was consigned. George Reardon, William Cavanaugh, and James Dean were killed. Hugh Dougherty, Thomas Faust, John A. Buck, Jerome Miller, and John J. Moore were dangerously injured, and Faust, Dougherty, and Moore may die.

SAW-MILL (34). A large saw-mill owned by Wilbur Armstrong, at West Liberty, near Kokomo, Ind., was blown to pieces by a boiler explosion on Feb. 9th, and all the mill hands were injured. It is thought that two, Sherman Armstrong and Jacob Sifer, are fatally hurt. Four others were badly cut and scalded, but will recover.

SAW-MILL (35). The boiler in the saw-mill of Jacob Henry Kisling, six miles north of Eaton, O., exploded with fatal effect on Feb. 11th, instantly killing two persons and seriously injuring another, and completely wrecking the entire structure. Those killed were William Kisling, son of the proprietor of the mill, and David Shiverdecker, a laborer in the mill. The remains of both were mangled and torn in a most frightful manner. Mr. Kisling, the owner of the mill, was badly scalded about the head and face, and was thrown about fifty feet from the mill. The full extent of his injuries are not known, but it is feared he is dangerously hurt. Henry Pense, a farmer, had left the mill but a few moments before the explosion, and thereby doubtless saved his life. The mill has been a very popular place of resort for the farmers, as a very extensive business was carried on, and it looks providential that the wreck came at the time it did.

SAW-MILL (36). By the explosion of a boiler in H. A. Crane's saw-mill near Bay City, Mich., on Feb. 12th, William Tyler was instantly killed. The boiler-room was completely wrecked, the roof being torn off, and the walls shattered. The engine was also blown from its foundation. The cause of the explosion, at last accounts, had not been ascertained.

SAW-MILL (37). On Feb. 13th the boiler at the saw-mill of Dennison Bros., two miles west of Ottawa, Kan., exploded, killing Henry Dennison and doing considerable damage. Three other men working with Dennison had stepped into the range of a large tree at the moment of the explosion and escaped injury. The explosion was probably due to some defect in the boiler, as it was carrying only 45 pounds of pressure.

Residence (38). A heating boiler exploded on Feb. 13th in the residence of Mrs. C. P. Dwight, 1,729 Walnut Street, Philadelphia. John Green, who attended to the heater, and Patrick O'Neill, a coachman, were severely burned, and Green will probably die. But little damage was done to the house.

Saw-mill (39). On Feb. 16th a forty horse-power saw-mill boiler exploded on the farm of Haman Putnam, at Navarre, near Canton, Ohio. The building was almost totally destroyed, but fortunately nobody was hurt.

Saw-mill (40). The boiler in Bennett's saw-mill at Harley, near Toronto, Ont., exploded on Feb. 21st, demolishing the whole building, a large wooden structure. The affair occurred just after 6 o'clock, and Mr. Bennett and the employes had only been away from the mill five or ten minutes.

Steam Launch (41). On Feb. 21st the boiler of the steam launch *Clara* exploded near Chico, Wash. The three passengers had all gone ashore for wood, and nobody was injured.

Locomotive (42). By the failure of a tube in a locomotive on the Pennsylvania railroad at North Penn Junction, on Feb. 24th, Jacob Freece was killed, and David Walker, James Foyle, and Andrew Rogers were painfully hurt.

Saw-mill (43). The steam-boiler at Neal Dowling's saw-mill, two miles from Newton, Ala., exploded on Feb. 24th, and instantly killed a white man named B. G. Hughbert. Several other were slightly injured.

Repair Shop (44). The boiler in the Savannah, Florida & Western railway shops at Savannah, Ga., exploded on Feb. 29th, killing three men and fatally injuring another. The building was wrecked, and the patterns of the company's machinery and locomotives were destroyed. The killed are John C. Murphy, Engineer White, and Fireman Stalt. The damage, outside of the loss of the patterns, is estimated at $8,000.

Watts' Dream about Shot.

Before Watts, the discoverer of the present mode of making shot, had his notable dream, induced by over-indulgence in stimulants, the manufacture in question was a slow, laborious, and consequently costly process. Great bars of lead had to be pounded into sheets of a thickness nearly equal to the diameter of the shots desired. These sheets had then to be cut into little cubes, placed in a revolving barrel, and there rolled round until, by the constant friction, the edges wore off from the little cubes, and they became spheroids.

Watts had often racked his brain trying to discover some better and less costly scheme, but in vain. Finally, after spending an evening with some boon companions at an ale house, he went home, went to bed, and soon fell asleep. His slumbers, however, were disturbed by unwelcome dreams, in one of which he was out again with "the boys," and as they were stumbling home it began to rain shot — beautiful globules of polished shining lead — in such numbers that he and his companions had to seek shelter.

In the morning Watts remembered his curious dream, and it obtruded itself on his mind all day. He began to wonder what shape molten lead would assume in falling through the air, and finally, to set his mind at rest, he ascended to the top of the steeple of the Church of St. Mary at Redcliffe, and dropped slowly and regularly a ladleful of molten lead into the moat below. Descending, he took from the bottom of the shallow pool several handfuls of the most perfect shot he had ever seen. Watts' fortune was made, for from this exploit emanated the idea of the shot tower, which ever since has been the only means employed in the manufacture of the little missiles so important in war and sport.— *Philadelphia Bulletin.*

The Pacific Coast.

By Samuel Nott, C.E.

The *Annual Review*, published by the San Francisco News and Shipping List, gives an exhaustive summary of the Pacific coast business, and from it we glean these notes: The California exports of flour and grain, from July 1, 1890, to July 1, 1891, amounted to 861,724 tons, being about 43,000 tons less than in the year before. The largest export was in the year 1882–3, when it amounted to 1,441,540 tons. The highest price of wheat during the year ending July 1. 1891. was $1.85; the average price (being the highest average since the year 1886–7) was $1.46¼ per cental. A noticeable feature of the table showing the dates of the arrival of new wheat at tide-water, is the nearly uniform earlier arrival, from year to year, beginning with July 14, 1859, and ending with May 24, 1891.

The rainfall table for 1849 to 1891 shows remarkable fluctuations, the variations being from 7.40 inches, in 1850–51, to 49.27 inches, in 1861–62. The average of the whole series of years is a trifle under 24 inches.

The grain-carrying trade is, of course, still mainly done by foreign vessels. In 1890–91 there were 213 of those, against 52 American vessels.

The Pacific coast furnished 954.728 tons of coal, out of 1,295,775 tons received in the year ending July 1, 1891.

Explosion of a Steam Table.

The top of a steam table, used to keep food warm, recently blew off in the United States Restaurant, on Clay street, San Francisco, frightening the patrons of the place, as well as the cooks, waiters, and dish-washers, who all fled into the street. The accident is thus graphically described by a San Francisco paper: "At 6.30 o'clock last night a large pile of dishes and edibles was placed on the heater, and the attaches of the place were busy with their duties. Suddenly there was a roar like thunder. The gaslights were extinguished by the concussion. Flying joints of meat, mashed potatoes and turnips, and showers of soup filled the air and mingled with the yells of the attaches. For a moment the patrons in the dining-room wondered what new dish was being ordered, but on seeing the steam they concluded not to wait for further information. As soon as possible the gas was lighted again, and an examination was made of the premises. It was found that the heater had been demolished, and pieces of broken iron lay scattered around on the floor. Several men were walking around in the soup, rubbing their injured parts that had been struck by flying iron. Charles Campbell, who prepared the vegetables, was the worst hurt. At the time of the explosion he was stooping over, tying his shoe-string. A piece of iron struck him in the pistol pocket, tearing away his trousers and making a cut on his hind leg. Until this wound heals

Mr. Campbell will sleep on his left side. A second piece of iron struck him on the right arm, breaking the bones above and below the elbow. Joseph Barash, the manager of the restaurant, was cut slightly on the leg by a piece of iron. The third victim was John Bender, the night cook. Bender is a very large, fat man, who has an extensive waistband. A piece of iron as large as a stove lid struck him square in the abdomen where it is the most prominent, and doubled him up until his face met his knees. Bender's abdomen looked as though he had had a personal encounter with a mustard plaster.

"The injured men received treatment at the hospital. The damaged steam table will receive treatment at the blacksmith shop."

A New York Incident.

An unusual accident occurred on Monday, March 7th, in the cigarette factory of Thomas H. Hall, 209 East Thirty-seventh street, New York, which resulted in serious and painful injury to one man, and in the enforced idleness of 450 girls. Here is the *New York Sun's* account of it.

"According to Mr. Hall, City Inspector Warren Harrington drove up to the factory about 11 A. M. on Monday, and took a pump out of his wagon down to the boiler room. He was going to make a hydrostatic test of the boiler. The fire was drawn, and Engineer Courtney was present to assist the inspector. Courtney, according to Harrington's directions, it is said, climbed up above the boiler to the safety-valve, while Harrington stood in front of the boiler near the steam gauge. Hall says that the inspector told the engineer to 'tap' the safety-valve, — that is, to open it so as to empty out the steam more rapidly. 'Is there much steam on?' asked Courtney. 'No,' said the inspector, according to Hall, who was not present at the time of the accident, but who took the engineer's statement later. Courtney 'tapped' the valve, and suddenly was enveloped in a blinding cloud of hot steam. His head and arms were burned and the whole upper part of his body was parboiled. He was able to help himself down. A doctor was called in, and he was sent in a carriage to his home at 165 Ewen street, Brooklyn. He grew much worse, and the flesh literally fell from him. It was necessary to keep him under anæsthetics. Yesterday he died. Inspector Harrington seems to have gone on with his work of inspection. At any rate Mr. Hall has a certificate dated March 8 that the boiler has been carefully examined and found to be in proper condition. The certificate says that the boiler was subjected to a hydraulic pressure of 120 pounds to the square inch, and the safety-valve had been set to eighty pounds. Mr. Hall said that the inspector hadn't been gone half an hour before the boiler was out of kilter. For some inexplicable reason all the bottom sections leaked. The moment the fire was rekindled it was put out by the water and the cellar was flooded. On the next day Mr. Harrington's certificate arrived, stating that the boiler was all right. Last night workmen were tearing down the masonry of the old boiler and getting ready to put in a new one."

The foregoing account is from the *Sun* of March 12th. Next day the following item appeared in the same paper:

"City Inspector Harrington made a statement yesterday about the accident at Hall's cigarette factory, 209 East Thirty-seventh street, which seriously injured the engineer, Charles W. Courtney, scalding him with steam and hot water. The report that Courtney had died yesterday proved to be incorrect. Mr. Harrington said that when he was testing the boiler, the engineer went up on top next to the safety-valve.

They noticed that the valve wouldn't open at a hydraulic pressure of 80 pounds, nor would it at 120 pounds. There was no steam on, Harrington says, but only hot water. Courtney examined the valve to see what the matter was, but he couldn't even raise it with a blow of the hammer. Finally he screwed the cap off, and the hot water was blown out by the pressure, deluging him. Harrington says that Courtney was to blame. In regard to the leak in the boiler, Harrington said that after the engineer was taken home and the test was completed, a boy in the factory let off the water and then fired up, and the bottom of the boiler was burned. Harrington was exonerated by Sergeant Mullen of the Boiler Inspection Bureau."

The Railroads in 1890.

Mr. Samuel Nott, C. E., kindly sends the following article from the Springfield (Mass.) *Republican*:

Poor's Manual, still the most complete and satisfactory repository of statistics and information relating to the operations and financial condition of the railroad companies of the United States, covers in the issue for 1891 an operated mileage of 157,976 miles, and a completed mileage at the close of the fiscal years of the companies in 1890 of 163,420 miles, the figures for the previous year being respectively 152,689 and 160,544. As the fiscal years of many of the companies represented end with June 30th, the publication for the past year does not cover all the track completed in the calendar year, which aggregated at the end of 1890 166,817 miles, against 161,396 at the close of 1889 — an increase of 5,421 miles.

The immensity of the railroad system of the United States becomes apparent when we consider that of the total track laid throughout the world at the end of the year 1889, 595,767 kilometers, the United States possessed 259,687 kilometers, or nearly one-half. The 163,420 miles completed in this country at the end of the fiscal years of the companies in 1890, represent a cost of road and equipment of $8,789,221,516, and other property amounting to about $2,000,000,000 — with a capital stock of $4,640,239,578, bonded debt of $5,105,902,025, and other debt of $6,400,000,000. Such figures carry their own comment.

It appears to have been a fairly good year for the companies. Gross earnings per mile increased from $6,524 in 1889 to $6,946, and net earnings from $2,095 to $2,195. Net earnings paid 3.4 per cent. on total investment against 3.3 per cent. in 1889, 3.2 per cent. in 1888, 3.9 per cent. in 1887, 3.7 in 1886, 3.4 in 1885, and 4.9 in 1880. Considering only the capitalization of the roads operated, the net earnings of 1890 paid 4 per cent. on the investment. Nevertheless, the average rate per ton per mile fell from 1.46 cents in 1889 to 1.37 in 1890, and the passenger per mile rate from 2.17 cents to 2.12. Average receipts from freight per mile of road were $5,611 against $5,363 in 1889, $5,126 in 1888, and $4,866 in 1887. The larger volume of passenger traffic at the lower rate also yielded larger receipts per mile of road — $1,732 as compared with $1,688 in 1889.

Taking the statistics of freight and passenger traffic by groups of States, the relation of rates to volume of traffic and length of haul is shown often in a striking way. Thus the New England roads received an average of 1.37 cents per ton of freight per mile, while the middle group of Atlantic States received only 0.82 cents, and the central northern group only 0.79 cents. But the New England roads had a volume of traffic of only 5,890 tons a mile of road operated, and the average haul per ton was only 69.4 miles; while Middle States carried 19,666 tons per mile operated at an average haul of 84.8 miles. On the other hand, the Central Northern roads had a smaller volume of traffic than the New England — 4,018 tons per mile — but their average haul was 136 miles, and this, together with the character of the freight, which is largely bulky grain, explains the still lower rate. The rule would be, then, the larger the volume of traffic, average haul remaining the same, the lower the possible rate; and the longer the haul, volume remaining the same, the lower the possible rate, though, of course, the volume of traffic has the much greater influence over rates.

Passenger statistics show substantially the same results. Here the New England roads are favored. They had a traffic of 15,810 passengers per mile of road operated, while the Middle States had 10,799, and the Central Northern only 2,106; but the average receipts per passenger per mile in New England were only 1.92 cents, while in the Middle States the rate rose to 2.04 and in the Central Northern to 2.28.

Another noticeable feature of the year's operations that should attract the attention of stockholders is the continued disproportionate increase of bonded debt. It now exceeds the stock capitalization by nearly half a billion dollars. Up to the year 1888 the stock was the larger liability; now, bonds have become much the larger. This is true of all the groups of roads save the New England, South Atlantic, and Pacific groups. Bonds are not only building the roads but are providing for improvements to a large degree. When a road wants money for new track or buildings or equipment, or to buy additional mileage, bonds are sold instead of new stock issued. And the result is that the bonded debt is now out of all proportion to the stock, and the fixed charges for all seasons, good and bad, have been unduly increased to the disadvantage of the companies.

Internal Revenue Problems. — Truth is often much funnier as well as stranger than fiction. An important public officer of Duisberg, in Germany, is an ardent entomologist, and made a costly purchase of rare butterflies in Holland. The collection arrived in due time at the Duisberg custom-house, where the inspectors were at a loss to know whether the insects were dutiable or not. They finally came to the conclusion that, inasmuch as they had wings, they must be classed as poultry, and much explanation and expostulation were required before they could be induced to regard them in any other light. This recalls the story of the English railroad guard who told the famous naturalist, Frank Buckland, that a marmoset, which he had in his pocket, must go into the guard's van, because, in the eyes of the law, it was a dog, and, therefore, could not be allowed in a first-class carriage. Buckland protested in vain, and finally drawing a tortoise from another pocket — he always carried a menagerie about his person — said, with scornful indignation, "Perhaps you call this a dog too?" "Oh, no, sir," replied the guard with judicial civility; "cats is dogs, and rabbits is dogs, and so is monkeys, but turtles is insects." — *Evening Post.*

The best men, doing their best,
Know, peradventure, least of what they do.
Men usefullest in the world are simply used.
The nail that holds the wood must pierce it first,
And he alone who wields the hammer sees
The work advanced by the recurring blows.

— *E. Barrett Browning.*

The Locomotive.

HARTFORD, APRIL 15, 1892.

J. M. Allen, *Editor.* A. D. Risteen, *Associate Editor.*

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The annual report for 1891, of the *Sächsischer Dampfkessel-Revisions-Verein*, of Chemnitz, is at hand.

We have received, from the Belgian Association for the Inspection of Steam Boilers, the reports of the sittings of the fourteenth congress of the chief engineers of the *Associations de Propriétaires d'Appareils à Vapeur*, held at Marseilles. It forms quite a volume, and contains much interesting and instructive matter. It is illustrated with 14 plates.

We have read Mr. Simpson Boland's book, *The Iron Founder*, with much interest and profit. Mr. Boland is an experienced moulder and founder himself, and the information given in his book will be found to be useful and practical. The text is illustrated with over three hundred illustrations. Mr. Boland's book ought to be in the hands of every moulder and foundryman. It is published by John Wiley & Sons. ($2.50.)

We have received a copy of Mr. George B. Grant's *Odontics, or the Theory and Practice of the Teeth of Gears*, published by the Lexington Gear Works. Mr. Grant's name will be familiar to readers of the *American Machinist*, to which paper the articles in the present volume were contributed. The subject of gears is exhaustively discussed by Mr. Grant, and there are few who will not find in his volume something new to them.

Messrs. John Wiley & Sons, of 53 East Tenth Street, New York, send us a copy of the second edition of Tillman's *Elementary Lessons in Heat*. The work is intended as a text-book, "to meet the necessities of a very short course of study at the Military Academy" at West Point. For this reason the author found it impossible to treat his different topics extensively; but he shows considerable familiarity with his subject, and the book is one that we can recommend to those wishing a general knowledge of the principles of heat phenomena. Some few changes have been made since the appearance of the first edition, mostly in the phraseology of passages that appeared to trouble the students at the academy. A collection of elementary problems has also been appended.

The Midvale Steel Company of Philadelphia send us a photo-engraving of a remarkable steel casting recently made by them for the United States Government. It is a box-slide casting for the 12-inch turret mount for the *Puritan*, and its weight, when shipped, was 15,547 pounds. The specifications under which it was made were as follows: Tensile strength, 65,000 pounds; elastic limit, 25,000 pounds; extension, 15 per cent.; contraction of area, 25 per cent. Tests showed that the actual properties of the casting were: Tensile strength, 65,174 pounds; elastic limit, 31,058 pounds; extension, 25.10 per cent.; contraction of area, 35.04 per cent. We need hardly say that these results are highly creditable to the company.

A water-back in the kitchen range of the Allen House, Pawtucket, R. I., exploded recently. The range was completely demolished, the windows were blown out, large quantities of plastering were torn from the walls and ceiling, and live coals were scattered everywhere. The wood-work about the kitchen took fire, and the fire department was called out. The inmates of the hotel were somewhat startled by the explosion, and if the domestics had not happened to be all absent from the room at the moment, some of them would certainly have been badly hurt. It is supposed that the explosion was caused by the freezing of the supply pipe.

The First Tubular Boiler.

There is no place in this country where one can get so good an idea of all kinds of boats as can be obtained in the National Museum. Here one sees boats of bark, boats made out of the skins of animals, with bone and bamboo ribs; dug-outs, smooth bottom, clinker-built, flat, sharp, and perfectly round boats that resemble a tub. The highly-decorated flat-bottomed Mississippi steamboat can be seen, full of fancy gingerbread work, with saloons and staterooms piled above each other, looking like a floating house and suggestive of "life on the Mississippi" as Mark Twain and others saw it.

In strong contrast to the ark-like Mississippian are the full-rigged and polished ocean ships, the yachts, and beautiful models of war ships and others. These claim the attention of thousands of visitors; but there is more real interest shown in a small corner where a bust of Robert Fulton looks down upon things which taxed the inventive genius of men who inaugurated the reign of steam. Here, with a coat of black paint on it to check the tooth of time, which has gnawed it almost through, is a tubular boiler. This boiler was patented by John Stevens in the United States in 1803 and in England in 1805.

In his English patent specification, Mr. Stevens — beginning with "Whereas, His most Excellent Majesty, King George the Third, by his letters patent bearing date at Westminster the thirty-first day of May, in the forty-fifth year of his reign"— says, further on: "In the boiler I am about to describe, I apprehend the improvement is carried to the utmost extent of which the principle is capable." In describing, he continues: "Supposing a plate of brass of one foot square, into which a number of holes are perforated, into each of which holes is fixed one end of a copper tube of about an inch diameter and two feet long, and the other end of this tube inserted in like manner into a similar piece of brass, the tubes, to insure their tightness, to be cast in the plates. These plates are to be enclosed at each end of the pipes by a strong cap of cast-iron or brass, so as to leave a space of an inch or two between the plates or ends of the pipes and the cast-iron cap at each end; the caps at each end are to be fastened by screw-bolts passing through them into the plates. The necessary supply of water is to be injected by means of a forcing-pump into the cap at one end, and through a tube inserted into the cap at the other end the steam is to be conveyed to the cylinder of the steam engine; the whole is then to be encircled by brickwork or masonry in the usual manner, horizontally or perpendicularly."

The first patents in America were to Reade, Fitch, Rumsey, and Stevens, in August, 1791. Reade's was for a portable furnace tubular boiler: Fitch's was for driving a vessel by taking in water at the bow and forcing it out at the stern. The principle of Rumsey's and Stevens's patents was much the same as Fitch's.—*Mechanical News.*

Aluminium.

It is proposed to give some account in The Locomotive of the elementary substances of which the earth is composed. The present article is the first of the series, and is devoted to aluminium because in the list of known elements that metal comes first alphabetically.

The word is also spelled *aluminum*, but the spelling given above appears preferable, because its termination is uniform with that of sodium, potassium, chromium, calcium, magnesium, strontium, and other well-established names, the only marked exception being platinum, which, to accord with the analogy above suggested, should be platinium.

The name of this element is derived from the Latin word *alumen*, which means "alum"; but the Romans and the Greeks had no very exact knowledge of chemistry, and "alumen" and its Greek equivalent were used to designate a variety of substances, whose one common property is an astringent taste. The substance that is now commonly called alum was in all probability included among them, for it was well known to Geber. Alum was long believed to be of the same nature as the vitriols, until Paracelsus announced that the vitriols contain metals, while alum, he said, does not contain a metal, but derives its properties from an "intermixture of the earths." For a long time it was believed that the earth contained in alum was of a calcareous or lime-like nature. In the seventeenth century, however, it was noticed that an alum may be obtained by treating clay with sulphuric acid, and in a treatise published in 1746 Pott stated that the earth that forms the basis of alum is of an argillaceous or clay-like nature. Eight years later, in 1754, Marggraf announced that alumina, the earth of alum, is entirely different from lime, and that it exists in clay, combined with silica.

At the beginning of this century alumina was generally admitted to be the oxide of some metal, and Sir Humphrey Davy and other chemists endeavored to decompose it and obtain the metal. They were unsuccessful, however, and the isolation of the new metal was first accomplished by Wöhler in 1827. He heated the chloride of alumina with metallic potassium, the potassium abstracting the chlorine and leaving behind it the metal now known as aluminium. Paracelsus was therefore wrong in asserting that the base of common alum is not a metal, his error being caused by his ignorance of the fact that the so-called "earths" are oxides of metals.

The new metal proved to be most remarkable. Although it had so powerfully resisted all the earlier attempts to separate it from the oxygen with which it was combined, yet, when the separation had once been effected, it was found that the metal exhibits no very marked tendency to oxidize, even when heated in oxygen. It is nearly white, but has a slightly bluish tinge. It is about as hard as silver, and is very malleable and ductile. It can be readily drawn out into wire or beaten into leaf. It may also be highly polished. It has a tensile strength about equal to that of copper, and its specific gravity is only 2.583. It melts at about 1,300° Fah., its specific heat is 0.221, its coefficient of expansion is .00232 per degree Centigrade, and its atomic weight is 27.02. Bars of the metal emit a very musical sound when struck, but it is said that a bell made of it "sounds like a cracked pot." The metal is very feebly magnetic. It is scarcely affected by nitric acid, though muriatic and sulphuric acids will dissolve it. It is entirely unaffected by sulphur, except at high temperatures. Solutions of caustic potash or caustic soda, however, dissolve the metal readily.

It will be seen, from the foregoing statement of its properties, that aluminium differs in many important respects from all of the metals in ordinary use. It is strong but light, it takes a good finish, and it does not tarnish. It is also ductile and malleable. Until recently it has been too expensive for general use, but with every improvement in manufacture the price is materially lowered. Aluminium is abundant enough in nature, for, next to oxygen and silica, it is the chief component of the earth's crust. Feldspar and mica contain it in considerable amounts, as well as common clay, which is formed by the disintegration of feldspar. The oxide of aluminium occurs in many beautiful forms, giving us the ruby, the sapphire, besides forming an essential part of the garnet, topaz, turquoise, and emerald. Corundum and emery are also forms of the oxide, which are very useful to us for grinding and polishing. Kaolin, used in the manufacture of porcelain, is a very pure silicate of aluminium, and earthenware, "stoneware," and common bricks contain large amounts of the metal. The beautiful *lapis-lazuli* contains a considerable proportion of aluminium, and ultramarine blue, formerly obtained by powdering *lapis-lazuli*, is now prepared artificially from kaolin, together with other substances. The ruby and the sapphire are merely crystals of aluminium oxide, colored by traces of other metals. The red color of the ruby is due to a trace of some chromium compounds, and the blue of the sapphire is probably due to a trace of some compound of cobalt. By melting oxide of aluminium in the oxyhydrogen blow-pipe flame, adding a slight amount of certain metallic oxides, and cooling again, artificial rubies and sapphires have been made, which have all the properties of the natural gems.

Although aluminium occurs so abundantly in nature, and is found in considerable quantities in all fertile soil, "it is not taken up by plants, with the exception of a few cryptogams, especially the species of lycopodiums. The ash of *Lycopodium clavatum* contains up to 26.65 per cent., and that of *Lycopodium chamæcyparissus* even as much as 57.26 per cent. of alumina, while other plants, such as oak, fig, and birch, grown in the same soil, contain none."* Since it is not taken up by plants, it does not occur in the bodies of animals. Alum is sometimes used in baking powders, since it makes bread beautifully white; but it is believed to be injurious when used in this way.

Although aluminium is far more abundant than tin, copper, lead, zinc, or iron, and though it is distributed all over the earth, it can be extracted from the minerals in which it occurs only with the greatest difficulty. It is at present prepared in a variety of ways, all of which are more or less expensive. For the details of the various processes the reader must refer to the technical literature of the day. Most of them, however, are based upon the fact that chlorine has more affinity for sodium than it has for aluminium; and the general method of procedure is to heat some chlorine-compound of the metal with metallic sodium. The price of aluminium, therefore, depends on the price of sodium, and any improvements in the preparation of the latter metal will correspondingly cheapen the former.

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* Roscoe.

The properties of aluminium are so different from those of any one of the more familiar metals that jewelers and machinists often have trouble in working it. Those interested in working the metal will find many useful points in a book by Joseph W. Richards, entitled *Aluminium*. In addition to the information there given, we may mention one other fact that will be found valuable. In turning the metal in a lathe, keep the work and the tool wet with a mixture of equal parts of olive oil and Santa Cruz rum. The two will not mix, so they must be continually shaken together. In filing the metal keep the file wet with the same mixture.

The most valuable property of aluminium seems to be the facility with which it alloys with most other metals, except lead. The metal has been alloyed with bismuth, calcium, copper, chromium, gold, iron, magnesium, manganese, mercury, molybdenum, nickel, platinum, silver, sodium, tin, titanium, tungsten, and zinc. Some of its alloys with gold are very beautiful, and it has been proposed to use one of them in the manufacture of coins. (It has also been proposed to use the metal itself for coins of small value, like the one and five-cent pieces.) An alloy with nickel, called "nickel silver," promises to be useful in the future, as it is strong and easily worked, and has a beautiful white luster that will not tarnish. The addition of three per cent. of silver to aluminium gives it the color and luster of pure silver, over which it has the great advantage of not being tarnished by sulphuretted hydrogen. The most useful alloys of the metal at present, however, are those with copper, which are known as "aluminium bronzes." They contain the two metals in widely different proportions. That with three per cent. of copper has a whiter color than aluminium, the color being more like that of silver. When the alloy contains from 90 to 95 per cent. of copper, it has a color resembling gold. (Only those which contain a large proportion of copper are properly called bronzes.) Aluminium bronze is hard and elastic, and is not easily affected by chemical reagents. It is much used in the manufacture of articles of all kinds, from cheap jewelry to heavy bearings for machinery.

A Wonderful Dark Star.

The many wonderful discoveries in astronomy recently made by the aid of photography have seemed to leave the older methods of astronomical investigation far in the rear. But just now Mr. S. C. Chandler of Boston has made what may be called a discovery by the aid of mathematical methods, recalling the achievement of Leverrier and Adams in the detection of Neptune fifty years ago. There is in the northern sky a star known as Algol, which the sharp-sighted Arabs who discovered its variations in light called the demon star. Every two days twenty hours and forty-nine minutes this star suddenly begins to fade, and continues to grow fainter for three or four hours, at the end of which it has sunk from the second to nearly the fourth magnitude. After remaining thus for a few minutes, it begins to brighten, and in the course of three or four hours more regains its former brilliancy. Within the past few years it has been discovered that there is a huge dark body revolving around Algol at a distance of some three million miles, and to this phenomenon the variations in Algol's light are due. At regular intervals this dark companion star comes into the line of sight between Algol and the earth, and thus partially eclipses Algol, cutting off perhaps five-sixths of its light.

These stars, Algol and its strange non-luminous comrade, are of great size, Algol itself being more than eleven hundred thousand miles in diameter, while the diameter of the dark body that circles around it is eight hundred and forty thousand miles.

Mr. Chandler, meditating on certain irregularities in the motions of Algol and its companion, suspected that they might be due to the presence of another invisible star in their immediate neighborhood. He carefully compared the observations back to the time of Goodricke more than a hundred years ago, and pursuing a mathematical method similar to that which resulted in the discovery of Neptune through the effect of its attraction on Uranus, he arrived at the conclusion that such another star must actually exist. According to his conclusion, this mysterious body is far more massive than either Algol or its companion, but does not give forth any perceptible light, and it forms a center of attraction, around which both of the other stars revolve in a nearly circular orbit, in a period of one hundred and thirty years. Mr. Chandler's theory seems to fit in well with the observed irregularities of Algol. He remarks, moreover, that there are several other stars known to astronomers to be variable which evidently have one or more dark companions like those of Algol.

It is natural to inquire what is the nature of these mysterious dark bodies existing in the neighborhood of bright stars comparable in brilliancy with our own sun, and evidently obeying the same law of gravitation that prevails in our solar system. The primary distinction between a sun and a planet is that the former glows with a brilliant light of its own, while the planet, having been encrusted with a solid and opaque shell, only shines by the reflected light which it receives from its sun. The dark companions of Algol may then be regarded as in the planetary condition, at least so far as the question of luminosity is concerned. But they differ widely from any of the planets of our system in their great size as compared with the sun in whose neighborhood they circle. That companion of Algol, which, by its eclipsing effect, produces the variation in the light of the star, is not very far inferior in size to its bright comrade, while the greater dark body, whose existence seems to be demonstrated by Mr. Chandler's investigations, greatly exceeds them both in mass. Here, then, if we choose to adopt the idea that this great invisible orb around which Algol revolves is a planet in our sense of the word, we have a world which is the center of motion for the sun that illuminates it. This is going back to the old pre-Copernican idea of the earth as the center of the solar system, having the sun as its satellite. Such a system seems unnatural, if not impossible, because the ordinary laws of the radiation of heat require that a large body, other things being equal, should cool down from the solar to the planetary condition later than a smaller body. But it would seem that in the Algol system, for some reason yet to be discovered, the most massive member of the system has parted with its light and heat far earlier than one of the satellites revolving around it.

If it should prove to be true, as Mr. Chandler suggests, that there are other, and perhaps many other, systems similar to that of Algol, then we shall simply have additional evidence of the great variety that exists in the arrangements of the stellar universe. There really is no reason why we should take our own solar system as an invariable type to which all the other systems throughout space must correspond. It might be suggested that in the case of such a system as that of Algol, all the bodies belonging to it have long since become extinct through the operation of those laws of cosmical evolution which seem to be manifested in the universe at large as well as in our own planetary system, and that through some such cause as a collision one of the minor bodies of the system has again been brought to a luminous condition.

But there is no end of speculation when we try to interpret the wonderful discoveries with which the astronomy of our time is continually surprising the world. — *New York Sun.*

The Locomotive.

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The Connection of Steam Mains to Boilers.

We have discussed this subject in THE LOCOMOTIVE on several occasions, but our experience and observation indicate that it will do no harm to say a little more yet. Where steam drums are used in connection with boilers set in battery, they are too often connected with the boilers by short cast-iron or wrought-iron necks, which make so rigid a connection that the least independent movement of one of the boilers is almost

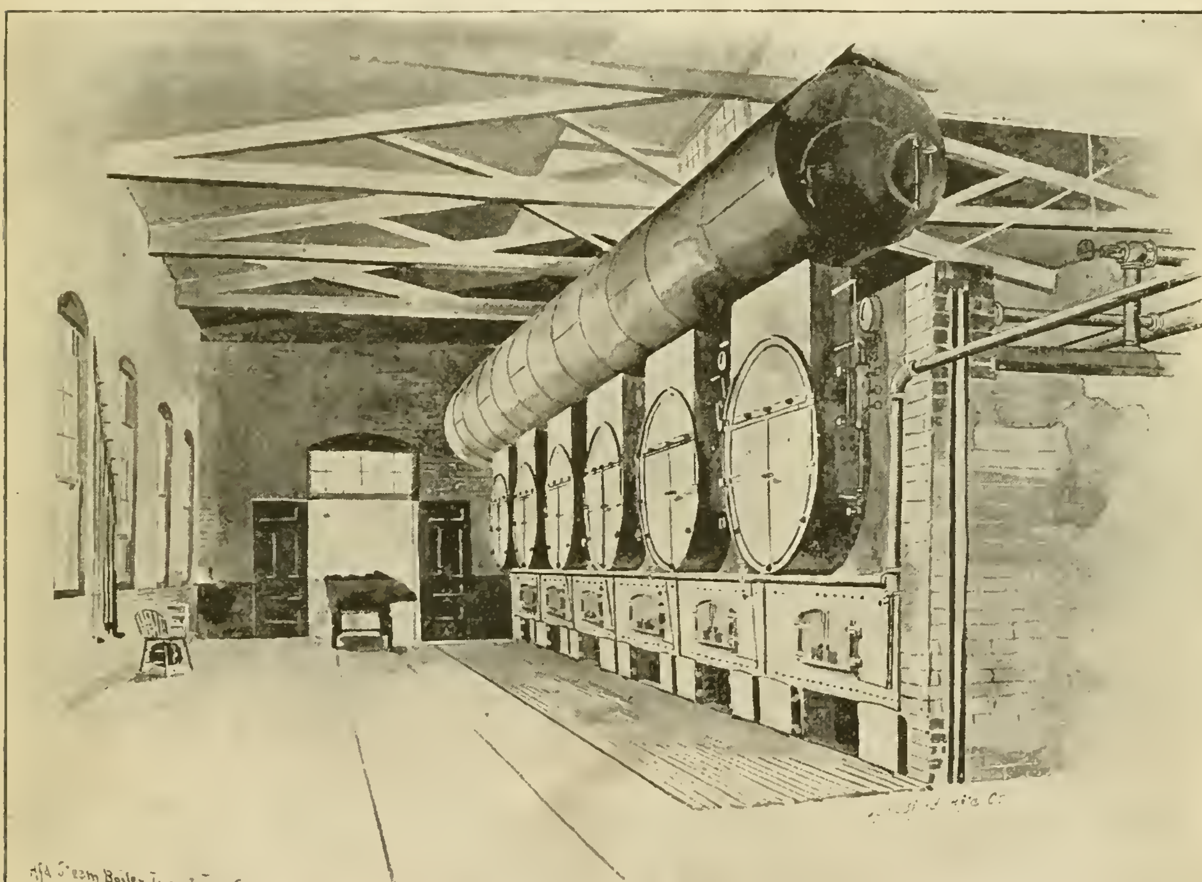

FIG. 1. — A MODEL BOILER ROOM.

sure to start a leak, or break something. The force exerted by expanding iron is tremendous, and the piping and connections of boilers should always be arranged in such a manner that slight movements of the boilers, from expansion and contraction, cannot give rise to severe strains at any point. Numerous accidents have happened from the use of too rigid steam connections, and accidents will continue to happen so long as such connections are used.

The accompanying engravings are from photographs of the boiler-room of a manufacturing company in New England. The boilers, settings, and piping were designed by the Hartford Steam Boiler Inspection and Insurance Company. The particular purpose that we have in mind in producing these engravings is to call attention to the manner in which the steam main is connected with the boilers. The steam main may be seen in the upper right hand corner of Fig. 1, back near the rear wall of the boiler-room; but it is more distinctly shown in Fig. 2. The center of the steam main is 4 feet 10 inches above the upper surface of the boilers, and connection is made with it by means of risers and horizontal pipes, arranged as shown in Fig. 2. The length of each riser, in the clear, is about 3 feet 6 inches, from the nozzle to which it is attached to the angle valve at its upper end; and the horizontal pipe that runs from each of these valves to the steam main is 7 feet long in the clear. There is no harm in making both the risers and the horizontal pipes longer than is here indicated, when

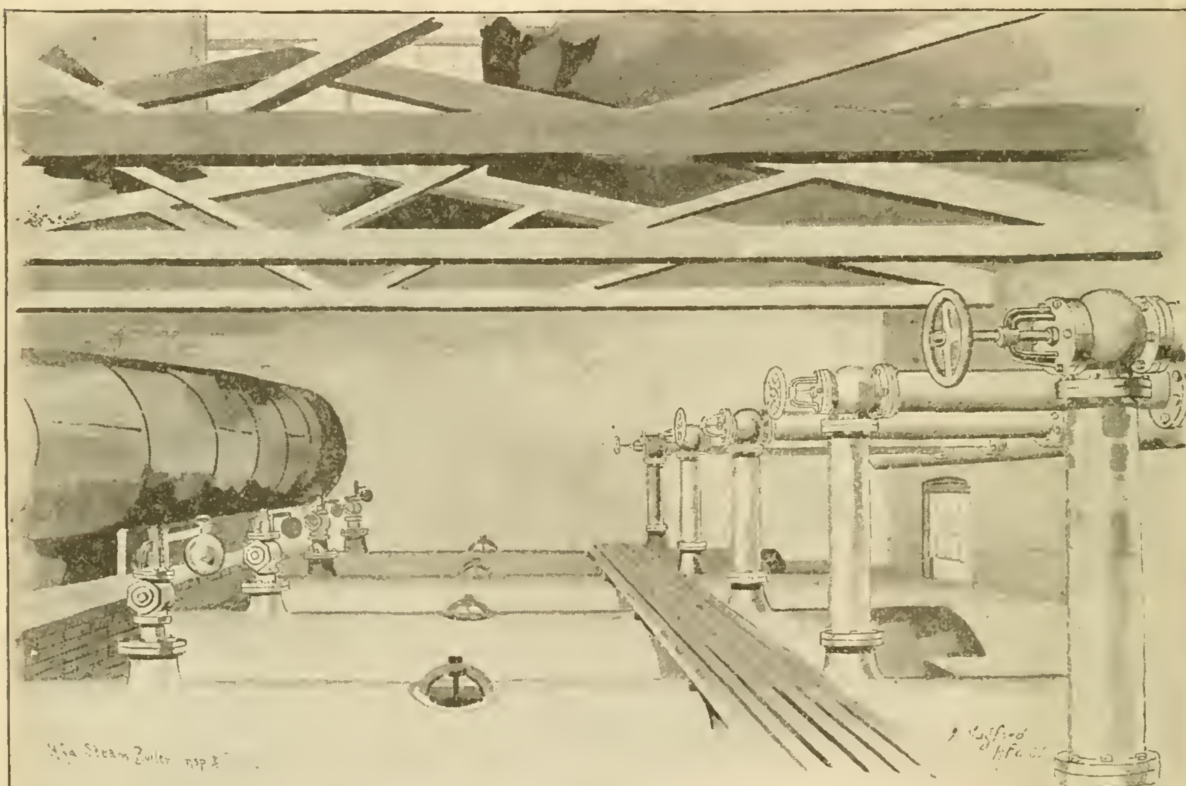

Fig. 2. — Showing Connections to Steam Main.

there is sufficient room, but experience has shown in the boiler-room illustrated above, that the dimensions given are sufficient to provide for the slight movements that the boilers and piping have in the case under consideration.

These boilers are 66 inches in diameter, and have 72 tubes each, 18 feet long and 3½ inches in diameter. There are six in number, and, as shown in Fig. 1, they are set in a single battery. They supply steam for two large engines, for a bleachery, and for two dye houses, one of which is 400 feet from the boiler-house. The drying machines consume about 150 horse power, also, and steam is used for heating, pumping, and other purposes. The main steam-pipe is 12 inches in diameter.

It will be noticed that these boilers have no steam drum. We believe steam drums to be unnecessary in most cases where they are used, but we are aware that many experienced engineers claim them to be indispensable. If such drums are used, they should be connected to the boilers in the way the steam main shown in Fig. 2 is connected, with risers and horizontal pipes.

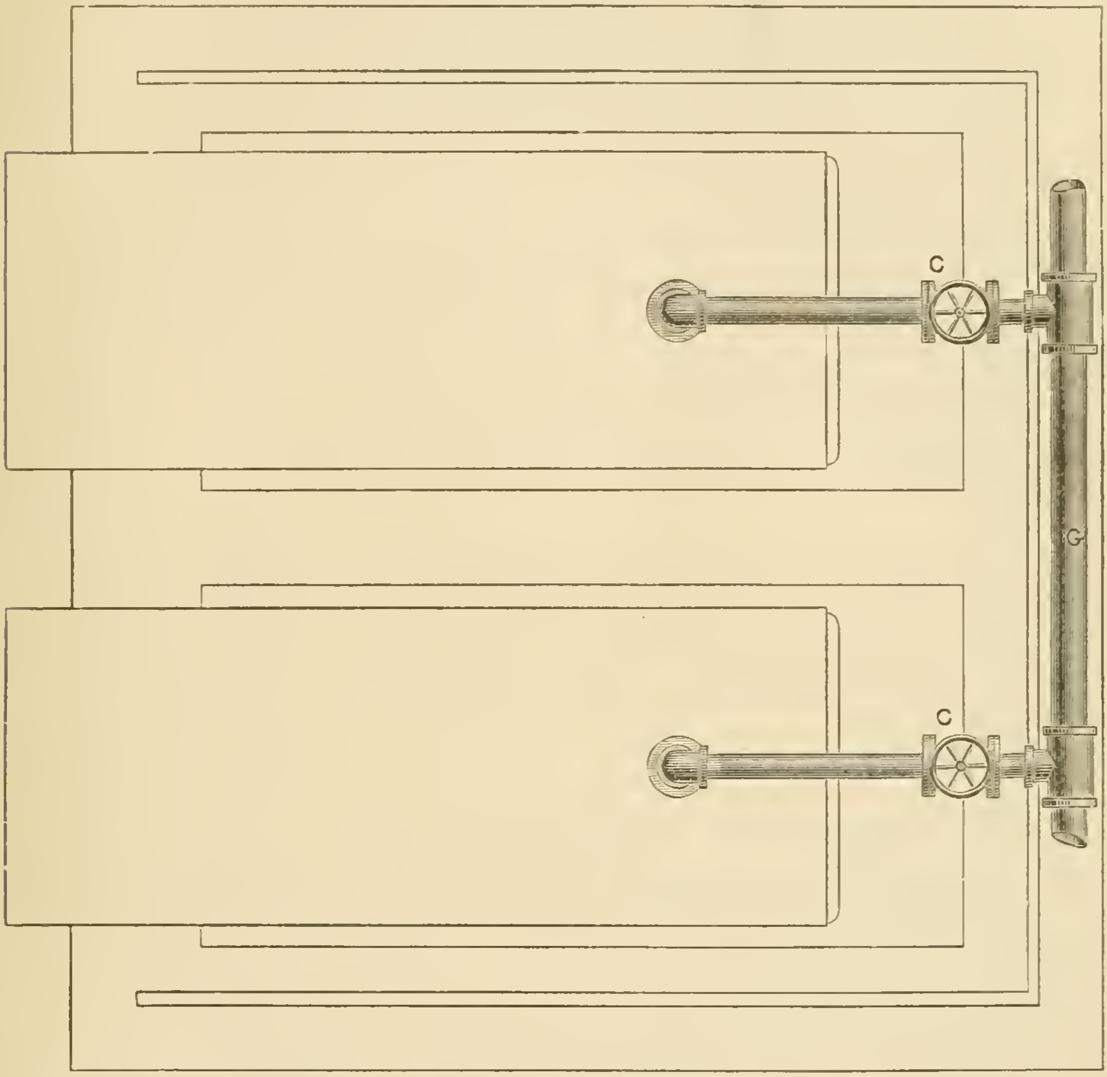

Fig. 3. — Plan View of Two Boilers.

Fig. 3 gives a plan view of two boilers connected as explained above, except that in Fig. 3 the stop valves are placed in the horizontal pipe instead of at the top of the riser. We prefer the angle valves shown in Fig. 2, though the arrangement in Fig. 3 works satisfactorily. It will be noted that by a mistake of the engravers the valves *C C* in Fig. 3 are shown with the stems *vertical* instead of *horizontal*. They should, of course, be horizontal, as otherwise the valves will trap water.

The Midvale Steel Company send us a photo-engraving of another remarkable steel casting, recently turned out by them. The subject of the engraving is a stern frame, for the U. S. Cruiser *Marblehead*. The specifications of the Navy department, under which this casting was made, called for a tensile strength of 60,000 pounds, and an elongation of 15 per cent., in a test bar half an inch in diameter, and two inches between measuring points. The official tests of the casting showed a tensile strength of 65,174 pounds, an elongation of 32.2 per cent., and a contraction in area of 48.7 per cent. A bar one inch square, cut from the casting, was also bent cold at a right angle over a 3-inch round, without developing the least crack or flaw. The casting, as shipped, weighed 9,213 pounds.

Inspectors' Report.

January, 1892.

During this month our inspectors made 6,498 inspection trips, visited 12,274 boilers, inspected 3,828 both internally and externally, and subjected 485 to hydrostatic pressure. The whole number of defects reported reached 8,221, of which 1,199 were considered dangerous; 93 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	571	47
Cases of incrustation and scale,	1,009	72
Cases of internal grooving,	59	20
Cases of internal corrosion,	322	59
Cases of external corrosion,	730	68
Broken and loose braces and stays,	140	43
Settings defective,	265	19
Furnaces out of shape,	303	28
Fractured plates,	279	99
Burned plates,	166	45
Blistered plates,	203	14
Cases of defective riveting,	1,474	102
Defective heads,	72	23
Serious leakage around tube ends,	1,271	321
Serious leakage at seams,	390	40
Defective water-gauges,	275	30
Defective blow-offs,	107	27
Cases of deficiency of water,	11	9
Safety-valves overloaded,	73	40
Safety-valves defective in construction,	97	27
Pressure-gauges defective,	306	29
Boilers without pressure-gauges,	11	11
Unclassified defects,	87	26
Total,	8,221	1,199

Boiler Explosions.

March, 1892.

Saw-Mill (45). On March 3d a terrible boiler explosion occurred at H. C. Terrell's saw-mill, fifteen miles south of Longview, Gregg Co., Texas. Lee Berry, a temporary fireman, was instantly killed, and fearfully mangled. So also were J. M. Burcham, a saw filer, and James Flower, shingle cutter. Abe Mitchell, night watchman, was hurt about the head, perhaps fatally. Francis Fambrough was also badly bruised and cut about the head, though his injuries are not necessarily fatal. Ed. Curry was seriously hurt in the shoulder, and Bert Burcham, Joe Cleburne, Bob Finlay, and Henry Russell, were injured to some extent. Squire Jones Dillingham, one of the county commissioners, a man eighty years of age, but very vigorous, father-in-law of Superintendent Brasher, was standing near by and was struck and knocked down with a piece of the boiler about eight feet square, of several hundred pounds weight. This iron was rolled off his insensible body, and his head was found to be crushed in, so that he died shortly afterwards. He was the oldest inhabitant in Gregg County, having fought Indians and served in the last three wars. The explosion was exceedingly violent, and was distinctly heard fifteen miles away. Big masses of iron and other materials were hurled from two to four miles. The account says that "the mill-pond which was near by was blown dry, and all the houses in the vicinity were demolished." The account also says, that Berry, thirty minutes before the explosion, said that he was "going to make the mill work or blow it to hell." He seems to have been eminently successful.

Mill (46). By a boiler explosion at Wood's mills, at Twenty-Second and Spring Garden streets, Philadelphia, on March 3d, Engineer Charles H. Rementer was scalded so severely that he died from his injuries, eight days later, in the German hospital.

Saw-Mill (47). The boiler in Charles White's saw-mill, ten miles west of Port Huron, Mich., exploded on March 4th, killing Frank Morran, and, it is thought, fatally scalding five others. Pieces of the boiler were blown forty rods, and the report was heard four miles away. The building was demolished, the property loss being estimated at $4,000.

Oil Well (48). The boiler at the Miller oil well No. 4, of Greenlee & Forst, at Laurel Hill, near Pittsburgh, Pa., exploded March 5th, and Conrad Daugherty, a tool dresser, was instantly killed. He was thrown sixty feet away and terribly mangled. The coroner's jury recommended that less steam be carried by oil well boilers, having ascertained that, although the Miller boiler was warranted to stand 100 pounds, as high as 160 was frequently carried.

Grist Mill (49). A serious boiler explosion took place at Stephenson's mill, Wake Co., N. C., on March 9th. Stephenson's mill is situated on Swift creek, and was until recently run by water power. Some time ago the dam broke and the water power was lost, after which a twelve-horse power steam engine was extemporized to run the mill. This was located about seventy-five yards below the mill and connected with it by a wire cable. At the time of the explosion there were only three persons near the boiler. John Stephenson was blown sixty yards, striking a tree and dying instantly. Furman Jones, who was standing at the side of the boiler, and who had come to the mill to have some grinding done, was blown about fifteen or twenty feet, and was badly stunned, but was able after a while to walk and drive his wagon home. His injuries at last accounts were considered serious, but not fatal. Nat Stephenson, brother of the young man who was killed, was standing near young Jones, but was not injured. The boiler was blown some fifty yards.

Electric Light Station (50). On March 10th, a boiler exploded in the Electric Light Station in Narasota, Texas, seriously scalding William Bissett, who has charge of the electric lights. The boiler was shattered to fragments, and the city was left in darkness for a few days.

Smoking Car (51). By the explosion of the heating apparatus in the smoker of the Santa Fé train, bound from St. Joseph to Topeka, Kan., on March 12th, Almon Richards and Alexander Erickson of Topeka, were badly hurt, and afterward died, and five others were painfully injured.

Machine Shop (52). The boiler in John R. Vallier's machine shop, in Strong, near Livermore Falls, Me., exploded on March 14th, seriously and perhaps fatally injuring

Mr. Valliers, who was standing near. The boiler was thrown 150 feet into the air. It is said that the safety-valve was out of order.

Locomotive (53). The boiler of engine 393 exploded on the Catawissa Branch of the Philadelphia and Reading Railroad at McAuley, Pa., on March 15th, killing two men and injuring three others. The killed are engineer Charles Clarence Campbell, and fireman Frank Brockie. The injured are brakeman George Benton, and two trackmen. The explosion occurred while engine 393, with a train of loaded cars, was passing over the Catawissa Branch. The two trackmen, who are said to be badly injured, had been ordered out in the early part of the evening, and were inspecting a side track which was supposed to be in an impassable condition, when engine 393 came in view. They stepped to one side with the intention of jumping on and riding to their destination, a mile or so from McAuley. They were in the act of boarding the engine, when the explosion occurred. Both of young Benton's arms had to be amputated, and he may not recover.

Tube Works (54). On March 14th, a boiler exploded in the Paige Tube Company's works, Warren, O., entirely wrecking the boiler-house, and riddling the machine-shops and welding mills. Over 200 men were employed, and but one immediate death resulted, that of Cyrus Milton, a colored coal shoveler. Many of the men were struck with timbers and other flying débris. Captain William Shannon, the electrician, was struck in the back with bricks and is seriously injured; fireman William Barnardy, arm broken, scalded, and fatally hurt internally; fireman James Jackson, critically jammed. The boiler that let go was one of a battery of four tubulars. Half of the exploded boiler rose through the roof, and dropped 150 feet away. Night engineer Charles Webb had just left the boiler-house and gone into the mill. The gauge showed ninety-five pounds steam pressure, which was the usual amount carried. The mill was running double turn and the fact that there were not more fatalities is marvelous, considering the havoc created. It is estimated that fifty thousand dollars will not more than rebuild the mill.

Saw-Mill (55). John Alexander was instantly killed, and his son James fatally injured, by the explosion of a saw-mill boiler near Linneus, Mo., March 18th.

Saw-Mill (56) The boiler in Wilson McCreadie's saw-mill, near Aylmer, Canada, exploded March 18th. Mr. McDonald, head sawyer, was struck by flying missiles, and severely hurt, but perhaps not fatally so. Iron and brick were thrown in all directions, some pieces being carried an eighth of a mile. Mr. McCreadie's loss was considerable, as the engine and building were badly damaged.

Steel Works (57). On March 19th, one of the boilers at the Wheeling steel plant, Wheeling, W. Va., exploded with a loud report, scattering bricks and pieces of iron in all directions and breaking the steam pipe. John Crane, one of the workmen, who was a few feet away at the time, was struck on the head with a brick, which cut a large gash and stunned him for a time. Another employe was injured but not seriously. The plant had not been in operation for a week, and only a small amount of steam was in the boilers at the time. Had the accident happened when the mill was going the result would have been more serious.

Fire Brick Works (58). One of the big boilers at the Laclede Fire Brick Works in the western part of St. Louis, Mo., exploded on March 21st, and four men were killed, and three injured. The boiler was in a shed adjoining the main building, and at the time of the explosion seven men were on the roof repairing the whistle. The boiler was torn into two pieces, one going over the main building and falling on the other side of the street. The other was carried only ten or twelve feet. The killed were Joseph Beckley, John Dubouchy, John Deideke, and Harry Hussy. John Seger, John Cellert, and a man named Inman were badly injured. James Seger, the fireman, was blown into a creek thirty feet distant, from which he was fished out some moments later. He was badly burned and scalded, but still alive. The four men who were killed were all terribly mangled. [One of the injured ones has since died.—Ed.]

Planing Mill (59). On March 21st, a small boiler explosion occurred in Ingard & Young's planing mill, Upper Sandusky, O., setting fire to a lot of shavings. The fire was extinguished, or thought to be, but in the evening it started anew, and destroyed the entire establishment. The loss is estimated at $6,000.

Lumber Mill (60). The boiler of the East Jordan Lumber Company's mill No. 2, East Jordan, Mich., blew up on March 21st, instantly killing William Beach, Simon Carney, Peter Sheldon, John C. Brown, Bert Cook, and Emanuel Hunt. Anozi Christy was fatally hurt and died soon afterward. Those dangerously injured are Sanderson Reinhart, badly injured about the limbs; John Ringle, who is seriously injured about the head, and will die; James Smith was seriously, and a score of others also badly injured. The noise of the explosion was heard plainly at Charlevoix, fourteen miles away. S. Pearson, who ran the engine, escaped uninjured. The engineer, who has charge of both mills, was James Pott. He had gone to breakfast, leaving the fireman, John Ringle, in charge. Ringle was in the engine-room at the moment of the explosion, and was too badly injured to be interviewed.

Saw-Mill (61). A horrible boiler explosion occurred at the village of Milford Center, ten miles east of Mechanicsburg, O., on March 22d. Lou Wilson, the saw-mill engineer, was instantly killed, his body being blown twenty feet high and 400 feet away, cutting limbs from the trees in its passage. Wilson was literally blown to pieces. Walter Walk, lumber off-bearer, had his skull fractured. The boiler landed 200 feet away.

Laundry (62). A small upright boiler exploded on March 23d, in Hill Harold's steam laundry, Uniontown, Pa. The boiler went up through the roof, and fell into an old cistern. Shingles and pieces of board were thrown 100 feet high, and in every direction. The noise of the explosion frightened the girls on the second floor, so that two of them jumped from a window, one being seriously hurt by the fall.

Saw-Mill (63). By the explosion of the boiler in William Leopard's saw-mill, in Frederick, eleven miles northwest of Dayton, O., on March 25th, William Leopard, John Castle, Edward Elliott, and Dello Poince were instantly killed. Samuel Davis was removed from the ruins, but it is doubtful if he will live.

On April 30th, the huge new engine in the Willimantic Linen Company's No. 4 mill, Willimantic, Conn., was wrecked by the failure of the main shaft. The break occurred at a shoulder, where the shaft was turned down from 18 inches in diameter to 15 inches. The engine, fly-wheel, and engine-house were transformed at once into a pile of bricks, mortar, and scrap iron. One man was bruised, but otherwise no personal injuries resulted. The fly-wheel was 28 feet in diameter, and 9 feet 2 inches across the face. The entire engine weighed about 125 tons.

The Locomotive.

HARTFORD, MAY 15, 1892.

J. M. ALLEN, *Editor.* A. D. RISTEEN, *Associate Editor.*

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Papers that borrow cuts from us will do us a favor if they will mark them plainly in returning, so that we may give proper credit on our books.

THE Twenty-first annual report of the *Schlesischen Verein zur Ueberwachung von Dampfkesseln* (for 1891) is at hand.

WE desire to acknowledge, also, the nineteenth annual report of the *Sächsisch-Thüringischer Dampfkessel-Revisions-Verein*, of Halle.

THE following extract from the Philadelphia *Press* of May 10th should make engineers and firemen thoughtful: "While George Stringer, 28 years, of 520 Argyle Street, was inside of one of the large boilers at the Pennsylvania Salt Works, near Greenwich Point, cleaning it out yesterday afternoon, one of the employés of the company, not knowing that Stringer was in the boiler, turned on the full head of steam. He was rescued from his terrible position as soon as his outcries were heard, but not before he was horribly burned with the hot vapor. He was removed at once to the Pennsylvania Hospital, where his injuries were dressed. At midnight Stringer was in a critical condition."

Many of our inspectors have had narrow escapes from death in this way. Steam has been turned on while they were in boilers, either by mistaking one valve for another, or in the belief that the inspector had left the boiler. The only safe way is to let *every* valve strictly alone until the inspector is *known* to have come out.

MESSRS. John Wiley & Sons, of 53 East Tenth Street, New York, send us a copy of Church's *Notes and Examples in Mechanics*, a book intended to serve as a companion to the same author's *Mechanics of Engineering.* In the present volume the first chapter contains a discussion of the center of gravity of bodies. The second chapter considers the equilibrium of forces lying in a plane, and includes applications to trusses and link-work. Several cases of the motion of a material point are then considered, and a collection of numerical examples in the statics of a rigid body, and the dynamics of a material point is then given, the examples being worked out. Chapter five is devoted to the moment of inertia of plane figures, and the sixth chapter contains a variety of problems in the dynamics of rigid bodies. There is a good appendix on the graphical statics of mechanism, based on the work of Prof. Herrmann of Aix-la-Chapelle. Altogether, Prof. Church's book is an interesting one, though it is intended to be read in connection with his treatise on the *Mechanics of Engineering*, referred to above; and it cannot, therefore, be considered complete in itself. It assumes, also, a certain familiarity with the principles of the differential and integral calculus; so that considerable portions of it will not be accessible to those unacquainted with these principles.

Fall of a Chimney in England.

We have received, from the Yorkshire Boiler Insurance company, a copy of Mr. John Waugh's report on the recent Cleckheaton chimney disaster, which is sufficiently interesting to warrant us in reproducing the following abstract of it. The fathers and uncles of the present firm of Messrs. Thornton Bros. wished to build a chimney about the year 1859. No regular designer of such structures was employed, but Mr. Brook, a "joiner and architect," was consulted. Whether any plans or specifications of the chimney were made at the time does not appear; but none were produced at the inquiry. When the chimney was forty yards high, it was found to have settled, so that it leaned some seven inches in a southeasterly direction. In consequence of this, work was suspended for some months. The chimney was straightened, and was then carried up twenty yards further, making it about sixty yards high over all. It is said that Messrs. Thornton's attention was called to signs of distress in the chimney some time prior to the eighth of February, this year. It is admitted that on that day their attention was called to the state of the chimney, and they immediately set to work to obtain some advice or opinion upon the structure. They were advised to apply to John Moulson & Sons, of Bradford, who ultimately agreed to send over a man of experience to examine the chimney. In accordance with this agreement, they sent, on the fourteenth of February, a man called Harrison, who examined the base of the chimney, inside and out. He gave his opinion to Messrs. Thornton's employes, to the effect that the "chimney appeared to be all right," but he advised the bricking up of seven holes he found in the inner shell, left, as he thought, since the building of the chimney, and he also recommended the renewal of the brickwork about several oblique cracks on the northerly side, and a bulge on the easterly side, all on the outer shell of the chimney. He was of the opinion that the renewal of the brickwork about the cracks and the bulge could be accomplished without difficulty or danger. Arrangements were at once made to carry out these recommendations, and on the following Sunday, the twenty-first of February, Harrison came, as arranged, to brick up the openings in the inner shell, the bricks required for the work being sent by Messrs. Moulson during the intervening week.

Harrison, in carrying out the first part of the work, necessarily spent more time in the chimney than he did on his first inspection, and he noticed several additional facts that had escaped his attention before. He noticed, for instance, that there was a "run of water" not far from the entrance of the main flue to the chimney, and that the bricks forming the main flue, in and about the entrance to the chimney, were in a bad condition, being "decayed with damp." In digging holes in the flue dust at the bottom of the chimney for his scaffold, he found it "sludgy and wet." By measurement he found that the brickwork of the inner shell was only fourteen inches thick, the outer shell being the same; and he noticed that the space of two feet, two inches, between the shells, was filled with flue dust as high as he could reach. To these facts he called the attention of Mr. Willoughby, the engineer. After this examination Harrison practically condemned the chimney by saying to Willoughby, "You had better get a new foundation and build a new chimney."

Harrison reported the result of this visit to his employers, and expressed a wish that some one else would view the chimney before anything was done. Next day Mr. William Moulson visited the chimney, with the result that, on February twenty-third, Harrison began work on the repairing of the outer shell. He commenced with one of the cracks furthest from the bulge, and says that he took out the old brickwork, half a brick in thickness and eighteen inches square, at a time, and then made the opening good with new brickwork before making another opening of similar area; and he further says that he dealt with several such spaces on this day, leaving open only the toothings for further repairs next day. On Wednesday he began with another height on the left of his first day's work, and nearer the bulge, adopting the same method as on the previous day, leaving only the toothings for the next day's work. His work on Wednesday left him about a yard from the bulge. It is contended by other witnesses, however, that Harrison did not proceed with his work as described above, but that he made openings in the brickwork (though not through into the cavity) some five and one-half feet high and four feet wide. However that may be, before leaving work on Wednesday, the twenty-fourth, Harrison thought it advisable to prop the "loose brickwork of the bulge" from the boiler-house wall. While in the act of propping it up, he felt the brickwork of the outer shell press against his knees, and the chimney immediately settled down, and finally tumbled over in an easterly direction, destroying about half the adjoining mill and killing fourteen persons.

Mr. Waugh adds that he considers, from personal examination, that the bricks used in the construction of the chimney were originally poor, and that they had deteriorated greatly from some cause (probably moisture) since the chimney was built. "They were of various sizes," he says, "and of various material, and differed very much in the degree of burning. They were unfit for building a chimney, even if it was composed of solid brickwork."

The dimensions of the chimney were as follows: Height, sixty yards; outside diameter at base, fifteen feet; inside diameter at base, six feet; thickness of outer wall, fourteen inches; thickness of inner wall, fourteen inches. The stump of the fallen chimney projected only a little above the ground, and the foundation was found to be level and in good condition. An excellent photolithograph of the ruined mill is appended to Mr. Waugh's report.

A Benzine Explosion.

A sad accident occurred, in Philadelphia, recently, resulting in the death of two men, and in serious injuries to another. The men were repairing a leak in the boiler of locomotive No. 618, of the Philadelphia & Reading railroad company, known as the "Reading Flyer." The top of the dome had been removed, and at the moment of the explosion the men were still working about the dome. The foreman, whose name was Hoster, was inside the boiler, and the other two men were on the top of it outside. A can of benzine had previously been taken into the boiler, and Hoster, apparently forgetting this fact, asked one of the men to hand him a light through the dome. As the lamp was passed to him, the vapor from the benzine ignited. The flame spread instantly to the body of the fluid, and a terrific explosion followed. Hoster, being in the dome, blocked up the only vent, and he was blown violently into the air like a shot from a cannon. His body lodged in the truss-work that supports the roof of the building. A ponderous electric crane was moved across under the hanging form of the injured man, and from it workmen reached Hoster and brought him to the floor. He was still living, and was removed to the hospital, where he soon died. Within half an hour of his death he talked cheerily to the occupant of the next cot, telling him what he knew of the explosion. He congratulated himself upon what he called his own "close call," expressed regret at the death of Jordan, and said he hoped Kenney and himself would soon recover. Jordan, who had his head over the dome at the time of the explosion, was struck by Hoster's body, and badly mutilated and burned about the face. He was thrown to the ground, and died in a few minutes. Hoster was a skilled mechanic and a careful workman, well aware of the danger of working about benzine with a light; and when he called for the lamp, he must have forgotten, for the moment, that the can was in the boiler.

Accidents of this character sometimes happen when a light is brought to the open hand-hole or man-hole of a boiler in which kerosene has been used to remove scale, though we do not know of an accident of this kind whose results were so terrible.

Bagasse as Fuel.*

In order to meet the present low price of sugar and almost valueless molasses, under the bounty law and with the possibility of the bounty not lasting many years, it becomes absolutely necessary to reduce the cost of sugar manufacture.

The judicious use of bagasse as fuel is perhaps one of the most important questions with which we have to deal, and which has a direct bearing on the reduction of the cost of manufacture.

There is a general tendency among people connected with the sugar industry of Louisiana to disregard bagasse in all calculations, being a by-product costing nothing. Were it not for the expense and bother of carting it away, even at this late day, few people would take the trouble to burn it.

Nevertheless, since bagasse contains "carbon," it has an intrinsic fuel value equal to the additional cost of that proportion of coal necessary to do the work which the bagasse is capable of performing. Appreciating the difficulties which surround the practical determination of this value on a manufacturing scale, it is perhaps best to try and establish it in the abstract. That is to say, as a source of heat, regardless of the manner in which this heat is to be applied.

In an article from the pen of Mr. N. Lubbock, published in *The Sugar Cane* for October, 1891, and reprinted in the *Bulletin de l'Association des Chemists de Sucrerie et de Distillerie de France et des Colonies*, the author, after calculating the number of heat units obtainable from the carbon contained in the fiber and other organic substances of bagasse, deducting that proportion of heat lost in waste gases in vaporizing the moisture and heating the air of combustion, concludes that to produce the same number of available heat units contained in one pound of Scotch coal requires 4.83 pounds of bagasse from a double mill making a 72 per cent. extraction, and 5.98 pounds of single mill bagasse of 66 per cent. extraction.

These figures cannot very well be applied to Louisiana cane, for his calculations appear to be based on tropical cane containing 12½ per cent. woody fiber, against, say, 10 per cent. for ours.

A common impression obtains that within certain limits a low extraction gives bagasse most valuable as fuel, owing to its sugar content. The above figures show the contrary to be the case. In the first place 100 pounds of low extraction bagasse contains

* A paper read by Prof. L. A. Becuel before the Louisiana Sugar Chemists' Association, March 12. 1892.

a smaller proportion of woody fiber, more water, and not a sufficiently increased quantity of combustible organic salts to supply the heat units lost in the woody fiber. Secondly, since the lower extraction bagasse contains more water, a greater proportion of heat units have to be expended in vaporizing it, thus leaving a smaller margin of available heat units.

For instance, with cane containing 12.5 per cent. woody fiber, a juice containing 16.13 per cent. solids, and 83.87 per cent. water, bagasse of, say, 66 per cent., and 72 per cent. mill extraction would have the following percentage:

Composition, viz.:	66 per cent. bagasse.	72 per cent. bagasse.
Woody fiber, . . .	37	45
Water, ...	53	46
Combustible salts, . . .	10	9
Totals, . . .	100	100

This shows that 72 per cent. bagasse contains 54 parts of combustible matter against 47 parts for 66 per cent. bagasse, which is an excess of nearly 13 per cent. in favor of 72 per cent. bagasse.

In addition to being inferior in heat-producing properties, the 66 per cent. bagasse contains 15.2 per cent. more water to be evaporated, before the heat produced by the combustion of the bagasse becomes available for manufacturing purposes.

The author referred to states that the woody fiber contains 51 per cent. "carbon," and the sugar and other combustible matters an average of 42.1 per cent. At 12,906 units of heat generated for every pound of carbon consumed, the 66 per cent. bagasse is capable of generating 297,834 heat units as against 345,200, or a difference of 47,366 units in favor of the 72 per cent. bagasse.

Assuming the temperature of the waste gases to be 450° F., that of the surrounding atmosphere and water in the bagasse at 86° F., and the quantity of air necessary for the combustion of one pound of carbon at 24 pounds, the lost heat will be as follows: In the waste gases, heating air from 86 to 450° F., and in vaporizing the moisture, etc., the 66 per cent. bagasse will require 112,546 heat units, and 116,150 for the 72 per cent. bagasse.

Subtracting these quantities from the above, we find that 66 per cent. bagasse will produce 185,288 available heats units, or nearly 38 per cent. less than 72 per cent. bagasse, which gives 299,050 units. Accordingly, one ton of cane at 66 per cent. mill extraction will produce 680 pounds bagasse, equal to 125,995,840 available heat units, while the same cane at 72 per cent. extraction will produce 560 pounds bagasse, equal to 167,468,000 units.

We therefore find that, after taking everything into consideration, one ton of cane at 72 per cent. mill extraction will produce for steam-making purposes 41,472,160, or about 33⅓ per cent. more available heat units than the same cane at 66 per cent. mill extraction.

It follows, from the foregoing, that in order to be accurate, every case should be handled separately. To do this would require more time than the writer can devote to an article of this character. He believes, however, that, assuming, say, 75 per cent. average mill extraction from Louisiana cane, containing, say, 10 per cent. woody fiber and 16 per cent. total solids in the juice, a fair average value can be placed on bagasse from double mills.

By making the same calculations that were made in the case of tropical cane, bagasse from one ton of Louisiana cane contains 157,395,640 heat units, from which 56,146,500 have to be deducted.

This would make our 75 per cent. Louisiana bagasse, worth on an average of, say, one-half barrel, or nearly 92 pounds coal per ton of cane ground. Under fairly good conditions, 1 pound coal will evaporate $7\frac{1}{2}$ pounds water, while the best boiler plants evaporate 10 pounds. Therefore, under fairly good conditions the bagasse from 1 ton of cane at 75 per cent. mill extraction should evaporate 689.25 pounds of water, and under the best conditions 919 pounds water. The juice extracted from such cane would under these conditions contain 1,260 pounds of water. If we assume that the water added during the process of manufacture is 10 per cent. (by weight) of the juice made, the total water handled is 1,410 pounds. From the juice represented in this case, the commercial masse cuite would be about 15 per cent. of the weight of the original mill juice, or say 225 pounds. Said mill juice 1,500 pounds, plus 10 per cent., equals 1,650 pounds liquor handled; and 1,650 pounds, minus 225 pounds, equals 1,425 pounds, or about the quantity of water to be evaporated during the process of manufacture. To effect a $7\frac{1}{2}$-pound evaporation requires 190 pounds of coal, and $142\frac{1}{2}$ pounds for a 10-pound evaporation.

To reduce 1,650 juice to syrup of, say, 27° Baumé, or 50 per cent. brix, requires the evaporation of 1,170 pounds of water. If this work be accomplished in the open air, it will require about 156 pounds of coal at $7\frac{1}{2}$ pounds boiler evaporation, and 117 at 10 pounds evaporation.

With a double effect the fuel required would be from 59 to 78 pounds, and with a triple effect, from 36 to 52 pounds.

To reduce the above 480 pounds of syrup to the consistency of commercial masse cuite means the further evaporation of 255 pounds of water, requiring the expenditure of 34 pounds coal, at $7\frac{1}{2}$ pounds boiler evaporation, and $25\frac{1}{2}$ pounds with a 10-pound evaporation. Hence, according to our premises, to manufacture one ton of cane into sugar and molasses, it will take from 145 to 190 pounds, equal to from 0.30 to 0.54 barrel additional coal, to do the work by the open evaporator process; from 85 to 112 pounds, equal to 0.11 barrel coal with a double effect, and only $7\frac{1}{2}$ pounds evaporation in the boilers, while with 10 pounds boiler evaporation the bagasse alone is capable of furnishing 8 per cent. more heat than is actually required to do the work. With triple effect evaporation depending on the excellence of the boiler plant, the 1,425 pounds of water to be evaporated from the juice will require between 62 and 86 pounds of coal. These values show that from 6 to 30 pounds, or from 0.02 to 0.16 barrel of coal, can be spared from the value of the bagasse to run engines, grind cane, etc.

It accordingly appears that with the best boiler plants, those taking up all the available heat generated, by using this heat economically the bagasse can be made to supply all the fuel required by our sugar houses. If this has not yet been accomplished in Louisiana, may it not be due more to imperfect boiler and evaporating plants than to a deficiency in heat-producing properties of the bagasse used? In conclusion, the writer firmly believes that the day is not far distant when the only additional fuel used will be that needed to start mills, burners, and to boil when the mills are not running.

— *Louisiana Planter.*

Engineering calls attention to the following interesting facts: Montana is larger than Turkey; Texas is larger than the whole Austrian Empire by 30,000 square miles; and New Mexico is larger than Great Britain and Ireland put together.

Antimony.

The metal antimony is found in nature in the metallic state, but the chief source of it is in the mineral stibnite, which is a compound of antimony and sulphur. Stibnite was known in very early times. It has been used by the women of the East for many centuries for painting the eyebrows and eyelashes, and for giving luster to the eyes; and before the discovery of the metal itself, stibnite was called "antimony." It appears that the paint used by Jezebel (2 Kings, ix: 30) was finely ground stibnite. The Arabs called this face paint *al-Koh'l* ("al" means "the"), and this word passed into other languages as *alkohol* or *alcohol*, so that this familiar word originally signified the paint used by the Eastern women in beautifying their eyes and faces. Whitney says that it was afterwards used to mean any very fine powder. The English philosopher, Robert Boyle, used the word in this sense. It was next extended to essences, quintessences, and spirit, especially the rectified spirits of wine, and finally it came to be used as at present.

The origin of the word antimony is not known. There is a legend that certain monks were once poisoned by it (for the compounds of antimony are poisonous), and that the word is derived from the Greek word *anti*, against, and the French word *moine*, a monk. Thus *antimoine* or antimony would mean "monk's bane," or something like that. This derivation, however, is entirely fanciful.

The first distinct mention of the metal itself is made by Basil Valentine, who gives a process for extracting it from stibnite, though he does not claim to have discovered it. Several methods of extracting it are now in use, the chief one being as follows: Two parts of stibnite are melted with one part of thin scrap iron, in plumbago crucibles. The sulphur leaves the antimony and combines with the iron, so that sulphide of iron and metallic antimony result, the iron sulphide floating as a slag. The crude antimony so obtained is next melted with a small amount of sulphate of soda, and a little of the slag obtained from the operation next to be described. By this means the metal is purified somewhat. It is then cast into molds, and when cold, it is broken up into small pieces, to prepare it for the third operation, which is called "melting for star metal." This third process consists in melting sixty parts of the broken metal with two parts of pearlash and five parts of slag from a previous operation of the same kind. The resulting metal or regulus is poured into square molds, into which some slag has first been allowed to run, and is cooled slowly, while still covered with slag. If the metal is of good quality, the resulting blocks will have a stellated or crystalline surface. Thorpe says that "antimony, unlike many other metals, carries on its face its own character for purity. When pure, a beautiful fern leaf or star appears upon its surface, and according to the length and form of this star on the ingot, its quality is determined. The presence of a relatively small percentage of impurities in the metal will prevent it from 'starring.' It is this peculiar characteristic of pure antimony to crystallize on the ingot in the fern leaf or star form when cooling, which originates the trade term of 'star antimony' for good quality of antimony."

The total consumption of the metal amounts to 3,000 tons per annum, nearly all of which is smelted and refined in England. Ores of the metal (of which stibnite is the most important) occur in Mexico, California, and Nevada, New Brunswick, Hungary, Bohemia, Bavaria, Australia, New Zealand, Borneo, Japan, Asia Minor, Cape of Good Hope, Algiers, Italy, Spain, and Portugal, Corsica, and Sardinia.

Antimony is a brilliant, bluish-white, brittle, crystalline metal. Its specific gravity varies from 7.72 to 7.86. It melts at about 840° Fah., and, if protected from the air, it boils at a white heat. At ordinary temperature it is not acted upon by air or water, but it oxidizes quickly when melted, and at a red heat it burns with a brilliant white flame, and can decompose water. It expands upon solidifying, and imparts this property to its alloys. Its coefficient of expansion is about .0000064 per degree Fahrenheit. The tensile strength of cast antimony is about 1,000 pounds per square inch of sectional area. It is a comparatively poor conductor of heat and electricity, its thermal conductivity being only about one twenty-fifth of that of silver; its electrical resistance is 0.488 of that of mercury at the freezing point, and 0.704 of that of mercury at the boiling point (*i. e.*, 212°). Its chemical symbol is Sb (from the Latin word *stibium*), and its atomic weight, according to Clarke, is 119.96, or, in round numbers, 120. The chief lines in its spectrum have the wave lengths 6128.7, 6078.2, and 6003.7 (Thalén's measures). It is *diamagnetic* — that is, a sphere made from it is *repelled* by a magnet. Its thermo-electric properties are strongly marked, and it is therefore used in the laboratory in the construction of thermopiles.

Antimony forms valuable alloys with other metals, and this is its most important use in the arts. Type metal is an alloy of lead, antimony, and tin, with sometimes a little copper. The tin gives toughness while the antimony gives hardness, and causes the alloy to expand in solidifying, giving an accurate cast of the letter. The composition of type-metal varies somewhat, but Roscoe recommends the following: Melt together 2 pounds of tin and 1 pound of copper foil, under finely divided charcoal. To this add 5 pounds of lead, and, after the mixture has been strongly heated, add 2 pounds of antimony. One pound of old type-metal may be added also.

Britannia metal, plate pewter, white metal, and Babbitt metal are alloys containing antimony. Following are some of the proportions used:

	Britannia Metal.		Plate Pewter.	Babbitt Metal.	White Metal.
Tin, ...	85.7	81.9	89.3	45.5	85.0
Antimony, ...	10.1	16.2	7.1	13.0	10.0
Copper, ...	1.0	....	1.8	1.5	5.0
Zinc, ...	2.9	1.9	....	....	....
Bismuth, ...	....	....	1.8	....	....
Lead, ...	....	....	....	40.0	....

All of these alloys vary somewhat with different makers, especially Babbitt metal. The "white metal" referred to in the last column is used by German locomotive builders for lining brasses, and for bushes.

Some of the salts of antimony are largely used in medicine. Chief among these are "tartar emetic," which is a tartrate of potassium and antimony. Taken in small doses (from $\frac{1}{16}$ to $\frac{1}{6}$ of a grain) tartar emetic acts as a diaphoretic, rendering the mucus surfaces moist and promoting secretion generally. In larger doses it acts as an emetic, as its name indicates. The so-called "butter of antimony," which is a concentrated solution of the trichloride of this metal, is used for giving a brown surface to gun-barrels and other articles of iron and steel. It is also somewhat used in medicine on account of its powerful caustic properties.

The Locomotive.

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Concerning Blow-Off Pipes.

In previous issues of The Locomotive we have discussed the proper location of blow-off pipes on externally fired boilers, and in the September number a sleeve was shown for protecting the pipe from the sharp action of the flame. We frequently meet with ruptured or burned blow-off pipes, and receive inquiries regarding such failures. The sleeve referred to above is of much value in protecting the pipe, but the quality of the pipe, the connections, and the boiler-room practice, have much to do with the failure of the blow-off. Not infrequently we find brass pipes used for the purpose, as they do not so readily become foul by the adhesion of sediment; and when they are not exposed to high temperatures, there can be no objection to their use. On locomotive, vertical tubular, and other types of internally fired boilers, they are efficient and durable. The nature of brass, however, is such that the metal will become soft at temperatures that

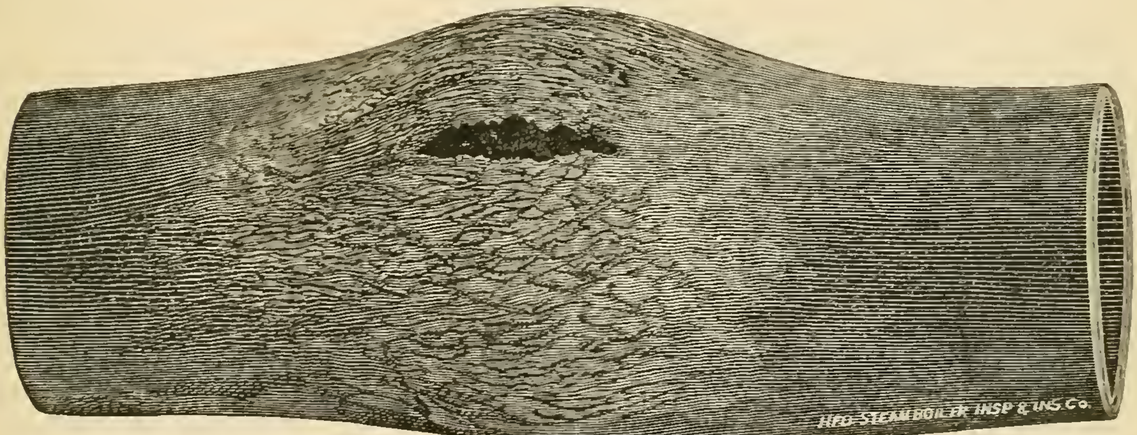

Fig. 1.—A Ruptured Brass Blow-Off Pipe.

do not injure iron. When the blow-off pipe is directly exposed to the heat, without protection, some steam must be generated in it; and the film of steam next to the metal, by preventing the contact of water, may allow the pipe to be heated to such a temperature that the brass will soften. The illustration (Fig. 1) shows a case of this kind, of which we have met many instances. The pipe was perfectly free from scale and sediment, and appears to have failed on account of local elevation of temperature and consequent softening, as explained above. We have found the most durable material for blow-offs to be extra heavy iron steam pipe.

Trouble also frequently arises from an accumulation of sediment and pieces of scale in the pipes. Such accumulation may have several causes. For example, it is by no means uncommon to reduce the size of the blow-off somewhat after it leaves the boiler. This should never be done, as pieces of scale that can enter the blow-off at the boiler end may be unable to pass through the smaller pipe with which it is connected. The same remarks apply to the use of globe valves on blow-offs, for these obstruct the blow-off in such a manner that the pipe may become entirely blocked up in the course of time, from scale and sediment. Straight-way valves, with openings *the full diameter of the blow-off*, should always be used. Even then attention should be paid to the manner in which the flushing is done, for improper flushing may also give trouble. Opening the valve only partially, or so as to know that the pipe is not closed up, is as bad as not opening it at all, for, by so doing, sediment is drawn into the blow-off, but not blown out. High pressures are not necessary in flushing out, but *the valve should be thrown wide open* for two or three seconds or more, according to the amount of sediment

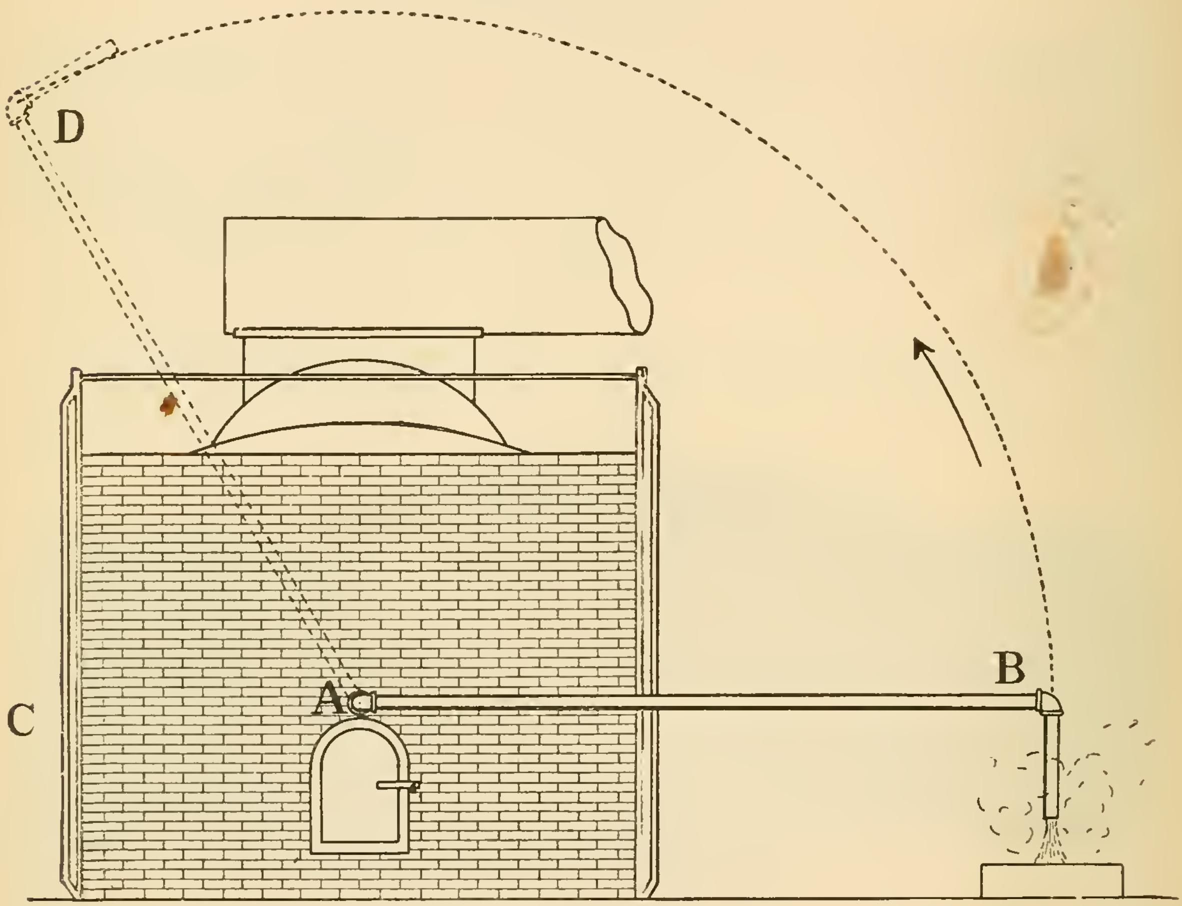

FIG 2. — AN ACCIDENT FROM AN UNANCHORED BLOW-OFF.

collecting, so that the full force of the water may, in its passage through the pipe, remove all sediment adhering to the pipe or lodging in the fittings. It is well to flush the pipes when the boiler is practically at rest, say in the early morning, or when the fires are banked, because at such times the sediment is settled and more of it will be blown out.

The frequency of flushing depends upon the condition of the feed water. Some waters are so free from sediment that twice a week would keep the pipes clean, while other waters may deposit enough solid matter to make it prudent to flush every twelve hours. In general terms, it may be said to be good practice to flush the pipes daily, and, in cases of much sediment, oftener.

Blow-off pipes should be supported in such a manner that the reaction of the water escaping from them will not displace them. Accidents occasionally happen from a neglect of this principle, and though they are not very common, they should be carefully provided against. Fig. 2 illustrates a case of this kind that recently came to our notice. The blow-off pipe came out through the rear of the setting, as shown at *A*, and then turned to the right, running horizontally along the rear wall of the setting to the point *B*, a distance of 12 feet. At *B* it turned downward and discharged into a barrel which was drained by separate pipes. One Saturday evening, at about half-past six, the engineer opened the blow-off cock (at *A*) to empty the boiler, and although this had often been done before, on this particular occasion the reaction of the water, as it escaped downward at *B*, caused the pipe *AB* to turn on the thread at *A*, so that the end *B* was blown violently upward as indicated by the dotted line *BD*. This did not take place until the boiler had been blowing off for some time; and when it *did* happen, the watchman, on his regular rounds, was coming through the passageway at *C*, so that the pipe struck him squarely on the top of the head, fracturing his skull and killing him instantly. The pipe should have been secured at the free end, so that such an accident could not happen; and in all cases it is well to secure the ends of blow-off pipes that have elbows in them, so that accidents of this character may be avoided with certainty.

Although the blow-off should be secured in such a manner that the reaction of the escaping water will not displace it, it should not be built solidly into the setting, for it will then have no chance to expand and contract. It should be anchored *outside* the setting.

Inspectors' Report.

February, 1892.

During this month our inspectors made 6,153 inspection trips, visited 12,499 boilers, inspected 4,196 both internally and externally, and subjected 596 to hydrostatic pressure. The whole number of defects reported reached 8,837, of which 948 were considered dangerous; 45 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	582	30
Cases of incrustation and scale,	1,139	64
Cases of internal grooving,	79	20
Cases of internal corrosion,	378	45
Cases of external corrosion,	564	55
Broken and loose braces and stays,	187	84
Settings defective,	231	34
Furnaces out of shape,	340	25
Fractured plates,	207	47
Burned plates,	122	24
Blistered plates,	203	15
Cases of defective riveting,	1,748	139
Defective heads,	85	29
Serious leakage around tube ends,	1,529	101
Serious leakage at seams,	364	28
Defective water-gauges,	334	46
Defective blow-offs,	122	32
Cases of deficiency of water,	15	10
Safety-valves overloaded,	47	19

Nature of Defects.	Whole Number.	Dangerous.
Safety-valves defective in construction,	89	41
Pressure-gauges defective,	397	49
Boilers without pressure-gauges,	9	9
Unclassified defects,	66	2
Total,	8,837	948

Boiler Explosions.

April, 1892.

Saw-Mill (64). On March 29th the boiler of the saw-mill belonging to Mr. W. C. Thomason, Gayton, Va., exploded. Fortunately, no one was seriously injured. [Received too late for insertion in the March list.]

Locomotive (65). A tram locomotive boiler exploded at W. T. Carter & Bro.'s mill on the Trinity & Sabine road, near Colmesneil, Texas, on April 3d, no one being injured. The locomotive was wrecked, the tender tank being blown off, and a house roof near was lifted and badly damaged by the explosion. No one was near the engine when the accident occurred.

Locomotive (66). The crown sheet of locomotive No. 206 of the Illinois Central Railroad blew out on April 4th, in Chicago, demolishing the engine, seriously injuring George H. Prescott, engineer, and Joseph Butler, fireman, and giving the many passengers aboard the train a bad shaking up. The train, which is known as the fast Harvey train, left that town at 3.13 o'clock. A 3.29 a stop was made at Pullman, and then Engineer Prescott pulled open the throttle. Burnside crossing was reached and passed with the train running thirty miles an hour. At Seventy-ninth street the explosion occurred. The passengers were startled by a loud roar, and were thrown violently out of their seats as the train came to a sudden stop. When they could leave the cars they found that the engine had been wrecked by the explosion, the engineer and fireman being blown on either side of the track. Engineer Prescott was found unconscious in the ditch eight feet from the track on the right side, and Fireman Butler in a similar condition about ten feet on the other side. The Grand Crossing police were called, and the injured taken to Grand Crossing, where they received medical attendance.

Saw-Mill (67). A large boiler in the Somerset Lumber Company's saw-mill, Uniontown, Pa., exploded on April 5th, completely wrecking the mill, and instantly killing the sawyer, Peter Tree, of Three Springs, Huntington County.

Locomotive (68). On April 6th the boiler of Engine No. 49, of the Long Island railroad, exploded at Blissville, Long Island City. Joseph Losh and Theodore Van Luben were killed, and James Cloyne, John Laffy, and Andrew Walker were seriously injured. The only outward indication that anything had happened to the locomotive was the absence of the furnace door, which had been torn from its hinges, and the presence of numerous pieces of half-burned coal in the cab. The explosion had not even broken the panes of glass in the sides or front of the cab. An examination of the interior of the furnace showed that one of the side plates of the fire box had been blown in. This is the second instance of a locomotive exploding on the Long Island railroad within seven months. On September 8th, locomotive No. 113, attached to a passenger train, while standing at the Oyster Bay station awaiting the signal to start, exploded, instantly killing three men — the engineer, fireman, and a brakeman — whose bodies were terribly mangled, and thrown several hundred feet through the air. In that case the crown sheet of the fire box was blown down.

Saw-Mill (69). W. J. Harper, engineer at J. F. Wheatley's steam saw-mill, about five miles from Federalsburg, Md., was killed by an explosion of the boiler on April 8th. Mr. Harper was blown, together with the boiler, through the roof, and landed twenty-five feet from the mill. The boiler lodged about one hundred yards from the mill, striking a large pine tree, which it cut entirely off.

Greenhouse (70). The greenhouse on the premises of P. Halstead Scudder, at Roslyn, N. Y., was badly wrecked on April 12th by the explosion of the boiler. The accident occurred about midnight. Mrs. Scudder observed a bright light in the direction of the greenhouse, and called her husband's attention to the fact. Mr. Scudder hastily donned his clothing and was hurrying toward the greenhouse when the explosion took place. The building was badly wrecked, and many of the rare plants in the house completely destroyed.

Saw-Mill (71). On April 15th the boiler in the planing mill of D. A. Welsh, Bender, Mich., blew up. Fortunately, the fireman had just left the engine-room to attend to other duties. Parts of the boiler were carried over thirty rods. No one was near the boiler at the time, and there were no fatalities.

Portable Boiler (72). The boiler of a portable engine exploded on April 18th, at 185th Street and Inwood Avenue, New York city. Thomas McDonald, the engineer, was severely injured, and two laborers were knocked to the ground by the force of the explosion. The explosion made a terrific report, and was heard a long distance away. The engineer was working about the machine at the time. He was thrown many feet and was picked up unconscious. He was badly burned about the head, arms, and legs, and his right arm was broken. One laborer was struck by a piece of the flying boiler on the arm, causing an ugly gash.

Manufacturing Building (73). A slight boiler explosion, which occasioned a considerable panic among the inmates of the building, occurred in the old silk mills building, corner of Bank and Wickliffe Streets, Newark, N. J., on April 18th. William H. Smith, the fireman, was scalded. No other person was hurt. The boiler was a "safety" water-tube one, and the explosion was due to the bursting of one of the tubes. Other tubes were also found to be broken or cracked. The building in which the explosion occurred is a large, four-story brick structure, occupied by several manufacturing concerns.

Saw-Mill (74). The boiler of McAlester's new saw-mill at South McAlester, I. T., exploded on April 21st, causing the death of the owner, Ed. McAlester. A flying piece of boiler plate also tore away a limb of Fred Stevenson, an employe. The mill was completely demolished. It is remarkable that more of the employes were not killed or injured.

Saw-Mill (75). The boiler of Thompson's saw-mill, four miles north of Fremont, Col., exploded on April 23d, instantly killing Clark Dilldine and injuring the fireman, James Grove, perhaps fatally. The boiler was thrown up the mountain about a thousand feet, cutting off large pine trees in its flight, and the engine-house was blown to splinters. William Kirk, the regular engineer at the mill, gave up his job on the very morning of the explosion, declaring that, in his opinion, the boiler was unsafe to run;

and Dilldine, who was one of the proprietors, was working in his place. This is the second explosion that has happened at this mill.

BATH-HOUSE (76). On April 25th a heating boiler exploded in E. C. Bartow's bath-house and laundry, Greencastle, Ind., setting fire to the building. The fire was promptly put out, however, and nobody was hurt. Every window in the building was shattered, the doors torn from their hinges, and the boiler was blown through the roof, fully a hundred feet into the air.

SAW-MILL (77). A frightful explosion occurred on April 26th at Pullen & Haywood's saw-mill, seven miles from Rocky Comfort, Ark. E. W. Pullen, W. W. Haywood, W. A. Clem, and Frank Castleberry, a child 8 years old, were killed. Mrs. Castleberry and J. W. Kitmer were fatally hurt, and will die. Miss Dora Castleberry, Miss Ona Pope, Edmond Pope, Warren Stewart, R. A. Clem, Robert Pullen (son of E. W. Pullen), Maud Haywood, Allen Haywood. Mr. and Mrs. Hedley Short, Dickson Knight, and Allen Thompson, were wounded. The boiler, in its flight, cut in two a pine log, an ash tree, and an oak. This is the third boiler explosion that has occurred in this vicinity within the past year or so.

LOCOMOTIVE (78). On April 26th a locomotive on the Soo Line exploded at Whitedale, a few miles east of Manistique, Mich., and Engineer Hubbard and Fireman Stead were seriously injured. Both were badly scalded, and the fireman died next day.

One Series of Mistakes.

A short time ago our attention was called to some most remarkable doings in a boiler-room, which we proceed to relate. The boiler was originally built to furnish power, and was good for about 75 pounds steam pressure; but it is now used only for heating purposes. Some of the steam and return valves to the large coils leaked about the stems, and the owner of the boiler, instead of sending for a steam-fitter to re-pack them, called in a plumber. The plumber, being busy, sent his boy helper. The boy began work on some of the valves that were within sight of the boiler front, but, being troubled by the steam that escaped, he shut off the steam valves, leaving the return valves open. The coils were large, and when the steam in them had condensed, water began to back up into them from the boiler; for there were no check valves on the returns. As the boy worked away, he noticed that the water in the gauge glass was going down somewhat rapidly, and also that the steam pressure was rising. He did not know where the water was going to, nor did he know how to feed in more; but he thought that if he opened the furnace door and so checked the fires, the evaporation and the rise of pressure would proceed much more slowly. Jumping down into the pit in front of the boiler, he opened what he *thought*, in the darkness, were the fire doors; but it appeared subsequently that he *did* open the ash-pit doors, thus making matters worse instead of better. The fire brightened up, and the pressure began to rise rapidly, and the water level to go down. The boy was greatly troubled at this, and when the rubber diaphragm in the damper regulator burst from the increasing pressure, he "went all to pieces," as the saying is, and ran for his boss. The boiler being originally intended for furnishing power, the safety-valve could not be set to blow at less than about 20 pounds, while the damper regulator was designed to carry not more than six or seven pounds; so that its diaphragm burst, naturally enough, before the blowing-off point of the safety-valve was reached. The plumber came in haste, and found the people in the building overhead badly frightened, and the boiler-room filled with steam, so that he could not make out precisely what had happened. He told the boy how to turn on the feed, however, and that well-meaning but badly "rattled" individual went to the back end of the setting, and, instead of opening the plug-cock in the feed pipe, he opened the plug-cock in the blow-off pipe, which only added to the noise and confusion. Meanwhile the plumber hauled the fire out on to some pine boards that the regular attendant had laid in the damp pit. The boards took fire, and smoke was soon added to the escaping steam, to the intense horror of the occupants of the building, who by this time were on the other side of the street. When the fire had been hauled and the danger averted, the plumber soon learned the cause of the disturbance, and quiet was speedily restored by shutting off the damper regulator and the blow-off, and throwing a few buckets of water on the burning boards.

It seems hardly possible that a such succession of mistakes could follow one another in so orderly a manner, but we can testify, from personal observation, that they did. And we may add that not long afterwards, when the boiler was out of use, a coal-dealer put 100 tons or so of coal into that same boiler-room, piling it up in such a manner that some of it ran down into the open man-hole, and the rest of it buried up the blow-off pipe and the rear door of the setting, which were both open, so that there was plenty of trouble digging them out before the boiler could be started up again.

The Masonry of Boiler Settings.

The brick-work about boiler-settings is often very imperfectly laid. It is mostly done by contract, with no one to supervise it who understands the severe use to which it is to be put. The brick-layer, who may never have worked on a job of this kind before, builds good looking inside and outside walls, but the space between is apt to be filled up with odds and ends in the most promiscuous manner. Furthermore, he puts the same joint in that he would use if he were building a house, and this is just what we do not want in a boiler-setting, particularly in the fire-brick lining of the furnace. The joints throughout the setting should be thin, and the work should be done as faithfully inside as outside. Kaolin or prepared fire-clay is used in laying the fire-brick, and it should be mixed up so thin that it cannot well be used with a trowel. Some mill-owners who have had experience in this direction will not allow a trowel to be employed at all, but require the men to use iron spoons. The fire-brick should be dipped in water as they are used, so that when they are laid they will not immediately "drink up" the water from the cement. They should then receive a thin coating of the prepared fire-clay or kaolin paste, and be carefully placed in position with as little of the kaolin or fire-clay as possible. Every sixth course, beginning with the grates, should be a row of headers, *well bonded into the masonry behind.* The headers are of little use unless they are well secured into the walls of the setting, for when the lower courses of fire-brick have burned away more or less, we have to rely on these headers to a considerable extent to hold the upper part of the wall in position. In repairing fire-brick linings the lower courses, which burn out fastest, can be removed and replaced without disturbing the upper part of the wall, provided the headers are secure; while if they are not, the entire wall may have to be rebuilt, and this cannot be done without either removing the boiler or tearing down a considerable part of the setting.

The Locomotive.

HARTFORD, JUNE 15, 1892.

J. M. ALLEN, *Editor.* A. D. RISTEEN, *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.

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Papers that borrow cuts from us will do us a favor if they will mark them plainly in returning, so that we may give proper credit on our books.

WE have received the seventeenth annual report of the *Märkischer Verein zur Prüfung und Ueberwachung von Dampfkesseln.*

THE twenty-second annual report of the *Norddeutscher Verein zur Ueberwachung von Dampfkesseln* is at hand; also a copy of the rules and by-laws of the association.

THE illustrations in THE LOCOMOTIVE are taken from photographs, whenever this is possible, but in preparing the April issue we could procure no photograph, and had to rely on a cut that appeared in a newspaper clipping that somebody kindly sent us — an unusually accurate cut, we may add, for a daily paper. There was nothing about the clipping that would indicate what paper it was taken from, and for this reason we gave no credit. We have since learned that it first appeared in the New Bedford (Mass.) *Standard.*

THE report of chief engineer Sinigaglia, of the *Associazione fra gli Utenti di Caldaie a Vapore* of Naples, for 1891, is at hand. This association was organized in the latter part of 1890, so that this is its first annual report. It contains considerable general information, and some interesting statistics. Among other things, it is said that "the French associations have under their surveillance about 16.5 per cent. of the whole number of boilers in industrial establishments, the total number of such boilers in France (exclusive of Algiers) in 1890 being 69,682," while the associations mentioned in the report had charge, during the year, of 11,492.

WE desire to acknowledge several copies of the report for 1891 of the chief engineer of the National Boiler Insurance Co., of Manchester, Eng. This report contains much that is of interest. It appears that "during 1891 32 actual explosions of steam boilers in the United Kingdom were reported, which caused the deaths of 12 persons, and injury to 39 others." It also appears that "the number of explosions in recent years [in the United Kingdom] is much smaller than in former years, the average number of explosions for the ten years ending with December, 1889, being 33.8 per annum, as compared with 57.5 for the ten years ending with December, 1874; and not only has the number been reduced, but the severity of the explosions, as measured by the loss of life and injury to person is also much less, the average number of persons killed and injured per annum being 174.9 for the ten years ending with December 1874 [*i. e.* 3.04 per explosion], and 84.7 for the ten years ending with December, 1889 [*i. e.* 2.51 per explosion." This diminution in the number of casualties speaks well for the improvements in construction and management of boilers that have come into use during the past twenty years, and also for the work of inspection carried on by the insurance companies.

In conclusion, we may call attention to the following very good advice, which boiler owners in this country would do well to heed: "Where there are two or more boilers, each should have a metal figure attached to facilitate correct reference, and avoid confusion or serious mistake."

A few months ago, a remarkable case came up in one of the San Francisco courts. Mr. Archibald McKinnon was on trial before Judge Morrow for violating the law relating to steam navigation by *sitting on the safety-valve* of the boiler of a coast steamer of which he was engineer. It does not appear that he denied the charge, for his defense was, that the United States inspectors had already punished him by suspension, and that he could not be punished twice for the same offense. Judge Morrow reserved his decision, and we have not learned how the case terminated.

Messrs. John Wiley & Sons, of 53 East Tenth street, New York, send us a copy of Prof. Cecil H. Peabody's new book on *Valve Gears for Steam Engines.* A number of books on this same subject have appeared recently, yet there appears to be abundant room for the present work, which is intended, as the preface says, "to give engineering students instruction in the theory and practice of designing valve gears for steam engines." Each type of gear discussed is illustrated by one or more examples selected from good practice. Professor Peabody gives preference to Zeuner's diagram, considering it at least as good as any other circular one. The book is a most excellent one, the treatment being intelligent and lucid, and as simple as the nature of the subject allows. Typographically there is nothing to be desired, and the thirty-three plates of illustration are of unusual excellence. (Price, $2.50.)

We have received from the American Society of Mechanical Engineers a set of separate copies of the papers read before the society at its recent meeting in San Francisco. Among them we note an exhaustive and fully illustrated paper by Mr. Albert W. Stahl, U. S. N., on the *Utilization of the Power of Ocean Waves*, and one on the *Elastic Curve and Treatment of Structural Steel*, by Mr. Gus C. Henning. A short but interesting paper on *Two-Cylinder versus Multi-Cylinder Engines* is contributed by Mr. Samuel M. Green and Mr. George I. Rockwood, in which the results of tests on the Merrick Thread Company's new triple expansion engine are given. Mr. Rockwood had previously taken the position that more than two cylinders are unnecessary in order to secure the highest attainable economy, and as this proposition had been "severely criticized and declared to be inconsistent with the modern philosophy of the steam-engine," the tests in question were made to verify or confute it, as the case might be. The authors state that "the results . . . would seem to support Mr. Rockwood's theory that the receiver may be so constructed as to take the place of the intermediate cylinder or cylinders of the multi-cylinder engine." A more extended paper, giving the results of further trials, is promised for the next meeting.

Progress in Color Photography.

M. Lippmann, who has been experimenting for some time on photography in colors, has obtained some promising results, which indicate that the complete solution of the problem is near at hand. Several very fair colored pictures were recently presented by him to the French Academy of Sciences, and in the *Comptes Rendus* a note from him appears, for a translation of which we are indebted to *Nature*.

"In the first communication which I had the honor to make to the Academy on this subject," he says, "I stated that the sensitive films that I then employed failed in sensitiveness and isochromatism, and that these defects were the chief obstacle to the general application of the method that I had suggested. Since then I have succeeded in improving the sensitive film, and, although much still remains to be done, the new results are sufficiently encouraging to permit me to place them before the Academy.

"On the albumen-bromide of silver films rendered orthochromatic by azaline and cyanim, I have obtained very brilliant photographs of spectra. All the colors appear at once, even the red, without the interposition of colored screens, and after an exposure, varying from five to thirty seconds. On two of these plates it has been remarked that the colors seen by transmission are very plainly complementary to those that are seen by reflection.

"The theory shows that the complex colors that adorn natural objects ought to be photographed just the same as the simple colors of a spectrum. There was no necessity to verify the fact experimentally. The four plates that I have the honor of submitting to the Academy represent faithfully some objects sufficiently diverse — a stained glass window of four colors, red, green, blue, yellow; a group of draperies; a plate of oranges, surmounted by a red poppy; and a many-colored parrot. These showed that the shape is represented simultaneously with the colors.

"The draperies and the bird required from five to ten minutes' exposure to the electric light or the sun. The other objects were obtained after many hours of exposure to a diffuse light. The green of the foliage, the gray of the stone of a building, are perfectly produced on another plate; the blue of the sky, on the contrary, was represented as indigo. It remains, then, to perfect the orthochromatism of the plate, and to increase considerably its sensibility."

We cannot undertake to describe M. Lippmann's method, but it may be said that his color effects depend on the interference of light, produced by a multitude of parallel layers of reduced silver in the sensitive film. "Mother of Pearl" owes its colors to the same general cause — the interference of light as it is reflected from the minute striæ on its surface.

Singular Coincidences in Names.

The Cincinnati *Commercial Gazette* tells of a number of cases in which there is a striking harmony between men's names and their businesses. On a shop in Ravenna, Ohio, is a sign bearing the name "M. E. Scripture," and in the window a stock of Bibles is displayed. Mr. Bookbuyer is in the book business in a Michigan town, and Mr. Tanner conducts a tannery at Kittanning, Pa. In Mascoutah, Mo., there is a hotel keeper whose name is George Hotel. Some curious combinations of names are given by the same paper. Thus, North West is a merchant in Bridgeport, Ohio; Going West is an attorney in Fredonia, N. Y.; and Wilde West lives in Rockford, Ill.

The *Gazette's* list of curiosities in names might be extended indefinitely, as every city furnishes a few. For example, the advertisement of a well-known New York firm reads: "Styles & Cash, Fine Stationery;" and a sign on Twenty-Third street, in the same city, reads: "A. Constable, Justice of the Peace." Everyone knows, too, that gunpowder is made at Hazardville.

In connection with this subject we may mention an Albany barber, whose name we have forgotten. When a stranger comes to his place, he receives a business card which quite overpowers him. It reads thus:

John Doe,
Tonsorial Artist, Capillary Abridger
and Professor of Crinicultural Abscission and
Craniological Tripsis.

Advance in Astronomical Photography.

The Boston Scientific Society recently held a meeting of unusual interest, says the *Boston Advertiser*, at which S. C. Chandler, the eminent astronomer, gave the first public presentation of the remarkable work now being done by Max Wolf at Heidelberg.

He said: "The position of asteroids in astronomical science is a peculiar, and I might say practically a useless one, so far as tangible results from their discovery are concerned. The discovery of a new comet is a matter of great importance, and the increase in their number contributes much to the knowledge of the science, but with asteroids, they must be found in large numbers before they become of special significance, and in that event, it has always been a debated question whether the immense amount of labor required in keeping track of them and performing the necessary computation, is really worth the while, when the actual results obtained are so small. They are known to exist by the thousands and tens of thousands down to the size of an ordinary rock, and to collate and preserve the knowledge obtained of them as fast as discovered has been a difficulty well nigh insurmountable.

"But the development of photography in connection with telescopy has seemed to open up an opportunity for accomplishing something in this line. If certain whole strips of the heavens could be tracked, and a record kept of the observations, a long step would be taken in solving this problem. Apropos of this matter, young Max Wolf of Heidelberg has been making some very unique discoveries. He uses a small telescope of six-inch aperture, and has devised a piece of mechanism by which he cannot only follow the heavens for a number of hours together, but can put away the plate, take it the next night and continue the record consecutively from the point where he left off. This continual exposure of the same glass night after night, has hitherto been regarded as impossible, and Wolf was scoffed at when he attempted it, but he has succeeded nevertheless. By this process he has been enabled to discover asteroids by observing their motions. Moreover, he does not use clockwork. His plates are exposed, and he keeps his instrument fixed for hours together on a given point by means of a subsidiary telescope. In this way he has discovered seven new asteroids and found between thirty and forty old ones, and thinks, also, that he has discovered a new comet, though that has not been fully demonstrated as yet.

"He has also discovered the tracks of meteors, and has found a succession of variations of their light by means of duplicate impressions with different telescopes, recording five or six distinct oscillations in brightness. His duplicate impressions agree perfectly. Wolf is now trying to find the companion of Algol." — *N. Y. Observer.*

Arsenic.

Compounds of this element have been known for many centuries, chiefly, we regret to say, on account of their poisonous character. The yellow sulphide of arsenic, otherwise called "orpiment," was known to Dioscorides, who called it *arsenikon*, probably on account of its powerful properties, the Greek word *arsen*, from which it is derived, meaning "male." Even at present the word arsenic is not used for the element itself, so much as for the oxide, to which we shall presently refer. Metallic arsenic, though easily obtained from nature, is not much used in the arts, and is therefore unfamiliar to the general public.

The element arsenic occurs in the metallic form in nature, usually associated with iron, silver, cobalt, nickel, and antimony. Large masses are found at Zimeoff, in Siberia, and it occurs also in Saxony, Alsace, Bohemia, Transylvania, in the Hartz, in Chili, in Borneo, at Kongsberg in Norway, and in parts of the United States.

Combined with other substances, it is one of the most widely distributed of the elements, though the total amount of it is not large. It occurs in various kinds of pyrites, and is therefore a common impurity in sulphuric acid, much of which is made from pyrites, and also in substances in the manufacture of which this acid is used. The minerals known as kupfer-nickel, realgar, orpiment, mispickel, and nickelglance contain it, and it also occurs in a great number of others.

The appearance of the element varies much with the method of preparing it. That obtained from pyrites is compact, crystalline, and nearly white, while that obtained from arsenious acid is gray and pulverulent. It is usually described as a "steel gray metalline mass," which, at ordinary temperatures, has neither odor nor taste. One chemist (Ludwig) obtained arsenic with "a perfectly bright surface, resembling freshly granulated zinc;" but it is doubtful if this was the pure metal, since in preparing it he mixed with it a small quantity of iodine. Arsenic oxidizes slowly when exposed to air, forming a gray powder which is sometimes sold under the name of "fly-powder." When heated in the air it burns with a blue flame, giving off a highly disagreeable garlic-like odor. It is not affected by pure water.

Arsenic resembles the metals in its physical properties, and chemists have often included it in the list of metals; but in its chemical relations it is decidedly non-metallic, and at present the books mostly place it among the non-metals, though it is still customary to speak of the element as "metallic arsenic," to distinguish it from the white arsenic of commerce, which is a compound of the element with oxygen.

Metallic arsenic is obtained by refining the element as it occurs in nature, or by extracting it from arsenical pyrites (mispickel). The process of extraction consists in heating the mispickel in earthenware retorts or tubes, arranged horizontally in a long furnace. A piece of thin sheet-iron is rolled up and inserted into the mouth of the retort. On distilling, most of the arsenic condenses on the sheet-iron, from which, after cooling, it may be detached. The arsenic so obtained may be mixed with pulverized charcoal and redistilled, to purify it. The earthenware tubes or retorts must be made with great care. They are composed of one part of fresh clay, and two parts of pulverized bricks or old retorts, and are coated with a mixture of blood, loam, forge-scales, and alum, which produces a glaze through which the poisonous vapors of arsenic cannot penetrate. They are then fired.

Arsenic is brittle and crystalline, and its hardness, on the mineralogical scale, is 3.5. Its specific gravity varies from 5.23 to 5.76, though, according to Bettendorff, a certain peculiar variety of it has a specific gravity as low as 4.71. It is allotropic. The specific heat of the crystalline variety is .083, that of the black, amorphous, allotropic variety being .0758. Its coefficient of expansion is .000 003 11 per degree Fahrenheit. It conducts electricity better than mercury does, its electrical resistance at the freezing point of water being 0.3733 times, and at the boiling point 0.5339 times the resistance of mercury at the freezing point. The chief lines in its spectrum have the wave-lengths 6169.7 and 5331.1 (Thalén), though there are numerous other well-marked ones. Its chemical symbol is As, and its atomic weight is 74.918 (Clarke), or, in round numbers, 75. At ordinary pressures it volatilizes at a red heat, without melting, its vapor being a light citron yellow, and phosphorescent. When heated under heavy pressure, arsenic melts at about 900° Fahrenheit.

Arsenic forms alloys with many metals, some of which are produced by pulverizing and intimately mixing the constituents, and subjecting them to heavy pressure (*i. e.*, about 6,000 or 7,000 atmospheres). If much arsenic be present, the alloys are usually brittle. It is an undesirable impurity in iron for most purposes, but it is sometimes added to iron and steel for the manufacture of small chains and ornaments, the resulting combination taking a very brilliant polish. When alloyed with copper it produces a brittle gray metal, having a brilliant, silvery appearance, which is used somewhat for making buttons. Its chief use, however, is in making small shot; for pure melted lead, when dropped from a height, tends to form tailed drops. Arsenic removes this tendency and makes the drops much rounder.

Arsenic forms two important compounds with sulphur, realgar and orpiment. Realgar is used in pyrotechny, for making blue fire and "white Bengal fire." It is orange red when pulverized, and the finest grades of it are used as a pigment by artists. "Orpiment" is a corruption of "auripigmentum," or "gold pigment," *aurum* being the Latin name for gold. It is of a beautiful yellow color, and was formerly much used as a pigment under the name of "kings yellow," but chrome yellow has now largely replaced it.

Scheele's green (known chemically as "arsenite of copper") is a compound of copper, arsenic, oxygen, and hydrogen, of a light green color. It was formerly much used in calico printing and for wall papers. Schweinfurth green is a different compound of the same substances, and is used for similar purposes. "Both are brilliant green pigments in extensive use," says the Encyclopædia Britannica, "and their employment by paper stainers has caused a good deal of excitement and unnecessary terror. The rubbing-off of arsenical particles in cleaning wall-papers may be injurious to health, but there is *no possibility of any arsenical exhalation* arising from the walls as has been alleged." This opinion would be comforting were it not for the fact that more recent investigations show that it is not well-founded. It has been discovered that "micro-organisms and fungi act on compounds of arsenic, producing arseniuretted hydrogen [a very poisonous gas] and Fleck, Sonnenschein, and others have conclusively shown that this gas is frequently present in the air of rooms with arsenical wall-paper."* It therefore appears that wall-paper colored with arsenical pigments is liable to injure the health, despite all statements to the contrary. Schweinfurth green is better known in this country by the name "paris green," and is much used in preventing the destruction of crops by bugs and insects.

The most famous compound of arsenic is arsenious oxide, or "white arsenic," known to the general public simply as "arsenic." It is used extensively in the arts, in the manufacture of indigo blue and aniline; in glass-making, to remove the color due

* Thorpe. *Dictionary of Applied Chemistry*, i. 201.

to the lower oxides of iron; in calico printing; in pyrotechny; for the prevention of boiler scale; in the manufacture of certain green, blue, pink, brown, and other colors; in fly and rat poisons; in taxidermy; and for many other purposes. It is very poisonous, and in the sixteenth and seventeenth centuries was commonly used in removing persons who were conceived, by their enemies, to have outlived their usefulness. Nearly all of the great poisoners in those times were women. In 1659, a secret society of young wives was discovered in Rome, some of whom belonged to the first families of the city, the sole or chief object of which was to make way with the husbands of the members. They met at the house of Hieronyma Spara, a woman who was reputed to be a witch, and who provided them with the poison and instructed them in the use of it. When the existence of the society was discovered, the hardened old hag La Spara "passed the ordeal of the rack without confession"; but another woman yielded up the secrets of the sisterhood, and La Spara and twelve other women were hanged, and many others, guilty in a lesser degree, were publicly whipped through the streets of the city. "Equally notorious, and far more destructive in her operations, was another woman named Tophania, a native of Palermo, who, in that city, and subsequently in Naples, sold a mysterious poison of her own concoction to wives plagued with obnoxious husbands. Four drops of this preparation were sufficient to give a spouse his quietus, and so extensively was it sold, that it was known throughout the country as *aqua Tophania*, or *aquetta di Napoli*. [It is now known to have been a solution of "white arsenic."] We are asked to believe that this creature of wickedness carried on her nefarious trade from her girlhood until nearly seventy years of age, without ever having fallen into the meshes of the law, and that upwards of six hundred persons were poisoned through her instrumentality. . . . Tophania was more artful than La Spara. She dealt only with individuals, after due safeguards had been built up; and she changed her abode so frequently, and adopted so many disguises, that her detection was rendered very difficult. She also called in the aids of religion and superstition. Her *aquetta* she sent forth in small phials labelled 'Manna of St. Nicholas of Barri,' and those who were uninitiated in the mystery of the potent elixir imagined it to be a certain miraculous oil, which was supposed to ooze from the tomb of the saint in question."* When the manufacture and sale of poison had at last been traced to Tophania, she took refuge in a convent, from which the abbess and archbishop refused to give her up. After some time the convent was broken into by a body of soldiers, Tophania was removed, tortured till she confessed, and strangled. Her dead body was then thrown into the garden of the convent from which she had been taken.

Detection almost certainly awaits the poisoner of to-day who uses arsenic. Marsh's test for it, described in all the books on chemistry, will prove the presence of incredibly small amounts of it. In cases of death from poisoning, the greater amount of the arsenic is found in the liver and intestines. The prominent symptoms of acute arsenical poisoning come on half an hour or so after the substance is swallowed. Faintness and a feeling of depression are followed by an intense burning pain in the stomach. Nausea and vomiting usually follow, but no relief comes from the ejection of the contents of the stomach. Purging follows next, blood being frequently distinguishable in the evacuations. The victim is thirsty, his pulse is feeble and irregular, and his skin is clammy and damp. Death usually results in from 18 to 72 hours. The treatment consists in the use of the stomach pump, the administration of emetics, large amounts of magnesia emulsion, and either freshly precipitated ferric hydrate or the solution known as

* *Romance of Invention*, p. 86.

"dialyzed iron." These last two have the property of making the poison insoluble. Some persons take relatively large doses of arsenic habitually, — "arsenic eaters," they are called. Such persons are usually stout and long-lived, but they are apt to die suddenly. The cause of their immunity from the ordinary results of the administration of arsenic is not known.

In medicine several arsenical compounds are used, the best known of which, perhaps, is Fowler's solution, which contains arsenite of soda. It is given as a tonic, and also in cases of indigestion accompanied by flatulence. In the latter case the trouble is due to the substitution of fermentation for digestion in the alimentary canal, and Fowler's solution probably renders the fermentive microbes inactive.

The other day a young man from Willows (we promised not to give his name) entered one of the jewelry stores in Colusa and informed the proprietor that his occupation was that of a carpenter, and he desired to get a pin emblematic of his profession. The obliging jeweler looked over his stock and, finding nothing else, showed him a very fine Masonic pin. The young man looked at it carefully. "Yes," said he, "there's the compass and square. I use both of them — but why didn't they put a saw in? It's first-rate as far as it goes. Hello! there's G there, what does that stand for?" The young man studied it carefully for a moment, and a bright idea struck him. His face flushed up as if he had made a discovery. "I have it," he said, "It's all right. G stands for gimlet. That will do, I'll take it."— *Ex.*

The very worst smell has been discovered at last. Two experimenters, MM. Baumann and Fromm, at Freiburg, have been investigating acetone and its derivatives, and in the course of their experiments they produced a very volatile substance with such a horrible odor that, although they took all possible precautions to confine it, the people living in neighboring houses could not stand it, and appealed to the authorities to have MM. Baumann and Fromm suppressed. They were obliged to discontinue their investigations. The odor is said to be so overpowering that bisulphide of carbon, sulphuretted hydrogen, rotten eggs, and other such unpleasant things are sweet perfumes when compared with it.

If the person who recently sent us the following letter will please forward his *name* (which he forgot to sign), we shall take pleasure in answering him to the best of our ability:

"*Dear Sir:*

"Please you to send the catalogue to me that you must explain me about the locomotive to run on the Rail road. I would pay you the catalogue of the locomotive or not. You must answer me quickly.

"Your Respectally."

A Washington man has a bright youngster who succeeded recently in getting even with his father in a very telling though unconscious manner. His father was reproving the little fellow's table manners. "Don't do that," said he, "or we'll have to call you a little pig." The warning seemed to be lost, for the fault was repeated. "Do you know what a pig is?" was the inquiry, put in a solemn manner. "Yes, sir." "What is it?" "A pig is a hog's little boy." The lesson in etiquette was suspended.

—*Washington Star.*

Incorporated 1866.

Charter Perpetual.

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The Locomotive.

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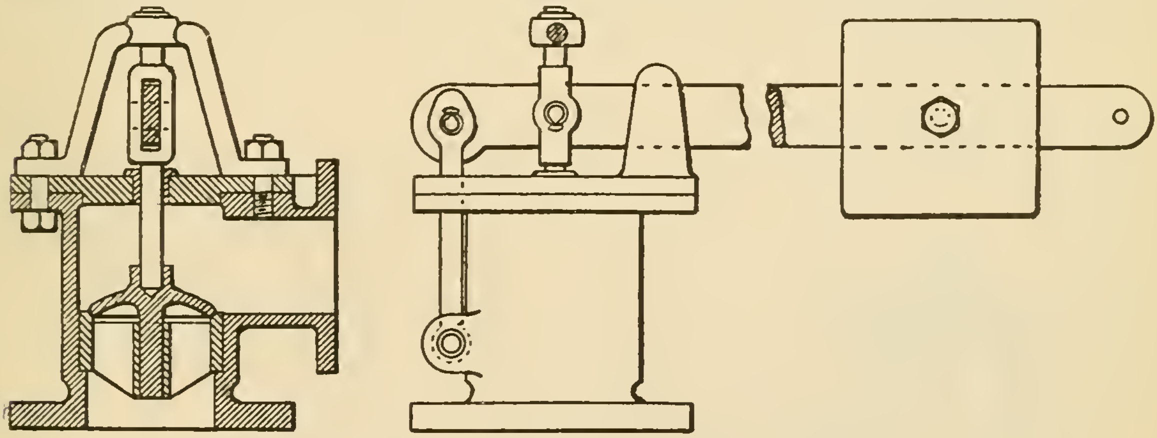
Lever Safety-Valves.

The safety-valve is the most important attachment to a boiler, and care should be taken to have it properly designed and well constructed. A great variety of valves have been made and placed on the market, each one claiming some special point of excellence; but the common lever valve is still by far the most frequently met with. A good safety-valve should open promptly when the pressure rises to the point at which it is set, and should close with equal promptness when the pressure falls to that point again; it should be capable of discharging all the steam the boiler can make, without allowing the boiler pressure to rise more than a few pounds above the point at which the valve is set; it should be simple in construction; and it should be free from liability to leak, bind, stick, corrode, or otherwise get out of order.



FIGS. 1 AND 2.—SAFETY-VALVE APPROVED BY THE U. S. NAVY.

It is not easy to unite all these requirements. Thus the common lever valve, though simple, and usually reliable, sometimes allows the boiler pressure to rise 10 per cent. above the point at which it first opens, before it blows freely; and it often allows the pressure to fall materially below this point before it closes tightly. Various devices have been proposed for overcoming these objections. In "pop" safety-valves, for example, the disk is so arranged that when the valve has once started to blow, a larger area is exposed to the boiler pressure, and the resistance of the spring is overcome at once, so that the valve suddenly opens wide.

The seats of lever valves are made sometimes flat and sometimes conical, both forms having advocates among engineers. The flat-faced disks work very satisfactorily, except that it is not easy to keep them tight. Our own preference is for the conical seat beveled at an angle of 45°, for it is easier to keep this kind of a valve tight, and its greater liability to stick may be overcome by trying it periodically when the boiler is under pressure,—a practice that we strongly recommend for all lever valves.

Some provision is usually made for guiding the disk, so that when it has raised from its seat it may come back on it fairly again when the pressure goes down. In very small valves the opening in the bonnet, through which the spindle passes, affords sufficient guidance; but in larger sizes some additional means must be provided. Many valves have three or four wings cast on the lower side of the disk, which fit loosely in the steam passage, and guide the disk to its seat again; but in the larger sizes, say from three inches up, it is customary to make the valve spindle project down through the disk and pass through a loose-fitting sleeve that is supported by a two-, three-, or four-legged spider cast in one piece with the seat. Whatever method of guidance is used, care should be taken not to have the stem fit too closely, or the rust, dirt, scale, and grease that inevitably work their way in will cause it to stick.

Figs. 1 and 2 show a form of lever valve that has been approved by the United States Board of Supervising Inspectors of Steam Vessels. In this valve the spindle does not project through the disk, but on the lower surface of the disk a stud is cast, which works in a sleeve that forms part of the valve-seat casting. The spindle is guided by a bearing in the bonnet, and another bearing in the standard that arches over the lever. (For the sake of clearness most of this standard has been removed in Fig. 2.) The following rules governing the proportions of this valve are given by Shock:* The distance from the fulcrum to the valve-stem must in no case be less than the diameter of the valve-opening; the length of the lever must not be more than ten times the distance

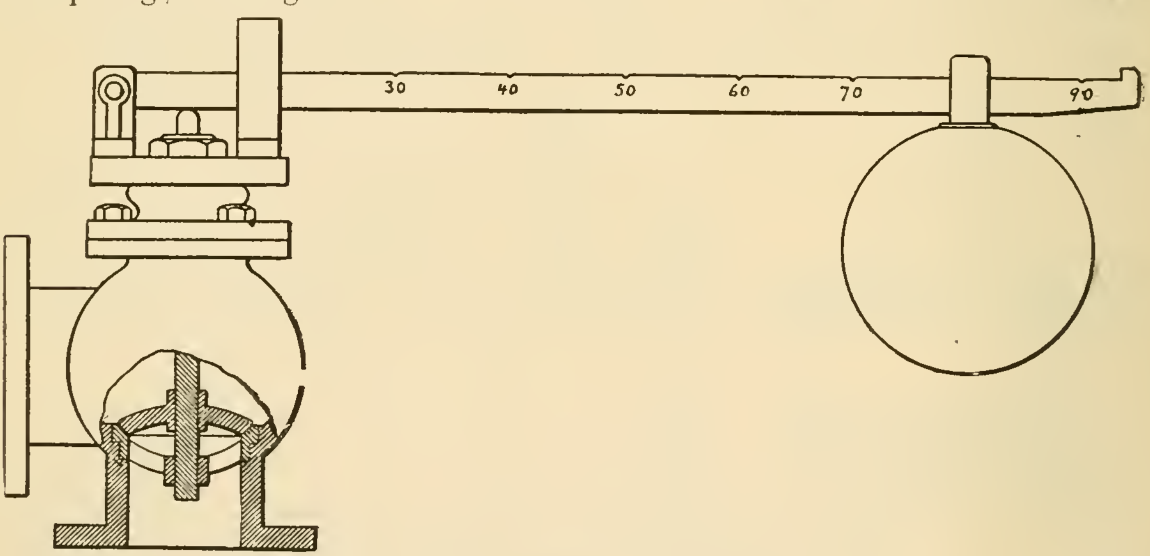


Fig. 3.— A Common Lever Valve.

from the fulcrum to the valve-stem; the width of the bearings of the fulcrum must not be less than three-quarters of an inch; the length of the fulcrum-link must not be less than four inches; the lever and fulcrum-link must be made of wrought-iron or steel, and the knife-edged fulcrum points and the bearings for these points must be made of steel and hardened; the valve must be guided by its spindle, both above and below the ground seat and above the lever, through supports either made of composition (gun metal) or bushed with it; and the spindle must fit loosely in the bearings or supports.

Fig. 3 shows a form of lever valve that is frequently met with in practice. The lever has no link, but swings on a fixed pivot, and is guided by two lugs that project upwards from the bonnet on the opposite side of the valve stem. The upper end of the stem, where it rests against the lever, should be rounded off so that there is only

* *Steam Boilers*, p. 345.

a point of contact. This is often neglected in practice, the end of the stem being left square; and the result is that as soon as the valve begins to rise the point where the pressure is applied to the lever shifts to the edge of the stem that is nearest the fulcrum. A change of leverage is thus produced, which is disadvantageous to the valve: and the pressure in the boiler has to rise considerably before the valve blows off freely. It will be noticed that the distance from the fulcrum to the stem is not nearly so great as the diameter of the disk, as required by the navy authorities. This is generally the case with safety-valves; for if this distance is four inches or so, either the lever will have to be very long, or the weight will have to be too heavy and unwieldy for convenience. In most ordinary valves it is only about 2½ inches from the fulcrum to the stem.

The cut (Fig. 3) shows a "swivel valve," so constructed that the lever and weight can be swung around horizontally into any desired position. This arrangement is convenient, but most of the valves in use are not provided with it.

A frequent source of trouble, and even danger, in safety-valves, lies in the smallness of the lever employed. In Fig. 3 the lever has purposely been represented as rather too small, to indicate clearly the defect we wish to call attention to. The lever is made strong enough to support the weight without breaking, but it is often so small or so thin that it can easily be bent sidewise, so as to bind against the guides. We have seen many valves in which the fulcrum pin was considerably smaller than the hole in the lever, so that the lever canted over somewhat, the weight then bending it sidewise so as to cause it to bind quite strongly. Care should always be taken to have the lever large enough to be quite stiff. It seems proper to say, in this place, that little reliance can be placed on the lever markings on most of the valves in the market. The valve should be set by trial so as to agree with the steam gauge; and the gauge should be previously tested, to ensure its accuracy.

When we come to consider the proper diameter of the safety-valve for any given boiler, we find a striking variety of opinions among the authorities. Various rules are given which differ from one another, and from such experimental data as are obtainable. The opening should certainly be large enough to discharge all the steam the boiler is capable of making; but it must be remembered that it is not solely the *diameter* of the valve that determines how much steam will escape from it. When a valve blows off it "lifts" a surprisingly small distance from its seat; and the real area of discharge that we must base our calculations upon is the annular or ring-shaped space between the valve-disk and the seat; and we cannot calculate this area without knowing the "lift" of the valve, as well as its diameter. Several series of experiments have been made for determining this lift, among which we quote the following series, published in 1862 by Mr. Burg of Vienna. They were made with a four-inch valve.

BURG'S EXPERIMENTS ON THE RISE OF SAFETY-VALVES.

Boiler Pressure.	Rise of Valve.	Boiler Pressure.	Rise of Valve.	Boiler Pressure.	Rise of Valve.
12 lbs.	$\frac{1}{36}$ in.	45 lbs.	$\frac{1}{65}$ in.	70 lbs.	$\frac{1}{120}$ in.
20 "	$\frac{1}{45}$ "	50 "	$\frac{1}{86}$ "	80 "	$\frac{1}{132}$ "
35 "	$\frac{1}{54}$ "	60 "	$\frac{1}{86}$ "	90 "	$\frac{1}{168}$ "

In the light of these results the instructions of the English Board of Trade that "care should be taken that the safety-valves have a lift equal to at least one-fourth their diameter" seem sufficiently remarkable.* Commenting on the foregoing experiments

* See *Instructions to Surveyors of Ships*, 1880, p. 38.

Trowbridge says, in his *Tables and Diagrams relating to Non-Condensing Engines and Boilers* (p. 43), "These results have been confirmed in another manner. Baily, in experimenting with his volute springs, found that, for an ordinary locomotive, a valve of 13 inches diameter was required [to discharge all the steam the boiler could make], and with this the pressure in the boiler rose considerably above the pressure at which the valve was set. With ordinary valves he found that there was no relief of the boiler when the fires were kept in full blast. Gooch, the English engineer, recommended three safety-valves to each locomotive. And Mr. Holley, in his recent work on *Railway Practice*, recognizing the inefficiency of the ordinary valve, states that he has seen the pressure in a locomotive boiler rise to 140 lbs., with two valves blowing off at 100 lbs. . . . Another series of experiments, made by Mr. Burg, is still more conclusive, and justifies him in the statement that the 'most *incomprehensible delusion* has existed with regard to the efficiency of the valve, as commonly employed'; and that it acts at most only as an alarm, but cannot be depended on as security against explosions. . . . If the fires are kept up, and no other relief afforded than the self-action of the valve, the pressure on the boiler must continue to rise, and in a few minutes inattention on the part of an engineer may result in an explosion."

We have quoted Mr. Trowbridge at some length because we have the highest regard for him as an authority; yet we feel that he has stated the case against the safety-valve perhaps a little too strongly. Since his book was written other experiments have been made by the United States Board of Supervising Inspectors,* and while the results are similar to Burg's, they do not seem to confirm the extreme deductions that Messrs. Burg and Trowbridge have drawn. The Committee of the Board of Supervising Inspectors examined forty-four valves sent to them by various makers about the country, and also six other common lever valves which they had "caused to be constructed under their supervision, and in a superior manner." We shall consider only the six lever valves made by the committee, and for the tests of the others must refer our readers to the original report. The valves were made of such diameters that their areas were respectively 5, 10, 15, 20, 25, and 30 square inches. The following table gives the observed lift of each valve at the several pressures at which they were tried:

TABLE OF THE "LIFT" OF LEVER SAFETY-VALVES ACCORDING TO THE EXPERIMENTS OF THE U. S. BOARD OF SUPERVISORS.

PRESSURES AT WHICH VALVES WERE SET.	AREA OF VALVE IN SQUARE INCHES.					
	5.	10.	15.	20.	25.	30.
10 lbs.	0".20	0".19	0".17	0".17	0".15	0".16
20 "	.20	.18	.12	.13	.10	.11
30 "	.13	.13	.08	.08	.09	.10
40 "	.15	.11	.08	.09	.08	.06
50 "	.14	.11	.08	.10	.04	.04
60 "	.09	.09	.05	.08	.05	.04
70 "	.06	.09	.05	.04	.04	.03
80 "	.08	.06	.04	.03	.04	.02
90 "	.06	.06	.04	....	....	....
100 "	.05	.06	.03	....	....	....

* See their special committee's *Report on Safety-Valve Tests*, published in 1877.

It will be seen that these experiments agree with Mr. Burg's in the main, indicating, plainly enough, that the lift is less for large valves and heavy pressures than for small valves and light pressures.

We shall now compute the size of a safety-valve, in order that the correct process of computation may be made clear; and we shall select for the example a boiler that has been tested by this company. (For details of the test see THE LOCOMOTIVE for March, 1890.) The dimensions of this boiler were as follows: Diameter, 66 inches; length of tubes, 18 feet; total heating surface, 1,268 square feet; total grate surface, 27.6 square feet; working pressure by gauge, 80 pounds per square inch. The principle underlying the calculation is, that the effective area of opening of the valve must be such that at the pressure at which the valve is set this effective area will discharge all the steam the boiler can make.

We first assume a size of valve that would seem to be about right — say 5 inches in diameter. Then, by referring to the foregoing table we find that, under 80 pounds pressure, a valve of this size may be expected to rise about .03 of an inch. Now Rankine states that for pressures greater than 25 pounds absolute the weight of steam, in pounds, discharged from a boiler into the air through an aperture one square inch in area, is about equal to the absolute pressure of the steam divided by 70. In this case the gauge-pressure is 80 pounds, so that the absolute pressure is $80 + 15 = 95$ pounds; and $95 \div 70 = 1.36$ pounds per second. Then $1.36 \times 60 \times 60 = 4.896$ pounds per hour, which would be discharged into the air through an aperture 1 square inch in area. The actual weight of water evaporated by this boiler, per hour, was 3,969 pounds, so that to discharge all the steam formed the aperture would have to have an area of $3{,}969 \div 4{,}896 = 0.811$ square inch. Now if the seat of the valve is beveled at an angle of 45° the rule for finding the discharge area, when the lift and diameter are known, is as follows: To the diameter of the valve add half the lift; multiply the sum by 3.1416, again by .71, and again by the lift.* Since the lift is very small for valves such as the one under consideration, this rule amounts to the following: To find the effective area of opening of the valve, multiply the diameter of the valve by the lift, and multiply the product by 2.23.† And if the effective area is given, as in the present case, we may find the necessary diameter of the valve as follows: To find the diameter of the valve, divide the given effective area by 2.23, and divide the quotient by the lift of the valve.

In the present case we have found the effective area required to be 0.811 square inch. Then

$$0.811 \div 2.23 = 0.364$$

$$\text{and } 0.364 \div .03 \text{ [the lift]} = 12.1 \text{ inches.}$$

That is, according to the Navy experiments a 12-inch valve would be required, in order to blow off as much steam as the boiler can make. It is needless to say that such valves are not used in practice. We may attain the desired result, however, by using two 3 or 3½-inch valves. The lift of a 3½-inch valve, at 80 pounds, is shown by the table to be 0.06 of an inch; and the effective area required of each valve being 0.406 square inches ($.406 = .811 \div 2$), the foregoing rule gives us the following:

$$0.406 \div 2.23 = 0.182$$

$$\text{and } 0.182 \div 0.06 \text{ [the lift]} = 3.03 \text{ inches.}$$

Hence two 3-inch valves would discharge all the steam the boiler could make.

---

* .71 is the cosine of 45°. The formula given for this purpose in the Report of the Supervising Inspectors is wrong. It should be:

$$\text{Effective area} = \left(D + \frac{L}{2}\right) \times 3.1416 \times .71 \times L.$$

Where D = diameter of valve and L = lift, both expressed in *inches*.

† $2.23 = .71 \times 3.1416$.

Although the process explained above is the only logical one, it is customary in specifying the sizes of valves, to fall back on the results of general experience. We know, for example, that a certain sized valve has been found to be sufficient, when used on a certain boiler, under certain conditions; and we reason that the same size of valve ought to be sufficient on a similar boiler, working under similar conditions. Rules have been devised for representing, in a general way, the results of this kind of experience. They base the size of the valve on the grate surface, or the effective heating surface, or the horse-power of the engine that the boiler runs. As would naturally be expected, there is a great difference among them. Following are some of them,— the numbers in the brackets being the area of valve required for the boiler considered above, according to the rules that they come after:

RULES FOR FINDING THE REQUISITE AREA OF SAFETY-VALVES.

Rule of the U. S. Board of Supervisors: Divide the heating surface, in square feet, by 25. The result is the area of the valve-disk in square inches. [50.7.]

Rule of the English Board of Trade: Divide the grate surface, in square feet, by 2. The result is the area of the valve-disk in square inches. [13.8.]

Molesworth's Rule: The area of the valve-disk, in square inches, should be $\frac{4}{5}$ of the area of the grate, expressed in square feet. [22.1.]

Thurston's Rule: Divide four times the weight of coal burned per hour by the gauge-pressure, plus 10. The result is the area of the valve-disk in square inches. [21.2.]

Prof. Thurston has also given the following rule: Divide five times the heating surface by the gauge-pressure plus 10, and take half the quotient. The result is the area of the valve-disk in square inches. [35.2.]

Rankine's Rule: The area of the valve-disk, in square inches, should be .006 times the weight of water evaporated in one hour. [23.8.]

RULE OF THE COMMITTEE OF THE U. S. BOARD OF SUPERVISING INSPECTORS*: Multiply the weight of water evaporated in one hour by .005. The result is the area of the valve-disk, in square inches. [19.8.]

All these rules are for common lever-valves. For pop-valves, and valves of other special forms, different rules would have to be given; but we cannot discuss these points in the present article.

In our judgment, the last rule of the foregoing list is the most generally applicable, and it will be remarked that it agrees closely with that given by Rankine. In applying it to a new boiler, or to any boiler whose evaporative performance is not known, the probable evaporation must be inferred by estimation from the grate surface and heating surface, or by direct comparison with other boilers whose evaporation is known.

In closing, let us venture the following suggestion concerning the smallness of the lift of safety-valves. Remove the paper from one end of a large spool such as thread comes on, and lay a small flat card upon the end of the spool. A pin should next be thrust through the card in such a way that it will enter the hole in the spool and prevent the card from slipping off sidewise. Hold the spool up so that the card lies flat against it, and blow through the spool. One would naturally think the card would be blown high into the air; but as a matter of fact it rises only a small fraction of an inch. The experiment is very simple, and very suggestive. We are not prepared to say that a similar action *does* take place in safety-valves, but we should like to suggest the possibility of it.

* This rule was arrived at after a long series of experiments on the "lift" of valves, and on the amount the pressure rose after the point of first opening was reached. See their *Report*, referred to on p. 100 of this issue.

Inspectors' Report.

March, 1892.

During this month our inspectors made 6,430 inspection trips, visited 13,710 boilers, inspected 4,540 both internally and externally, and subjected 537 to hydrostatic pressure. The whole number of defects reported reached 10,566, of which 930 were considered dangerous; 44 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	770	51
Cases of incrustation and scale,	1,102	73
Cases of internal grooving,	74	21
Cases of internal corrosion,	441	41
Cases of external corrosion,	658	32
Broken and loose braces and stays,	107	40
Settings defective,	324	22
Furnaces out of shape,	357	15
Fractured plates,	205	48
Burned plates,	172	21
Blistered plates,	275	15
Cases of defective riveting,	1,637	29
Defective heads,	80	21
Serious leakage around tube ends,	2,792	321
Serious leakage at seams,	413	11
Defective water-gauges,	389	39
Defective blow-offs,	128	23
Cases of deficiency of water,	14	8
Safety-valves overloaded,	60	28
Safety-valves defective in construction,	75	28
Pressure-gauges defective,	425	40
Boilers without pressure-gauges,	2	2
Unclassified defects,	66	1
Total,	10,566	930

Boiler Explosions.

May, 1892.

Locomotive (79). The boiler of engine No. 25, running local on the Pennsylvania & Northwestern railroad, exploded in the yard at Irvona, Clearfield county, Pa., on May 4th. Engineer Molten and Fireman Ake were instantly killed. Fireman Ake's body was blown entirely through a box car, and the engineer's body was found one hundred yards from the scene of the explosion. Heavy pieces of iron, weighing from two hundred to five hundred pounds, were thrown into different portions of the town, some as far as a quarter of a mile, but doing no serious injury to any of the inhabitants or to the buildings. Both engineer and fireman leave families.

Saw-Mill (80). The boiler at Brooks' saw-mill at Golden Valley, near Wiarton, Ont., exploded on May 5th, and the mill was burnt. Benjamin Brooks, one of the hands, was scalded on the legs, but not dangerously. The cause of the explosion is unknown. The whole of the boiler was thrown 100 feet.

PORTABLE HOISTER (81). The water-leg of a boiler used by Contractor Thomas Fitzgerald of 505 West Fifty-sixth street, New York, exploded on the morning of May 9th, killing the engineer, William Dougherty, instantly, and severely injuring William McNeary. The boiler was of the locomotive type, and was supposed to be in good order. McNeary will probably recover. Dougherty's head was crushed in and nearly all his bones were broken. He was also badly scalded. He had been a boiler inspector for twenty years. David Cunningham, foreman of the work, said that the boiler had been inspected by the city four weeks before, and that it had stood a water pressure of 130 pounds without showing leakage or weakness. He also said that they never carried more than seventy or eighty pounds of steam.

FLOUR MILL (82). On May 10th the boiler in the flour mill at Elmwood, Ont., exploded, instantly killing Alexander Heller, the lessee of the mill, and inflicting serious injuries on his assistant, H. R. Clements. The engine room is completely demolished and the mill is badly wrecked. Parts of the boiler weighing about 400 pounds were carried into a field 100 yards distant from the scene of the accident. The boiler flues were blown in all directions. One fell on the roof of D. S. Craig's house with such force that the plaster was broken from the ceilings of the rooms. Another was found in Mr. Kaufman's lawn fully three feet in the ground. Mr. Clements was found to have three ribs broken, besides several bruises about the face and body. He is likely to recover. Mr. Heller leaves a wife and one child.

LUMBER MILLS (83). On May 12th a terrible explosion occurred in Midland, Mich., fifteen miles from Saginaw. Three boilers in the mill of the Midland Salt and Lumber Company blew up, and Charles Allen, Eugene Van Valkenburg, and Richard Stears were killed, and Gus Malcomb, Arthur Robinson, E. P. Elton, Charles Glenn, Charles Burt, Albert Bye, Patrick Burke, and Sanford Walton were seriously injured. Some dozen others received minor injuries. The boiler-house was demolished and the mill was completely wrecked. The building was formerly known as the Larkin mill, but about two years ago it passed into the hands of Wm. Patrick, W. D. Marsh, Max Anderson, and M. P. Anderson, who formed the present company. Some sixty-five hands were employed, and the mill cut about 50,000 feet of lumber and turned out 100 barrels of salt daily.

LOCOMOTIVE (84). A passenger train on the Hoosac Tunnel & Wilmington railroad collided with a twenty-ton rock on May 12th, two and one-half miles north of the Hoosac tunnel. Engineer Percy Kingsley saw the rock falling and reversed the locomotive. The shock burst the boiler and threw Kingsley and his fireman, Arthur Jolivette, through the windows of the cab, both sustaining painful injuries. The passengers were tossed over the seats and about the cars. All were slightly but none seriously injured. The cars did not leave the track.

SASH FACTORY (85). The boiler in Winslow's sash factory, Dunnville, Ont., exploded on May 13th, wrecking the building, but fortunately injuring nobody. The account that we received says that the fireman noticed that steam was rising rapidly, and found that the pump would not work. "Becoming alarmed," it says, "he at once called Engineer Jas. Urmy and Driller B. Stanfield, who on reaching the spot, saw at a glance the danger, as the excessive amount of steam and the low water had caused a generation of gas which locked the pin rendering the safety-valve useless to blow-off." This passage reminds us of "Mr. Blake's Item."

Locomotive (86). One man was killed, another was fatally injured, and a third badly hurt by the explosion of a locomotive boiler near Hot Springs, S. D., on May 15th. As train 45 on the B. & M. road, drawn by hog engine 178, was running between Edgemont and Newcastle, the boiler exploded without warning. Fireman Rhinehart was instantly killed and Engineer Wilson was so badly injured that he will die. Brakeman Woodberry, who was on the engine, was also severely injured. The cause of the explosion is not yet known.

Locomotive (87). Just as the east-bound freight, with thirty-seven cars, was pulling out of Billings, Mont., on May 17th, the boiler of the locomotive exploded, and eight cars were piled up on the track. Fireman Wm. Decamp was thrown out and died in five minutes. The head brakeman, Norman Davis, who was standing in the gangway, was also thrown out and severely scalded, and his wrist fractured. Engineer Williams Jones escaped with slight injury, though under the débris of the wrecked cab. Conducted Powell and Brakeman C. S. Wilson were slightly cut about the face.

Mine (88). One boiler out of a nest of fourteen exploded at the Conyngham breaker, Wilkesbarre, Pa., on May 22d, doing no further damage than tearing off most of the boiler-house roof. The two firemen were outside of the building at the time of the explosion. The boiler had been leaking for some time and no great surprise was felt by the firemen when the explosion ended the trouble. It will cause no delay, as the other boilers in the nest have sufficient capacity to supply enough steam for present use.

Saw-Mill (89). The boiler of the saw-mill of Mr. George W. Jones, about one mile and a half from Ivor station, on the Norfolk & Western railroad, near Petersburg, Va., exploded on May 23d. Arthur Bush, the fireman, and Dick Stokes, a laborer, were seriously scalded.

Planing-Mill (90). On May 24th the boilers in A. B. Brock's mills, Loveland, O., exploded, fatally injuring the engineer, Frank Malott, a young man of 19, and inflicting painful injuries on Samuel A. Malott, his father. The two-story building in which the boilers were was blown to pieces, and the mills were badly damaged.

Pulp-Mill (91). An explosion in the wood pulp-mill of the Friend Paper company at West Carrollton, six miles south of Dayton, O., on May 27th, demolished the building and killed Emory Blood, the assistant superintendent. Henry Stebbins, the superintendent, was slightly injured. Two other employes were hurt. The loss amounted to $30,000.

A Find of Flints. — Year by year fresh traces of the earth's early inhabitants are being revealed. One of the most important of recent discoveries is that of M. Armand Vire, who, in a valley through which runs the Lunain river, has come across the remains of, at least, ten pre-historic settlements. The immense quantity of flint implements and refuse at one place, near the village of Lorrezle-Bocage, some sixty miles south of Paris, seems to justify the conclusion that here must have been located a pre-historic manufacturing village where the flint was worked into the various shapes used by the primitive people of the early Stone Age. Some of the implements are of types hitherto unknown to science, including very small hatchets which are supposed to have been funeral or votive offerings, and flint hooks from one to three inches long, the smaller probably having been designed as fish-hooks.— *Patent and Court Record.*

The Locomotive.

HARTFORD, JULY 15, 1892.

J. M. ALLEN, *Editor.* A. D. RISTEEN, *Associate Editor.*

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*

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IT is said that considerable quantities of the rare metal vanadium have been found in the province of Mendoga, in the Argentine Republic. It is used in the arts in the form of vanadate of ammonia, and is useful to the dyer because, in combination with aniline, it produces an almost absolute black.

THE *Bulletin of Newspaper and Periodical Literature* is a weekly journal published at No. 5 Somerset street, Boston. It catalogues the more important articles in most of the leading papers and magazines of this country and Canada, arranging them under a number of general headings. There is certainly room for a periodical of this kind, and we trust that the *Bulletin* will meet with the success it deserves.

The Amendment to the Philadelphia Law.

A circular letter relating to the Philadelphia inspection law, and addressed to makers and users of stationary steam boilers, was issued on June 20, 1892, by Mr. John Overn, Chief Inspector of the Bureau of Steam Engine and Boiler Inspection. It reads substantially as follows: "Please take notice that the following is a true and correct copy of 'an ordinance approved June 15, 1892,' and is incorporated in the laws and ordinances governing this bureau.

"AN ORDINANCE

"Amendatory to an ordinance entitled 'An Ordinance regulating the inspection of steam boilers in and for the City of Philadelphia, and defining rules for rating the maximum pressure that shall be allowed to be carried on stationary steam boilers when they are made in whole or in part of wrought-iron sheets riveted together,' approved February 16, 1882.

"SECTION 1. *The Select and Common Councils of the City of Philadelphia do ordain,* That the ordinance entitled 'An Ordinance regulating the inspection of steam boilers in and for the City of Philadelphia, and defining rules for rating the maximum pressure that shall be allowed to be carried on stationary steam boilers when they are made in whole or in part of wrought-iron riveted sheets,' approved February 16, 1885, be amended by substituting for Formula (B), Section 1, the following:

"'The continued product of (1) the area of the hole filled by the rivet, (2) the number of rows of rivets in the seam, and (3) the shearing strength of the rivet per square inch of section, divided by the continued product of (1) the pitch of the rivets, (2) the thickness of the sheet, and (3) the tensile strength of the sheet per square inch of section = the percentage of the strength of the rivets in the seam as compared with the strength of the solid part of the sheet.

$$\left(\frac{A\ N}{p\ t}\right) \times \frac{S}{T} = \text{Percentage.}$$

"That the shearing strength of a rivet in a composite joint made of iron rivets and steel plates shall not be considered in excess of forty thousand (40,000) pounds. Take the lowest of the percentages as found by formulæ (*A*) and (*B*) and apply that percentage as the value of the seam in the following formula (*C*), which determines the strength of the longitudinal seams.

"And to add to the end of Section 2, the following proviso, viz.: *Provided*, that the factor of safety of four (4) in the said formula (*C*) shall not apply to boilers in which the exterior shell is subjected to the direct action of the flame from the fuel: *and provided*, that this ordinance shall not apply to boilers already constructed or about to be constructed under contracts executed prior to the passage of this ordinance.

"Attest: HENRY W. ROBERTSON, *Asst. Clerk Select Council.*

"JOHN OVERN, *Chief Inspector.*"

The formulæ referred to above occur in the Philadelphia law relating to the strength of riveted joints. Formula (*A*), in the original ordinance, determines the strength of the net section of plate, expressed as a percentage of the strength of the solid plate, by subtracting the diameter of the rivet-hole from the pitch, and dividing the remainder by the pitch. Formula (*B*), in the original ordinance, is substantially the same as the foregoing substitute, except that it contains no mention of the shearing or tensile strength of the materials. Formula (*C*) deduces the bursting pressure in the usual way, by multiplying the thickness of the plate by its tensile strength per square inch, and by the lesser of the results obtained by formulæ (*A*) and (*B*), and dividing the result by the radius of the boiler in inches.

The most important feature of this amendment is that it recognizes a difference between the shearing and tensile strengths of iron — a difference that was not recognized in the original ordinance. Until recent years it was customary to consider the tensile and shearing strengths of iron as about equal, and to make the combined area of cross section of the rivets equal to the net section of the plate. The introduction of steel plates, and improvements in the manufacture of iron, have impelled designers of boilers to recognize a difference between the two strengths; for while good steel plates may now be had with a tensile strength of from 55,000 to 60,000 pounds per square inch, the shearing strength of the iron rivets commonly used remains at about 38,000 to 40,000 pounds per square inch, and to consider the two as equal would now be decidedly erroneous. It will be noticed, in this connection, that the amendment places an upper limit of 40,000 pounds on the shearing strength of iron rivets when used with steel plates.

Another noteworthy feature is contained in the last paragraph, where the factor of safety of 4, which had previously been allowed under certain conditions, is now forbidden in all cases "in which the exterior shell is subjected to the direct action of the flame from the fuel."

This amendment is well-considered and timely. It is in conformity with the recent advances in mechanical arts, and we heartily approve of it.

An Engineer's Joke.

Mr. Smith tells of an instance illustrating the peculiar methods of Mexican administration of justice in connection with railways. "A friend of mine was on trial for his life on a charge of manslaughter down near Quintero. He had been running a passenger train and had had the misfortune to kill a man walking on the track. He had been in jail for several months, and finally Minister Osborne, who was then in Mexico, succeeded in having his case called for trial. Now, the Mexicans never listen to expert testimony. They might hear you and me in our own defense, but unless we could corroborate testimony by some tangible support like physical substantiation we would cut but a poor figure. In the case I refer to the authorities insisted upon having the engineer reproduce precisely the condition of affairs which led to the accident. Accordingly the railroad company had to rig up a train of cars precisely like that in which the accident occurred. It had to be loaded with just as many people as the original train had on board. It had to have the same engine and be taken to the precise spot where the accident occurred. A dummy figure was prepared to stand in the spot where the man was killed. Then the jury were to get on the train and the 'administrador de justicio' was to take a seat in the cab and observe the efforts of the engineer to stop it in time.

"Now, the engineer who was demonstrating the problem was a friend of the man on trial. He intended to show the 'administrador' something he had never before seen. The idea was to take the train over the same track. They went up the road about five miles and they switched to come back for the object lesson. The dummy was set up on the track. The 'administrador' took his place in the cab, leaning more than half his body out to better observe the figure, for he was to give the signal when to stop. The engineer let her out with a grin. He was not supposed to travel more than 30 miles an hour, but when the 'administrador' waved his hand to check her — 'man on the track' — he was going 50. The fireman pulled the whistle, the engineer sprang to his reverse lever and his sandbox and gave her all the air there was in the pump. In less than a second the 'administrador de justicio' was out of the cab window into the ditch with a broken ankle, the jury in the first passenger car was piled into a promiscuous mass, the buffer-couplers were smashed, the stove was upset, and yet the momentum was so great that the engine struck the straw man and knocked it 20 feet in the air. The result of that object lesson was that the 'administrador' lay in bed for six weeks, the engineer was acquitted, and the jury petitioned the legislature of Choacan for a change in the laws." — *The Review.*

Comparative Tests of a Boiler, When Clean and When Foul.

Much has been said and written about keeping boilers clean, and it is now pretty generally understood that the highest performance of boilers can be had only when they are free from scale internally, and free from soot and dirt externally. We present below the results of two tests that were recently made by one of our western inspectors, which demonstrate this fact conclusively. They were made on the same boiler, under the same running conditions, and burning the same quality of coal. On the 24th of May, when the first test was made, the boiler had been in constant use for four weeks, day and night. On June 4th, when the second test was made, the boiler had been in use but one day and night. The coal and feed water were both weighed carefully, and all pipes and connections were broken so as to detect any leaks or wastage.

Test No. 1, Made on May 24, 1892.

Manner of start and stop, and kind of run,	*Usual fire on grate. Stopped with fire in same condition.*
Source of feed water,	*Artesian well.*
Mine, and grade of coal,	*Ocean Mining Co., bituminous.*
Duration of test,	*7 hours.*
Average steam pressure,	*82.1 pounds.*
" temp. of feed water in tank,	*52°.*
" " " " at boiler,	*136.5°.*
" " external air,	*72°.*
" " boiler room,	*77°.*
Total water evaporated at temperature of feed,	*33,914 lbs.*
" " per hour,	*4,845 lbs.*
" " " per sq. ft. of heating surface,	*2.25 lbs.*
Total coal consumed,	*4,530 lbs.*
Moisture in coal,	*0.*
Net amount of dry coal consumed,	*4,530 lbs.*
Total coal consumed per hour,	*647 lbs.*
" " " " per sq. ft. of grate,	*12.4 lbs.*
" ashes and refuse removed,	*377 lbs.*
" combustible consumed,	*4,153 lbs.*
" " " per hour,	*593 lbs.*
Proportion of non-combustible to coal,	*8.3%.*
Water evaporated at temp. of feed per lb. of coal,	*7.48 lbs.*
" " from and at 212° " "	*8.34 lbs.*
" " at temp. of feed " of combustible,	*8.17 lbs.*
" " from and at 212° " "	*9.09 lbs.*
Temperature of escaping gases,	*551°.*
Horse power developed (Centennial rule),	*157.*

Note.—*This boiler was run continuously, and the observations were made during ordinary running hours. The boiler had been in use, night and day, for four weeks, without cleaning or change of water.*

Test No. 2, Made on June 4, 1892.

Manner of start and stop, and kind of run,	*Usual fire on grate. Stopped with fire in same condition.*
Source of feed water,	*Artesian well.*
Mine, and grade of coal,	*Ocean Mining Co., bituminous coal.*
Duration of test,	*7 hours.*
Average steam pressure,	*79.0 lbs.*
" temp. of feed water in tank,	*52°.*
" " " " at boiler,	*143.5°.*
" " of external air,	*68°.*
" " of boiler room,	*74°.*
Total water evaporated at temperature of feed,	*38,965 lbs.*
" " per hour,	*5,556 lbs.*
" " " per sq. ft. of heating surface,	*2.58 lbs.*
Total coal consumed,	*4,617 lbs.*

Moisture in coal,	*0.*
Net amount of dry coal consumed,	*4,617 lbs.*
Total coal consumed per hour,	*659.6 lbs.*
" " " per sq. ft. of grate,	*12.68 lbs.*
" ashes and refuse removed,	*305 lbs.*
" combustible consumed,	*4,312 lbs.*
" " " per hour,	*616 lbs.*
Proportion of non-combustible to coal,	*6.6%*
Water evaporated at temp. of feed per lb. of coal,	*8.44 lbs.*
" " from and at 212° " "	*9.34 lbs.*
" " at temp. of feed " of combustible,	*9.04 lbs.*
" " from and at 212° " "	*10.0 lbs.*
Moisture in steam,	*1.55%.*
Temperature of escaping gases,	*556.7°.*
Horse power developed (Centennial rule),	*179.*

Note.—*This run was continuous. The observations were taken the second day after the boiler had been cleaned and washed out. The calorimeter for determining the amount of moisture was designed by Prof. Carpenter of Cornell University.*

For some reason or other the moisture in the steam was not determined at the first test, but since the conditions under which the two trials were made were so nearly identical, there is good reason for believing that the moisture was approximately the same on both days. The striking feature of these trials is the unusual similarity of the conditions in the two cases, except in the cleanliness of the boiler. The effect of this cleanliness is seen at a glance, because there are not differences enough in the conditions to leave anything to conjecture, with the single exception above noted, of the moisture on the first day. Cleaning the boiler caused it to evaporate .91 of a pound more water per pound of combustible, or .33 of a pound more, per squre foot of heating surface, per hour.

The Nineteenth Century.

Few writers have a more vigorous style than Frederic Harrison, and this fact lends such interest to his essays that we reproduce below a portion of what he has to say with regard to the century now passing away. He does not think much of it. He considers that we are not becoming truly humanized at the pace that we ought.

"Civilization," he says, "is a very elastic, impalpable, undefinable thing. But where are we to turn to find the tremendous relative superiority of 1882 over 1782, or 1682, or 1582? We may hunt up and down, and we shall find only this: Population doubling itself almost with every fresh generation — cities swelling year by year by millions of inhabitants and square miles of area — wealth counted by billions, power to go anywhere, or learn anything or order anything, counted in seconds of time — miraculous means of locomotion, of transport, of copying anything, of detecting the millionth part of a grain or of a hair's breadth, of seeing millions of billions of miles into space and finding more stars, billions of letters carried every year by the post, billions of men and women whirled everywhere in hardly any time at all; a sort of patent fairy-Peribanou's fan which we can open and flutter, and straightway find everything and anything the planet contains for half-a-crown; night turned into day; roads cut through the bowels of the earth, and canals across continents; every wish for any material thing gratified in mere conjurer's fashion, by turning a handle or adjusting a pipe — an enchanted world, where everything does what we tell it in perfectly inexplicable ways, as if some good Prospero were waving his wand, and electricity were the willing Ariel — that is what we have — and yet, is this civilization? Do our philosophy, our science, our art, our manners, our happiness, our morality, overtop the philosophy, the science, the art, the manners, the happiness, the morality of our grandfathers as greatly as those of cultivated Europeans differ from those of savages? We are as much superior in material appliances to the men of Milton's day and Newton's day as they were to Afghans or Zulus. Are we equally superior in cultivation of brain, heart, and character, to the contemporaries of Milton and Newton? . . . .

"The incalculable accumulation of new material, and the intense competition to gather still more material, drive students to limit their research to smaller and smaller corners, until it ends often in ludicrous trivialities, and mere mechanical registering of the most obvious facts, instead of thought and mental grip. A hundred years ago a naturalist was a man who, having mastered, say, some millions of observations, had, if he possessed a mind of vigor, some idea of what Nature is. Now, there are millions of billions of possible observations, all in many different sciences, and as no human brain can deal with them, men mark off a small plot, stick up a notice to warn off intruders, and grub for observations there. And so a naturalist now often knows nothing about Nature, but devotes himself, say, to one hundredth or thousandth part of Nature — say, the section of *Annelida* — and of these, often to one particular worm, or he takes the *Gasteropods*, and then he confines himself to a particular kind of snail; and then after twenty years he publishes a gigantic book about the co-ordination of the maculæ on the wings of the extinct *Lepidoptera*, or it may be on the genesis of the tails of the various parasites that inhabited the palæozoic flea. I don't say but what this microscopic, infinitely vast, infinitesimally small work has got to be done. But it has its dangers, and it saps all grip and elasticity of mind when it is done in a crude, mechanical way by the medal-hunting tribe. . . . .

"Steam and factories, telegraphs, posts, railways, gas, coal, and iron, suddenly discharged upon a country as if by a deluge, have their own evils that they bring in their train. To cover whole counties with squalid buildings, to pile up one hundred thousand factory chimneys, vomiting soot, to fill the air with poisonous vapors till every leaf within ten miles is withered, to choke up rivers with putrid refuse, to turn tracts as big and once as lovely as the New Forest into arid, noisome wastes; cinder-heaps, cess-pools, coal-dust, and rubbish — rubbish, coal-dust, cess-pools, and cinder-heaps, and overhead by day and by night a murky pall of smoke — all this is not an heroic achievement if this Black Country is only to serve as a prison yard or a work-house yard for the men, women, and children who dwell there.

"To bury Middlesex and Surrey under miles of flimsy houses, crowd into them millions and millions of over-worked, under-fed, half-taught, and often squalid men and women; to turn the silver Thames into the biggest sewer recorded in history: to leave us all to drink the sewerage water, to breathe the carbonized air; to be closed up in a labyrinth of dull, sooty, unwholesome streets; to leave hundreds and thousands confined there, with gin, and bad air, and hard work, and low wages, breeding contagious diseases, and sinking into despair of soul and feebler condition of body; and then to sing pæans and shout, because the ground shakes and the air is shrill with the roar of infinite engines and machines, because the blank streets are lit up with garish gas-lamps, and more garish electric lamps, and the post-office carries billions of letters, and the railways every day carry one hundred thousand persons in and out of the huge factory we call the greatest metropolis of the civilized world — this is surely not the last word in civilization. . . . .

"What is the use of electric lamps, and telephones, and telegraphs, newspapers by millions, letters by billions, if sempstresses stitching their fingers to the bone can hardly earn fourpence by making a shirt, and many a man and woman are glad of a shilling for twelve hours' work? What do we all gain if in covering our land with factories and steam-engines we are covering it also with want and wretchedness? And if we can make a shirt for a penny and a coat for sixpence, and bring bread from every market on the planet, what do we gain if they who make the coat and the shirt lead the lives of galley slaves, and eat their bread in tears and despair, disease and filth?"

The Locomotive.

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The Arrangement of Steam Pipes.

We have, from time to time, called attention to the importance of suspending and securing steam pipes properly, and providing for their expansion and contraction. In this article we wish to call attention to a common but dangerous method of connecting boilers with main steam pipes.

Fig. 1 shows the way in which the connection is frequently made, the stop valve being near the boiler, and the pipe entering the steam main from below. The action of this arrangement is as follows: The boiler being out of use, entrained water from the other boilers in the battery, as well as water of condensation, settles in the space between the stop valve and the steam main. Then, when the boiler is put in use again, in order to prevent any sudden strain from being thrown on the boiler the stop valve is not opened until the pressure in the boiler has risen slightly above that in the main steam pipe. When it *is* opened there is a sudden outflow of steam, which raises the water in the connections, throws it against the first elbow, and, if that does not break, hurls it the full length of the horizontal pipe, against the second elbow, and then up into the main steam pipe. The shocks so produced are greater than would be imagined by one who has not had experience with water-hammers. In one case that came under our observation recently, *three* elbows were fractured in succession from this cause. When the first one broke the superintendent of the mill considered that there must have been a flaw in it. It was replaced by another, which lasted only a few days. A third elbow was put in, with a precisely similar result, and by that time the superintendent had become satisfied that something was wrong with the arrangement of the piping. The defect was pointed out to him, the pipe was re-arranged, and there has been no trouble since.

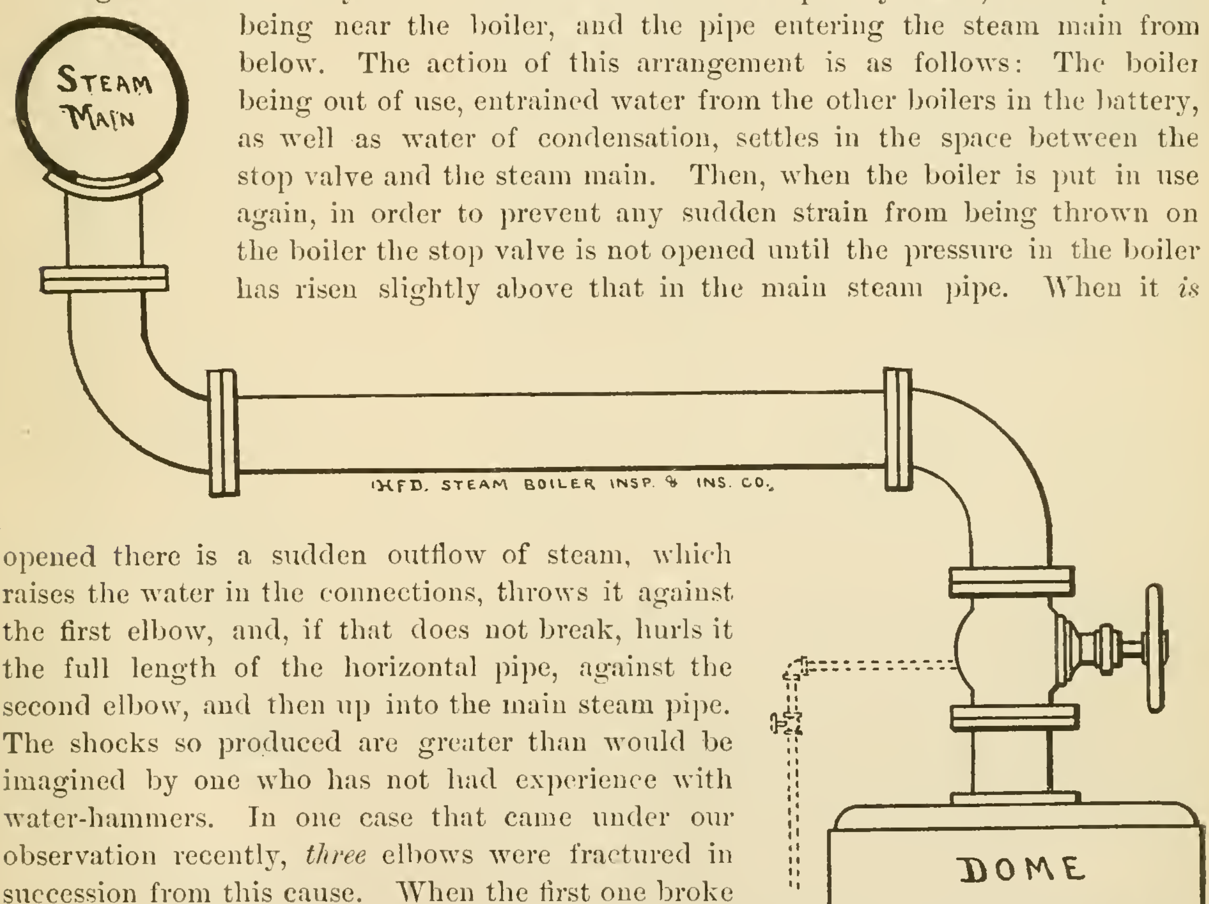

Fig. 1.—A Dangerous Mode of Connection.

It might be said that the stop valve should be opened when the pressure in the boiler is just *equal* to that in the main. This is true, but it is not easy to determine.

with any degree of precision, when these pressures *are* equal, and the engineer very properly prefers to err on the safer side, and have his boiler pressure a trifle too great, rather than too little.

The danger may be greatly lessened by putting in a drip pipe, as shown by the dotted lines in Fig. 1. The drip should enter the valve at as low a point as possible, and care should be taken, when the idle boiler is about to be thrown into use, to blow

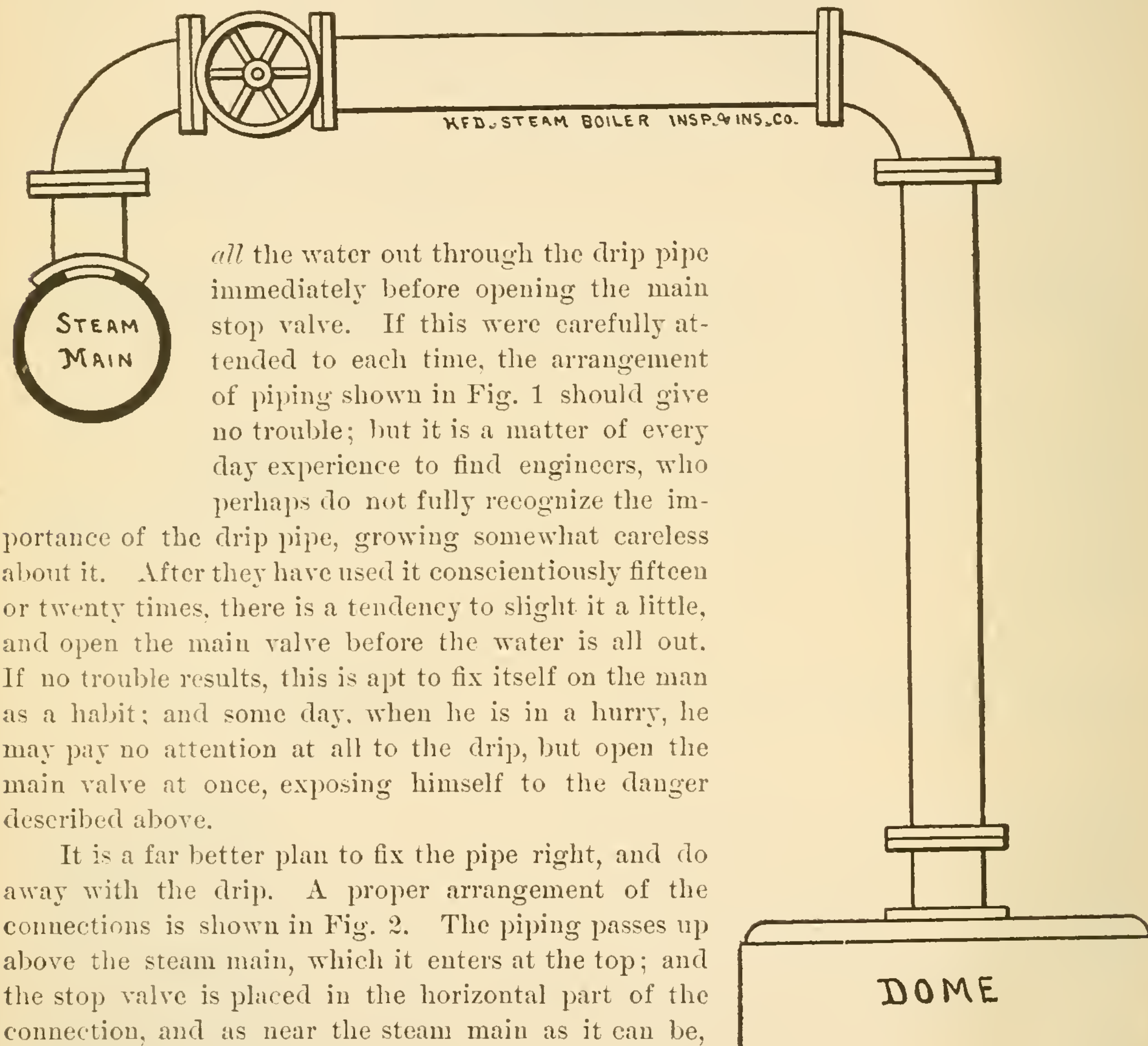

Fig. 2. — A Safe Mode of Connection.

all the water out through the drip pipe immediately before opening the main stop valve. If this were carefully attended to each time, the arrangement of piping shown in Fig. 1 should give no trouble; but it is a matter of every day experience to find engineers, who perhaps do not fully recognize the importance of the drip pipe, growing somewhat careless about it. After they have used it conscientiously fifteen or twenty times, there is a tendency to slight it a little, and open the main valve before the water is all out. If no trouble results, this is apt to fix itself on the man as a habit; and some day, when he is in a hurry, he may pay no attention at all to the drip, but open the main valve at once, exposing himself to the danger described above.

It is a far better plan to fix the pipe right, and do away with the drip. A proper arrangement of the connections is shown in Fig. 2. The piping passes up above the steam main, which it enters at the top; and the stop valve is placed in the horizontal part of the connection, and as near the steam main as it can be, conveniently. It will be seen that with this arrangement there is no possibility of trapping water. The entire connection, from boiler to main, remains dry, and no water-hammer action is possible.

Fig. 3 shows another way of arranging the connection so as to avoid the trapping of water. In this arrangement the pipe enters the steam main at the side, the elbows are done away with, and an angle valve is used to connect the horizontal and vertical pipes. A perspective view of this method of connection was given in The Locomotive for May, 1892, on page 66. When new work is being put in, we usually recommend the arrangement shown in Fig. 3 in the present issue; but if the piping has already been put up, in the manner shown in Fig. 1, or in

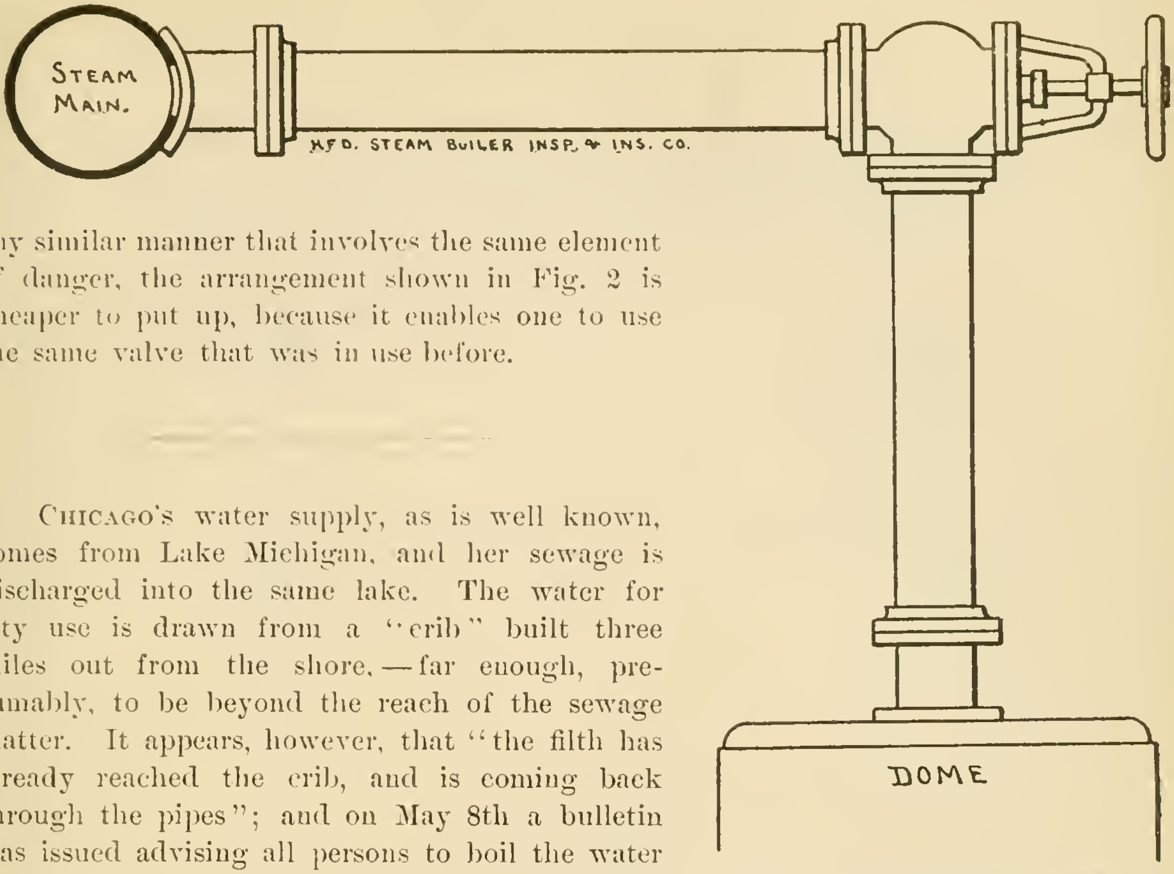

Fig. 3. — Another Safe Mode of Connection.

any similar manner that involves the same element of danger, the arrangement shown in Fig. 2 is cheaper to put up, because it enables one to use the same valve that was in use before.

Chicago's water supply, as is well known, comes from Lake Michigan, and her sewage is discharged into the same lake. The water for city use is drawn from a "crib" built three miles out from the shore, — far enough, presumably, to be beyond the reach of the sewage matter. It appears, however, that "the filth has already reached the crib, and is coming back through the pipes"; and on May 8th a bulletin was issued advising all persons to boil the water before using it. Of course this question is always of importance to the people of Chicago, but the whole world is interested in it at present, on account of the coming World's Fair. Various methods have been proposed for securing purer water, but the most promising seems to be what is known as the "low level drainage" plan, advocated by Mr. Gordon H. Nott, a civil engineer of Chicago. He contemplates the construction of an underground sewer at least 20 feet in diameter, commencing at Chicago at a level of some 35 feet below the lake, and extending to a point below Joliet, on the Des Plaines river. The tunnel or sewer would have a fall of a foot and a fraction to the mile, and branch drains would lead into it from all parts of the city.

We are indebted to Mr. Samuel Nott, the veteran civil engineer of this city, for detailed information concerning the proposed plan, and also to the Ottawa (Ill.) *Free Trader.* We see no reason why the low level system is not an ideal solution of the problem.

In connection with the article on barium in the present issue, an experiment recently made with hens may be mentioned. The properties of barium closely resemble those of calcium, or lime; and there is, therefore, some *a priori* probability that if hens were fed with barium compounds, instead of with compounds of lime, they would lay eggs with shells of barium carbonate. Several hens were selected, and these were fed on materials that were known to be entirely free from lime. After some days they began to lay shell-less eggs. Barium carbonate was then added to their food, but no shells were produced. The chloride, sulphate, and other salts were also tried, but all with negative results. In spite of their close similarity, the hen's internal machinery distinguishes barium from lime perfectly.

Inspectors' Report.

APRIL, 1892.

During this month our inspectors made 6,099 inspection trips, visited 11,720 boilers, inspected 5,253 both internally and externally, and subjected 524 to hydrostatic pressure. The whole number of defects reported reached 10,496, of which 862 were considered dangerous; 58 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	933	44
Cases of incrustation and scale,	1,578	81
Cases of internal grooving,	127	16
Cases of internal corrosion,	532	30
Cases of external corrosion,	651	36
Broken and loose braces and stays,	173	78
Settings defective,	290	29
Furnaces out of shape,	388	37
Fractured plates,	202	53
Burned plates,	137	19
Blistered plates,	296	10
Cases of defective riveting,	1,796	26
Defective heads,	101	21
Serious leakage around tube ends,	1,540	166
Serious leakage at seams,	409	29
Defective water-gauges,	301	44
Defective blow-offs,	133	45
Cases of deficiency of water,	21	11
Safety-valves overloaded,	61	9
Safety-valves defective in construction,	93	27
Pressure-gauges defective,	498	46
Boilers without pressure-gauges,	5	5
Unclassified defects,	231	0
Total,	10,496	862

MAY, 1892.

During this month our inspectors made 6,101 inspection trips, visited 11,575 boilers, inspected 5,171 both internally and externally, and subjected 658 to hydrostatic pressure. The whole number of defects reported reached 10,525, of which 742 were considered dangerous; 32 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	909	50
Cases of incrustation and scale,	1,614	56
Cases of internal grooving,	112	18
Cases of internal corrosion,	452	29
Cases of external corrosion,	813	41
Defective braces and stays,	152	61

Nature of Defects.	Whole Number.	Dangerous.
Settings defective,	289	25
Furnaces out of shape,	424	17
Fractured plates,	211	53
Burned plates,	219	45
Blistered plates,	285	9
Cases of defective riveting,	1,698	25
Defective heads,	95	16
Serious leakage around tube ends,	1,698	131
Serious leakage at seams,	435	22
Defective water-gauges,	301	55
Defective blow-offs,	124	19
Cases of deficiency of water,	19	7
Safety-valves overloaded,	61	12
Safety-valves defective in construction,	61	13
Pressure gauges defective,	458	30
Boilers without pressure gauges,	7	7
Unclassified defects,	88	1
Total,	10,525	742

Boiler Explosions.

JUNE, 1892.

MILL (92). On June 1st the boiler of a 10-horse-power engine, used for grinding tan bark by Mr. R. M. Anderson, of Andersonville, Buckingham Co., Va., exploded, killing Henry Epps and Justin Booker, and injuring —— Bradley, John Pearce, James Morgan, and two boys. The cause of the explosion is not known.

IRON MINE (93). A boiler at the iron ore mines at Rittenhouse Gap, near Leisholtzville, Pa., exploded on June 1st, entirely demolishing the engine house and injuring four men. The injured are: Benneville Reinert, engineer; William Buck, fireman; William Fenstermacher, outside foreman, and Henry Reider, miner.

PORTABLE ROAD ENGINE (94). On June 6th, a portable boiler exploded on Norton street, Rochester, N. Y. It was used to furnish power in constructing the new East Side sewer. There were about forty men at work in the neighborhood. The seriously injured are Matthew Rauber, fireman, Michael Villat, Valentine Kress, Frank Ferlaske, and Frank La Rose. At last accounts Rauber and Villat were in a critical condition. Charles Armstrong, F. H. Marcelle, and Herbert S. Harris were also injured, though to a less extent.

STONE YARD (95). On June 7th a boiler exploded at Pfeiffer's stone yard, St. Joseph, Mo. Great havoc resulted, and several persons had narrow escapes from death. Parts of the boiler were found 1,000 feet away.

TILE WORKS (96). The boilers in Linzie Coughill's tile works, near Logansport, Ind., exploded on June 7th, killing David Taylor, James Coughill, George Williams, and Bert Roller. Williams's right arm was blown off, and a piece of iron was blown through him. The mill was blown to atoms, and there is a large hole in the ground where it stood. The property loss is estimated at $15,000.

LOCOMOTIVE (97). The boiler of locomotive No. 29, of the Chicago & Grand Trunk railroad, exploded on June 14th, at Climax, a station near Battle Creek, Mich. William Wood, engineer, J. T. Smith, fireman, and B. U. Parker, head brakeman, were severely and perhaps fatally hurt. At last accounts it was considered certain that Smith would die. The boiler was blown clear of the frame and landed in a ditch, the drivers were blown over a fence some 50 feet away, and eight freight cars were derailed.

STEAMBOAT (98). The boiler on the steamboat *Rescue* exploded at Elizabeth, Pa. (near Pittsburgh), on June 21st. At the time of the explosion the boat was tied up at the wharf, and the crew were all ashore. The engineer had also just left a few minutes before, and was out on some rafts a short distance away. No one was injured. The *Rescue* was considerably damaged, but did not sink.

SAW MILL (99). On June 23d, a boiler exploded in Gottlieb Joecks's saw-mill, in the town of Grant, near Stevens Point, Wis. Edward Frost, a sawyer, and Charles Klug, were killed, and Gottlieb Joecks, the owner of the mill, and a boy named Dolka, were so badly injured that at last accounts their deaths were hourly expected. William Hager and a son of Mr. Joecks were badly but not fatally hurt, and a number of other employes received slight injuries. Considerable damage was done. The boiler was torn to shreds and scattered over an area of ten acres.

ICE FACTORY (100). A boiler exploded at the Consumers' Ice Company's works, on Magazine street, New Orleans, on June 25th, blowing down the walls of the factory and an adjoining building. The débris caught fire after the explosion, but the flames were quickly extinguished. Albert Coleman was instantly killed. Maurice Smith, engineer, received severe injuries on the head; Jacob Friekey, fireman, was dangerously injured internally; Hick Smith, a coal passer, had both legs broken and was severely scalded; William Scully, oiler, was scalded about the head and legs; Andrew Johnson had his head crushed and afterwards died; Mrs. John Hilbert and her five-months-old infant and nine-year-old son were scalded about the body; and Richard Meredith, James Brown, and Mrs. Comeaux were scalded or burned.

TUG BOAT (101). The tug *Governor Stoneman* met with an accident on June 27th, while on her way from San Francisco, Cal., to Oakland with the morning papers. When near Goat Island, one of the boiler tubes gave out, and the rush of steam and hot water drove both the engineer and fireman on deck, where they were forced to remain until the boiler was emptied. After the *Stoneman* had drifted about for an hour the tug *Annie* came along and the papers were transferred to her and taken on to Oakland. As soon as possible the leak in the boiler was repaired and it was filled with salt water. The steam was again got up and the tug returned to the wharf.

THRESHING MACHINE (102). On June 29th a threshing machine boiler exploded on the ranch of Dumont H. Millard, at Perkins, Sacramento Co., Cal. Ross Dinsmore, the engineer, was struck in the head by a piece of iron and killed. Thomas Wallace had his jaw broken, several teeth knocked out, and his hands and face badly lacerated. Henry Hortsman and the fireman, Johnson, were badly but not fatally scalded.

IT must have been pleasureable to Sir William Thomson to have his scientific attainments recognized by the Queen, and to be rewarded for his labors by elevation to the peerage. Yet so much of his best work was done under the old name, that it must seem strange enough to him to sign his papers "Lord Kelvin".

Barium.

Roscoe and Schorlemmer give an excellent general account of the history of this metal,* as follows: "Our knowledge of the barium compounds commences with that of the natural sulphate or heavy-spar. This substance was first examined in the year 1602, by a Bolognese shoemaker, V. Casciorolus, who noticed that it possessed the remarkable property of becoming phosphorescent when ignited with combustible matter. To this material the discoverer gave the name of *lapis solis* ['sun stone'], but it became better known as Bolognian or Bononian phosphorus, from the place in which it was first prepared, whence specimens of the shoemaker's handiwork found their way into the laboratories of the alchemists of the time. The mineral which yielded this [so-called] phosphorus, termed Bolognian spar, was first believed to be a peculiar kind of gypsum, and hence it was termed *gypsum spathosum* ['spathose gypsum']. In consequence of its high specific gravity, Cronstedt termed it *marmor metallicum* ['metallic marble'], and Marggraf in 1750, finding that it contained sulphuric acid, ranked it among what were then called the heavy fluor-spars. The nature of this mineral remained for some time obscure, and the learned mineralogist v. Justi writes in 1760 concerning it as follows: 'Our analysis has here reached its limits; we know of no smelting operation by which anything can be got out of this spar. Many profound chemists and skillful assayers have here tried their art in vain.' The next step in our knowledge of this subject was made in the year 1774, when Scheele, engaged in his investigation on the black oxide of manganese, examined a specimen of this mineral which he found to contain a new earth, and this when brought in contact with sulphuric acid yielded a salt insoluble in water. . . . Gahn afterwards showed that this earth is contained in heavy-spar, and Bergmann gave it the name *terra ponderosum* ['heavy earth']. Guyton de Morveau in 1779 proposed the name 'barote' (from βαρύς, heavy), and this name, slightly altered to 'baryta' by Lavoisier, was soon generally adopted."

Subsequently baryta was found to be the oxide of a new metal. This metal was isolated by electrolysis in 1808 by Berzelius and Pontin, and afterwards by Davy; and the name "barium" was given to it.

The properties of metallic barium are not yet satisfactorily ascertained, for it is probable that the metal has never been obtained in a state of even approximate purity. Thus, Davy says it is a silver-white metal; Clarke ascribes to it the color and luster of iron; Bunsen and Matthiessen describe it as a golden yellow metal; and Donath states that its true color is that of bronze. It oxidizes rapidly in the air, and it decomposes water readily. It is ductile and somewhat malleable. Its specific heat is not known. Its atomic weight is 136.76 (Clarke), and its chemical symbol is Ba. Its specific gravity appears to be between 3.75 and 4.00. It melts at about the same temperature as cast-iron. It is easily detected by the spectroscope.

The sulphate of barium, or "heavy spar," is the best-known compound of the metal. It occurs in nature in considerable quantities, and is one of the heaviest minerals known. When finely ground and mixed with more or less white lead it is used as a paint. It is also used to adulterate white lead. Artificial heavy spar is better for this purpose than the natural mineral, as it has more "body"; it is known in the trade as *permanent white* or *blanc fixe.* Caustic baryta, or barium hydrate, is used in refining sugar, and is much superior to lime. It forms an insoluble compound with cane sugar, from which the sugar may afterwards be set free by a current of carbonic acid gas.

Compounds of barium give an apple-green color to flames into which they are introduced, and they are therefore used in a great variety of ways in the manufacture of colored fires and other pyrotechnic material. The sulphate of barium is also used in the production of phosphorescent paint.

* *Treatise on Chemistry*, Vol. II, part I, p. 218.

The Locomotive.

HARTFORD, AUGUST 15, 1892.

J. M. Allen, *Editor.* A. D. Risteen, *Associate Editor.*

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Papers that borrow cuts from us will do us a favor if they will mark them plainly in returning, so that we may give proper credit on our books.

The *Annual Report* for 1891 of the committee of management of the Manchester [Eng.] Steam Users' Association is at hand.

Messrs. John Wiley & Sons, of 53 East Tenth street, New York, have issued a new book on *Dynamometers and the Measurement of Power*, by Prof. J. J. Flather, of Purdue University. This work has been used by Prof. Flather as the basis of a course of lectures to his students in engineering, and is the outgrowth of a series of articles first published in the *American Machinist.* The book is fully illustrated, and is very comprehensive. It represents our distinctively American practice, and for this reason it cannot fail to be serviceable to those interested in the measurement of power.

Prof. Rolla B. Carpenter, of Cornell University, has issued a work on *Experimental Engineering*, which is really a third edition of the author's *Notes to Mechanical Laboratory Practice*, first published in 1890. This book has been entirely rewritten, however, and very much enlarged; so that the change in the title is amply justified. In its present form it has 250 illustrations, and nearly 700 pages; and it is very comprehensive. The author says it is intended primarily for use in engineering laboratories; but we fear he is too modest. The greater part of it will be useful to any mechanical engineer. (Published by John Wiley & Sons.)

The general public has had some rather absurd expectations with regard to the present opposition of the planet Mars. It has been expected, by many, that something startling would be discovered; whereas, as a matter of fact, there is no reason for supposing that anything in particular will be learned about the planet, except that certain hitherto uncertain points in its geography may possibly be decided. Good micrometric measures of the two minute moons have also been made, and we shall no doubt have a better knowledge of their orbits before long.

The daily press is responsible in large measure for the unreasonable expectations of the people. The papers talked knowingly of "oppositions" and "perihelia" and other such words, apparently without having any very exact idea of what some of them meant. It was announced that the opposition would come off at twenty-one minutes past one on a certain night; and the enterprising newspaper associations telegraphed to the Lick Observatory for immediate details. They acted as though it was expected that at that precise moment there would be a grand burst of fireworks, or something of that sort, or else that a vast curtain would roll backward from the face of Mars and reveal, for a moment only, the secret mysteries of another world. Now that isn't what an "opposition" is, at all. The simple fact is, that Mars has come a little nearer to us than he usually comes, and we can therefore see him a little better. When he is exactly on the opposite side of us from the sun, he is said to be in "opposition"; but he can be seen very well for a long time before and after the precise moment of opposition, and there was no occasion for the feverish dispatches of the press associations. Newspapers ought to have their scientific news edited by a competent man of science. Such news would then inspire more respect than it does at present; for however excellent the daily papers may be in other respects, it cannot be denied that newspaper science, for the most part, is decidedly shaky.

In this connection we may mention the commendable spirit of the New York illustrated paper, *Once a Week*, which recently offered to pay Schiaparelli's expenses from Italy to California and back, if that distinguished observer would go to the Lick Observatory and "look at Mars with the great telescope and see for himself how well it shows his 'canals'." To this generous offer the Italian astronomer telegraphed the following reply: "Very thankful for your kind proposal, but cannot accept it. Planet too low [*i. e.*, too near the horizon] for good observation. In my opinion next opposition will give better opportunities. SCHIAPARELLI."

"Absolute Zero."

The expression "absolute zero" is frequently used in books and papers relating to heat and thermodynamics, and many persons read about it who do not thoroughly understand what it is, nor why it is any better than any other zero. We shall try to explain it.

In the first place, everybody knows in a general way what the word "temperature" means, and they know that temperatures are measured by observing how much some convenient substance expands or contracts. Mercury is convenient to use for measuring temperatures, for a variety of reasons. For instance, it is a liquid, and can be conveniently kept in the glass tubes that we call thermometers, sealed up tight and protected from dust. When the comparatively larger mass of mercury in the bulb expands, the increase flows freely up into the fine tube at the top, giving us a large movement of the column for a small change in temperature. Its freezing point is far below any temperature that we meet with in these latitudes, and its boiling point is much higher than that of water under any pressure reached in practice; so it is not likely to burst the tube, either by freezing or by boiling. Furthermore, it does not wet the tube it is in, and it expands with a fair degree of uniformity. Other liquids might be used in the place of it, if there were any good reason for preferring them. Thus we find alcohol thermometers, glycerine thermometers, and some few other kinds, with different liquids; but for general use mercury is regarded with the most favor. Metallic thermometers are also used, the expansion of a strip of metal moving a hand over a dial.

Now there is probably no substance whose expansion is *exactly* proportional to its temperature, so that if two thermometers with different liquids are placed side by side, they will not agree in their readings through any considerable range of temperature. The differences are not great enough, for the most part, to make much difference in the ordinary affairs of life, but when we want to measure temperatures accurately to the tenth, twentieth, or hundredth part of a degree, they become of the utmost importance. It is necessary, therefore, to find out all about the irregularities in the expansion of mercury and the other substances used in making thermometers, when such delicate measures are to be made. As has been said above, there appears to be no substance whose expansion is perfectly regular; but most gases are found to have a far greater degree of regularity than solids and liquids have, and hydrogen gas expands with *almost* perfect uniformity. Thermometers have therefore been made by filling a bulb with hydrogen, and allowing the gas to expand downward through a small tube partly filled with mercury and dipping below the surface of a dish of mercury. A yet better way is to keep the hydrogen at a fixed *volume*, and observe how its *pressure* changes. Temperatures may be measured in this way with great accuracy.

When the design of a thermometer, and the material to be used, have been decided upon, we must think about the scale we are going to use. This scale may be quite arbitrary. We may choose *any* two points on the tube and mark one of them 0° and the other, say, 100°, and divide the space between into 100 equal parts, which we will call degrees. But if thermometer makers were to graduate their instruments in this way, no two of them would read alike, and such instruments would be of very little use. In order that we may be able to compare thermometers with one another, they ought to be all graduated in the same manner, though it would not make much difference *what* manner. Unfortunately, several methods of graduation have been adopted in different countries, and the people in these countries have become so accustomed to their own thermometer scales that it is not easy, now, to induce everyone to adopt some one scale. Nearly all thermometers are graduated in one of three ways, however, and we have only to consider the Reaumur, Fahrenheit, and Centigrade systems.

Reaumur and Celsius (Celsius devised the Centigrade scale) placed their thermometers in freezing water and called the place where the mercury stopped "zero." They then placed them in boiling water, and marked the place where the mercury rose to "boiling point," but in numbering this point they differed. Reaumur marked the boiling point 80° on his thermometers, and he divided the space between this and the freezing point into 80 equal parts or degrees. Celsius marked the boiling point 100°, and divided the space between this and the freezing point into 100 equal parts or degrees. Fahrenheit marked the same two points, and divided the space between them evenly into 180 parts or degrees, and continued the scale in both directions with degrees of the same length. For some reason he chose his "zero" at the thirty-second graduation mark below the freezing point, so that on his scale the freezing point is at 32°, and the boiling point at $32° + 180° = 212°$. Of these various systems of graduation, the Celsius or Centigrade is very gradually coming into favor on account of its simplicity. We often see a thermometer with both the Centigrade and Fahrenheit scales on it, one each side of the tube; and the time will probably come when the Fahrenheit scale will give way entirely to the other, or perhaps both will give way to some better system that some one may devise in the future.

The choice of scales and zeros being arbitrary, the question arises whether, among the infinite number of places we *could* call zero, there is any one that is better, for any reason, than all of the others. It seems at first as though the simplest thing we could do is to follow Celsius and Reaumur and call the freezing point zero. This is true in a certain sense; but there is another way to choose the zero mark that is much more convenient for some purposes.

The most accurate thermometer, as has been said, is the gas thermometer, in which the gas may be hydrogen, nitrogen, air, or any one of many other gases. Any one gas expands about the same as any other, when their temperatures are raised by the same amount. It is therefore not a matter of any very great importance, for ordinary purposes, what gas is used in making the thermometer. Thus the gases that have been studied most expand as follows, per Centigrade degree: —

Hydrogen, ...	.0036613	of its volume at the freezing point.
Air, ...	.0036706	" " "
Carbonic acid gas, . . .	.0037100	" " "

These numbers, it will be seen, are nearly equal.

Now, if a cubic foot of hydrogen, for instance, contracts .0036613 of a cubic foot in cooling from 0° Centigrade to 1° below zero, and 2×.0036613 (=.0073226) of a cubic foot in cooling from 0° down to 2° below zero, and 10×.0036613 (=.036613) of a cubic foot in cooling from 0° down to 10° below zero, and 100×.0036613 (=.36613) of a cubic foot in cooling from 0° down to 100° below zero, there must be some point, if the contraction keeps on at the same rate, at which it will have contracted a *whole* cubic foot. Thus, in cooling from 0° down to 200° below zero, the original cubic foot contracts 200×.0036613 (=.73226) of a cubic foot; in cooling from 0° down to 250° below zero it will contract 250×.0036613 (=.91532) of a cubic foot; in cooling from 0° down to 270° below zero it will contract 270×.0036613 (=.98855) of a cubic foot; and in cooling from 0° (Centigrade) down to 273°.13 below zero it will contract 273.13×.0036613 (=1.00000) or exactly a whole cubic foot.

Similarly, a cubic foot of air would contract to nothing if we should cool it from 0° Centigrade down to 272°.44 below zero. For it contracts .0036706 for each degree, and 272°.44×.0036706=1.00000, which is the amount it would contract if cooled 272°.44. Carbonic acid, in the same way, would contract to nothing if cooled from 0° Centigrade down to 269°.5 below zero.

Now, if we should construct a thermometer scale by putting the zero mark at the point which on the present Centigrade scale is about 270° below the freezing point of water, no matter what size the degrees on our new scale might be, the volume of any gas, whose pressure does not change, would be proportional to its temperature on the new scale. Here, then, we have a thermometer scale of some material service to us in making calculations; and it is to be observed that since the size of the degrees we use will make no difference, we may use Centigrade degrees about as well as any other ones.

It may be shown by thermodynamics that when a gas reaches the zero point that we have been considering, it cannot expand again. It has parted with all its internal energy, and it cannot cool any further, because it no longer contains any heat. For this reason the zero we have been considering is called the *absolute zero*.

Now we found above that hydrogen, air, and carbonic acid gas, although they agreed in the main, gave slightly different results for the position of the point of absolute zero. The reasons for these differences have been investigated experimentally and mathematically by Joule and Thomson, and they will be found in the article on *Heat* in the *Encyclopædia Britannica*. We cannot enter into a full discussion of these reasons, and it must suffice to say, that the corrections are necessary because hydrogen, carbonic acid gas, and air, are not what are called "perfect gases". They are very slightly viscous, and they differ from the ideal "perfect gas" in other ways, too. By a study of their properties Joule and Thomson deduced certain corrections that must be applied to the figures we obtained above. Their results are as follows: —

Gas.	Coefficient of Expansion per Centigrade Degree.	Approximate position of Absolute Zero.	Joule and Thomson's Correction.	Corrected position of Absolute Zero.
		(Below Zero.)		(Below Zero.)
Hydrogen, ...	.0036613	273.13°	−0.13°	273.00°
Air, ...	.0036706	272.44°	+0.70°	273.14°
Carbonic acid gas, .	.0037100	269.5°	+4.4°	273.9°

The agreement is nearly perfect, after the theoretical corrections in the fourth column have been applied. Thomson states that since the properties of air are known more accurately than those of the other two gases, he considers that 273.1° is probably nearer the truth than either of the other numbers, and he considers that it is to be preferred to the average of the three determinations, also. For all practical purposes we may consider the "absolute zero" to be at the point which, on the Centigrade scale, is called "273° below zero." Hence, on the *absolute scale* the freezing point of water is 273 Centigrade degrees above zero, and the boiling point of water is 373 Centigrade degrees above zero; and the absolute temperature of anything may be found, in Centigrade degrees, by adding 273° to its temperature on the Centigrade scale.

From the freezing to the boiling point is 100° on the Centigrade scale, and 180° on the Fahrenheit scale. Hence 1° Centigrade is equal to 1.8° Fahrenheit, and 273 Centigrade degrees would be equal to $273 \times 1.8 = 491.4$ Fahrenheit degrees. Hence, the absolute temperature of the freezing point, in Fahrenheit degrees, is 491.4°; and since the Fahrenheit zero is 32° below the freezing point, the absolute temperature of the Fahrenheit zero, in Fahrenheit degrees, is $491.4 - 32° = 459.4°$, or say, in round numbers, 460°. Hence to convert the temperature of anything into absolute temperature in Fahrenheit degrees, we add 460° to its temperature on the Fahrenheit scale.

The facts of the case may be summarized as follows: If a gas were cooled to a point 273 Centigrade degrees below the Centigrade zero, or 460 Fahrenheit degrees below the Fahrenheit zero, it would lose all the energy it contains. It would have no more heat in it; and therefore it could not possibly be cooled *below* that point. Hence that point is called the *absolute zero.* Furthermore, if the temperature of a gas be varied while its pressure is kept constant, the space occupied by the gas will be proportional to the *absolute temperature* of the gas. Thus a certain amount of air occupies, let us say, 10 cubic feet of space at 14° Fahrenheit, and under atmospheric pressure. If we were required to find what space it would occupy at, say, 251° Fahrenheit, and at the same pressure as before, we should proceed as follows: The absolute temperature corresponding to 14° Fahrenheit is $14° + 460° = 474°$; and the absolute temperature corresponding to 251° Fahrenheit is $251° + 460° = 711°$. Hence the required volume is found by the following proportion:

$$474 : 711 :: 10 : \text{Required volume.}$$

Hence

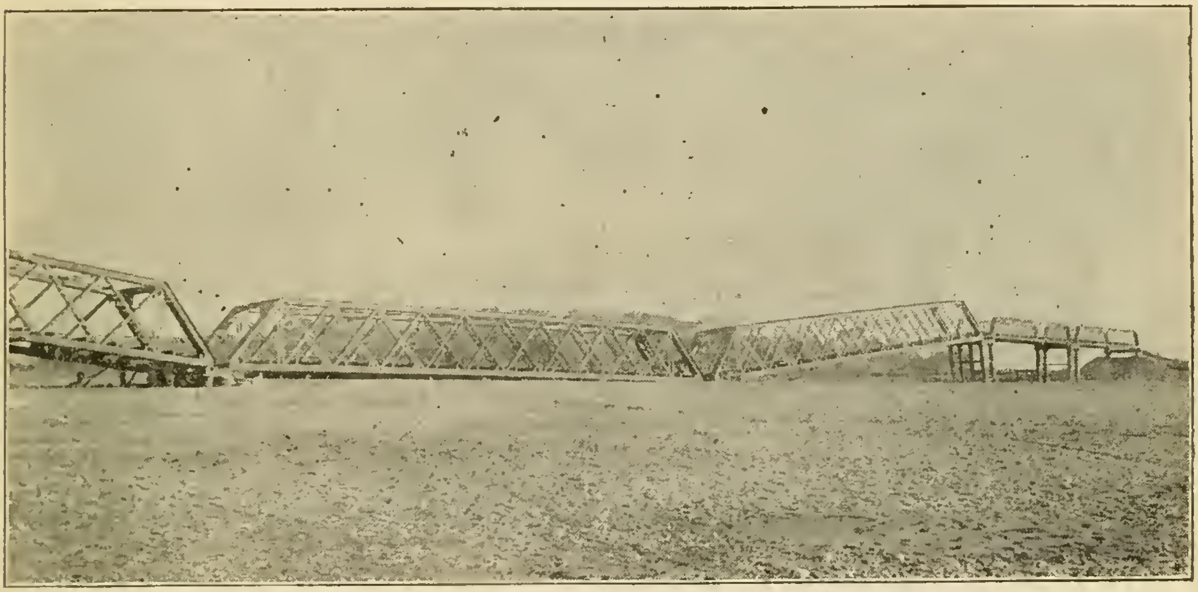
$$\text{Required volume} = \frac{10 \times 711}{474} = \frac{7{,}110}{474} = 15 \text{ cubic feet.}$$

Many other examples of the usefulness of the "absolute zero," and the "absolute temperatures" of things will be found in treatises on heat, and in the current mechanical, engineering, and scientific papers.

The Earthquake in Japan.

Through the kindness of a missionary in Japan we are able to present to our readers the accompanying photo-engraving of the ruined railroad bridge at Nakaragawa. This bridge is 1,400 feet long, with five spans of 200 feet each, and four spans of 100 feet each. Each of the piers consists of five iron piles, 2½ feet in diameter. Four of the piers were broken, two of them so badly that one span of the bridge was dropped down so as to rest on the dry river bed. (The main part of the river is to the left of the part shown in the engraving.) One of the abutments also subsided, leaving the rails 18 feet in the air.

Mr. William Silver Hall, the Japanese correspondent of *Engineering* (London), sends to that paper a very good account of the earthquake, from which we extract the following points: The first shock was felt on the morning of October 28th, and lesser shocks followed at short intervals for a week or so. No damage seems to have been done at Tokio.



Ruined Bridge across the Nakaragawa River, Japan.

At Yokohama, 18 miles away, the brick chimney of the electric light station was thrown down, and an old house was wrecked. The greatest damage was done at Gifu, Nagoya, Osaka, and Ogaki. The region in which these towns are situated is about 160 miles from Tokio, and seems to have been the center of the disturbance. There is a seismological observatory at Nagoya, and Mr. Sano, who has charge of it, says that the vertical motion there was fully 8½ inches. At Gifu, out of 182,499 houses, 41,642 were totally destroyed, 14,670 were partially ruined, and 5,564 burned. This left 236,030 people homeless. The report from Sichu and Gifu gives a total, for those prefectures, of 7,524 killed and 9,458 wounded. A spinning mill collapsed in Osaka, killing 24 and wounding 25. Another similar mill fell in at Nagoya, killing 35 and injuring 113.

The first shock at Gifu is thus described by the *Japan Mail*, whose correspondent was on a railroad train at the time: "It was accompanied by a loud rumbling and the movement was so violent that the passengers slipped from their seats and were thrown into a state of the greatest alarm, conceiving that a collision had taken place. On looking out of the windows, however, they perceived that the station was in ruins and that the water in a neighboring pond was dashing from side to side, indications which showed pretty plainly what had happened. The movement continued for some time with such severity that it was impossible to leave the carriages. Meanwhile large cracks, from two to three feet wide, were observed opening and closing in all directions, volcanic mud and ashes being thrown from some of them. So numerous were they that every step threatened destruction."

Mr Hall calls attention to the great Tokio earthquake of Nov. 4, 1855, and says that the Japanese have such peculiar regard for the thirty-seventh anniversary of a death, that some of the more superstitious had predicted a return of the calamity on its thirty-seventh anniversary; and he calls attention to the remarkable coincidence or agreement of prediction and fact. But it seems to us that the disturbance under discussion came in thirty-six years instead of thirty-seven; for although there were seismic disturbances in Japan in 1854, the Tokio earthquake, to which he seems to refer, occurred in 1855. The coincidence is therefore destroyed.

A Deed of a Dog.

The following legal document is self explanatory. It is a deed transferring a certain dog from one individual to another. The transfer took place in Massachusetts. We have purposely altered the names of the contracting parties, and of the city and county, to spare the said parties the annoyance that a fuller publicity might bring.

KNOW ALL MEN BY THESE PRESENTS,

That we, ARTHUR THOMPSON, JR., of Fall River, in the County of Berkshire and Commonwealth of Massachusetts, merchant prince, and ELIZABETH W. THOMPSON, wife of said Arthur, in her own right, IN CONSIDERATION of the love and affection we bear to HENRY W. COLEMAN of said Fall River, mariner, and of divers other good and valuable considerations us therefore moving, the receipt whereof can never be adequately acknowledged,

DO HEREBY GIVE, GRANT, BARGAIN, SELL, CONVEY, REMISE, RELEASE, AND FOREVER QUIT CLAIM, TRANSFER, SET OVER, AND SET ON to the said Henry W. Coleman two individual halves of a certain dog, hound, mastiff, bull-dog, collie, setter, pointer, harrier, retriever, beagle, pug, spaniel, terrier, cur, or canine creature, now known as TU TU THOMPSON, but hereafter to be called TU TU W. COLEMAN, SITUATED, when last seen, in the position of one about to "eat the crumbs which fall from his master's table," and bounded and described as follows, viz. : Beginning in the dining-room at breakfast, thence running northeasterly through the kitchen to a bone and biscuit ; thence turning and running southerly and westerly, on an irregular curve, in the direction of a certain black cat, to the point where said cat intersects with a cherry tree standing on land now or late of Joshua Crane ; thence turning sharply and running in a straight line, under the fence, to a swill-tub standing on land of one Robeson, there measuring three feet at every step ; thence turning southeasterly and walking slowly to the point of beginning. CONTAINING all that he can hold, more or less, and being the same dog described in a certain License dated May 1st, 1889, and recorded with the records of the Town Clerk of said town of Fall River.

TO HAVE AND TO HOLD the said TU TU, by a string attached to his collar, with all the privileges and responsibilities thereunto belonging, to the said Henry W. Coleman and his heirs and assigns forever, or until said string breaks.

AND we hereby for ourselves and our heirs, executors, and administrators, COVE-

NANT with the grantee and his heirs and assigns that we are seized with simple terror of said TU TU; that we have good reason to sell and convey him as aforesaid; that he is free from all incumbrances except stomach-ache, monkey-mange, rabies, hydrophobia, sunstroke, and gross and confirmed habits of raiding swill-tubs, running to fires, sheep-killing, and terrorizing the neighborhood: that we will, and our heirs, executors, and administrators shall, WARRANT him to run away whenever called; to consume blacking in any form, liquid or dry, from boots, bottles, or stoves: to religiously observe all dog-days; and when at sea to be thoroughly competent to act as the watch-dog of the dog watch; and that we will DEFEND HIM against the lawful claims of Mr. Robert Thompson, but against none others.

RESERVING to us and our heirs and assigns an estate in fee-tail in said TU TU, with the right of docking the tail just behind the ears on the breach of any of the conditions of this deed.

PROVIDED however, and this conveyance is made upon the express condition that the said Henry W. Coleman shall feed and water said TU TU once in each and every day without recourse to us in any event, and shall procure for him on or before the 1st of May in each year a license as a first-class victualler.

IN WITNESS whereof, we, the said Arthur Thompson, Jr., and Elizabeth W. Thompson hereunto set our hands and seals this first day of May, in the year one thousand eight hundred and eighty-nine.

ARTHUR THOMPSON, JR.,
ELIZABETH W. THOMPSON.

In presence of CHARLES A. SWETT,
W. W. TAYLOR.

COMMONWEALTH OF MASSACHUSETTS.

Berkshire, ss. Fall River, May 1, 1889.

Then personally appear before me, a Justice of the Peace within and for said County, the above-named Arthur Thompson, Jr., well known to me and to the police, and acknowledged the foregoing instrument to be his free act and deed.

C—— K. W——,
Justice of the Peace.

THE manufacture of wood pulp is a comparatively modern industry which has developed to very large proportions. Among the countries not possessing important paper mills, but which, nevertheless, have large supplies of wood, Norway occupies an important place as a producer of wood pulp, which is exported for the use of paper-makers in other countries. Of course, the introduction of such an important industry into Norway led to the establishment of similar undertakings cognate to it. Thus, of the fifty-eight wood pulp mills now in operation in Norway, ten have added paper factories, in order to employ the raw product and export the finished paper. One has also the plant for making water-buckets. The following figures, showing the exports of the wood pulp produced by mechanical means during the last five years, are illustrative of the steady expansion of the trade:—

1887, - - -	155,000 tons.
1888, - - -	175,000 "
1889, - - -	190,000 "
1890, - - -	207,000 "
1891, - - -	235,000 "

These figures include the 50 per cent. of water, and those for 1891 represent a value of about seven millon kronor. The chemical pulp or cellulose has not proved so profitable as the mechanical. In fact, the trade in this kind has been almost stationary during the last two years, if a comparison of the latest export statistics may be regarded as a fair criterion. — *Timber Trade Journal.*

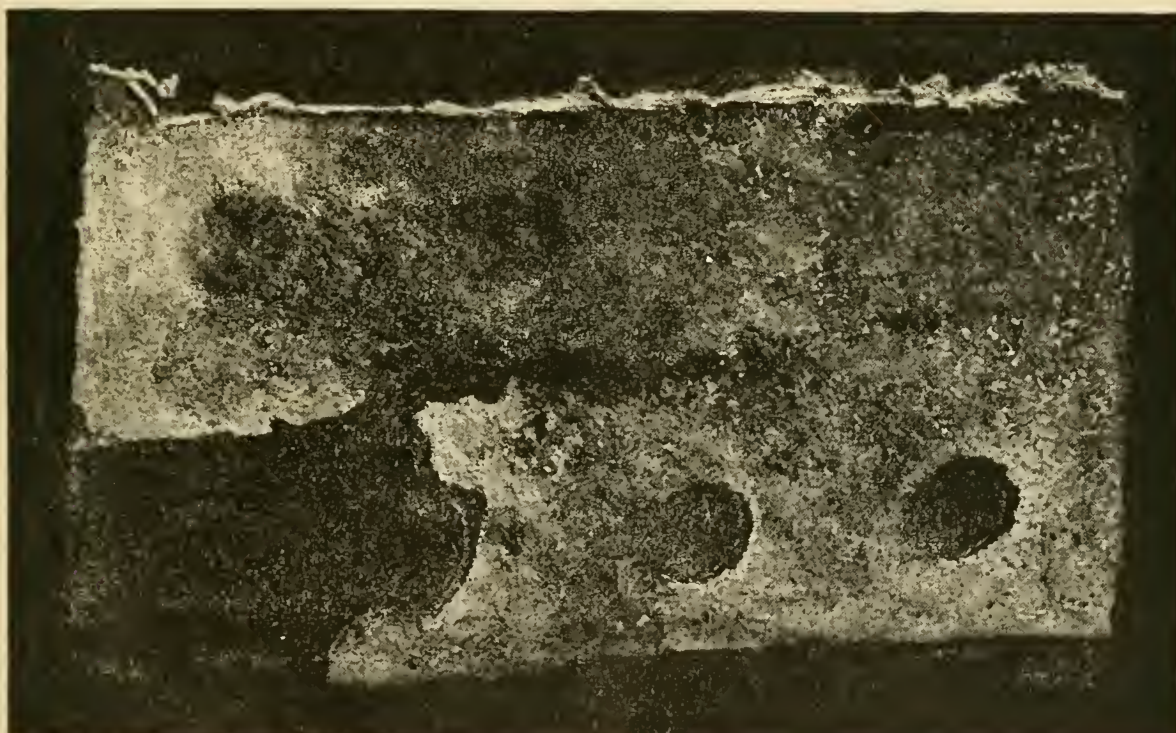
The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

New Series—Vol. XIII. HARTFORD, CONN., SEPTEMBER, 1892. No. 9.

Corrosion.

Corrosion is responsible for a large class of the defects that we meet with in the inspection of boilers. It causes rapid deterioration, and is especially dangerous because it is often unsuspected, even in bad cases. When the action is internal it may be due to impurities in the water, but it is more frequently caused by allowing the boiler to stand idle for considerable lengths of time, with water in it, ready to start up; and it is



Corrosion from Accumulated Ashes.

particularly noticeable in boilers used for heating purposes, for these are frequently left all summer with water standing in them.

If the boiler is kept lukewarm, as, for instance, when it is fired up only once or twice a week, the action is usually more rapid than when it is constantly cold; but in any case, pitting and corrosion are more destructive in boilers that are comparatively idle than in those that are in constant use. This fact has not escaped the attention of the chief engineers of the fire departments, who now almost universally put in auxiliary boilers in connection with those on the engines, in order to keep up a proper circulation and maintain a steam pressure. Many persons suppose that this arrangement is designed to ensure having steam up in case of fire; but while this is certainly one great advantage of the plan, the increased durability of the boiler is an equally important one.

In previous issues we have given illustrations of the pitting and corroding action of water, and in the present issue we present an engraving showing the effects of corrosive action of a different kind, arising from a different cause. It is frequently met with in the inspection of the fire-boxes of internally-fired boilers. The space between the fire-box and the grate bars, in these boilers, becomes filled with ashes, which are often allowed to get damp and attach themselves to the plate, or to pack themselves tightly in between the plate and the bars. Then if there is the slightest leakage or dampness these ashes begin at once to corrode everything in contact with them, and in a short time the boiler becomes unsafe. The piece shown in the cut was taken from a furnace about two years old and fully one-quarter of an inch thick. It was taken out just against and above the grate bars, and in places it was only $\frac{1}{32}$ to $\frac{1}{16}$ of an inch thick. This same state of things extended entirely around the fire-box.

The rapidity of the action in cases of this kind is caused partly by the character of the ash, and partly by the closeness with which it clings to the plates. The engineer is easily deceived as to the real state of things if he allows these incrustations to collect, for there is no evidence of corrosive action until the plate is destroyed, unless the coating is removed. No furnace should ever be allowed to get into such a condition. The accumulations should be removed every day by passing the cleaning hook between the grate and the plates of the water leg. It is good practice, also, to remove the grate and thoroughly clean the adjacent plates once in six months, painting them, after cleaning, with red lead and oil. This will check the corrosion in all cases, and unless leakage occurs it will stop it entirely.

Inspectors' Report.

JUNE, 1892.

During this month our inspectors made 6,438 inspection trips, visited 11,688 boilers, inspected 5,280 both internally and externally, and subjected 707 to hydrostatic pressure. The whole number of defects reported reached 9,740, of which 800 were considered dangerous; 42 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	737	19
Cases of incrustation and scale,	1,361	70
Cases of internal grooving,	73	11
Cases of internal corrosion,	517	33
Cases of external corrosion,	796	47
Broken and loose braces and stays,	121	38
Settings defective,	297	28
Furnaces out of shape,	412	20
Fractured plates,	155	59
Burned plates,	128	21
Blistered plates,	219	11
Cases of defective riveting,	1,658	138
Defective heads,	86	11
Serious leakage around tube ends,	1,662	125

Nature of Defects.	Whole Number.	Dangerous.
Serious leakage at seams,	373	42
Defective water-gauges,	294	25
Defective blow-offs,	125	34
Cases of deficiency of water,	34	10
Safety-valves overloaded.	55	15
Safety-valves defective in construction,	54	14
Pressure-gauges defective,	481	25
Boilers without pressure-gauges,	4	4
Unclassified defects,	98	0
Total,	9,740	800

Boiler Explosions.

JULY, 1892.

TAR WORKS (103). The explosion of a steam boiler on the premises destroyed Wilcoxen's tar works, in Virginia, Nev., on July 6th. The works were refining coal gas tar for the purpose of coating cables for the Comstock mine hoisting plants. The large reservoir, eighteen feet in depth, filled with tar, caught fire. The loss is estimated at $20,000.

SAW-MILL (104). On July 11th a saw-mill boiler exploded near Friends' Station, Tenn., (near Knoxville), killing Albert Whitaker instantly, and injuring two others.

TILE MILL (105). On July 11th a boiler exploded in Caughell & Kinsey's tile mill, three miles south of Idaville, near Monticello, Md. James Caughell and David Taylor, two of the owners, were killed outright, and Bert Roller and George Williams, employes, were so badly injured that they died within two hours.

SAW-MILL (106). The boiler in Baird's saw-mill, in Hague, Fla., (about eleven miles from Jacksonville,) exploded on July 13th. Aston Woodward and his son, John Woodward, were killed. William Robinson, Jack Benson, Daniel Day, and one other man, were badly hurt, and at last accounts Robinson was not expected to live. Mr. Baird estimates the property loss at $6,000.

PLANING MILL (107). On July 14th the boiler in Weimer's planing-mill in Johnstown, Pa., exploded and went up through the first and second floors and the roof of the mill, falling back into the cellar whence it came. The cause of the explosion is not known. The rear end of the mill was blown down, but nobody was injured.

THRESHER (108). The boiler of a steam threshing-machine, owned by Mr. J. G. Meares, exploded in Latrobe, Pa., on July 15th, and the machine was blown to atoms. The engine and thresher were passing down Ligonier street, propelled by steam and guided by horses, and the explosion occurred just as it was about to cross the Pennsylvania railroad tracks. The explosion was terrific and was heard in all parts of the town. The boiler was ripped to pieces and the flying scraps of iron injured several persons, killed one of the horses and broke large plate glass windows. James Morgan, the driver, was seriously hurt, but will recover.

THRESHER (109). A threshing engine exploded on July 18th in the grain field of Thomas Gomez, on the Haggin ranch, near Sacramento, Cal., killing Joseph Sanders and

John Merrion, and terribly injuring Thomas Butler, Archie Wilkes, and Manuel Silva. Butler had a leg broken, and the limb was so badly mangled that it had to be amputated. The other two were scalded and bruised. The engine and thresher were wrecked. Just as the explosion occurred eight other men were approaching the thresher with loads of grain from the header, but they were far enough away to be out of danger.

SEWER PIPE WORKS (110). On July 19th one of boilers in the extensive sewer-pipe works of N. U. Walker & Co., at Walker's Station, a western suburb of East Liverpool, O., exploded with terrific force, soon after the three hundred employes had gone to work. The building in which the boilers were located was almost demolished, and nearly a score of the workmen more or less injured. James Moneypenny, the engineer, was instantly killed, being almost literaly blown to atoms. The following is the list of those injured: John Hammond, struck by debris, badly cut about the head and shoulders; James Dansick, scalded about the face, hands, and arms; William Gould, scalded on face, hands, and back; William Costello, struck by flying timbers. Several others were slightly but not seriously injured.

FURNITURE FACTORY (111). The boiler in the furniture factory of Haynes, Spencer & Co., Richmond, Ind., exploded on July 18th, instantly killing Taylor Hall, the engineer, who had charge of the boiler ten years. Jack Schepman and a boy named Fred Hire were working in the machine-room, and knew nothing of it until pieces of the boiler came in with the caving walls and roof, which covered them from sight. Schepman forgot his own injuries in trying to get the Hire boy out, but fainted when assistance arrived, and proved to be scalded and burned over the back and shoulders, as well as badly bruised about the head and right hip. The Hire boy's hip was broken, and he was otherwise hurt. His father, Joseph Hire, was also hurt about the head and face, but not seriously, as were also Joseph Russell and Harry Parks, the latter of whom was in an outhouse some distance away. This was totally demolished, as was a hitching shed adjacent, in which was a horse and buggy that escaped almost unscathed. The boiler went as high as the four-story building to the south of the engine-room, and was then carried north over a hundred feet, falling on the Pan-Handle Railroad tracks.

BRICK YARD (112). A number of hands employed at the brick yards of Pettit & Miller, at South River, N. J., narrowly escaped death or serious injury on July 19th. The rear head of the boiler blew out a few minutes after 12 o'clock, just as the men had left for dinner, and fortunately, nobody was hurt.

THRESHER (113). On July 20th the boiler of Alphonso Whaley's steam-threshing outfit exploded while at work on the farm of Joseph Rice, three miles south of Morenci, Mich., fatally scalding the proprietor's son, Frank Whaley, who was acting as engineer.

ELECTRIC LIGHT PLANT (114). The boiler in the electric lighting plant at Grand Ridge, near Ottawa, Ill., exploded on July 20th. The station was partially wrecked, the debris caught fire, and the entire electric plant was destroyed, together with the planing mill and lumber office of J. M. Penndstone. The loss was estimated at $20,000. The electric plant had been in operation only about a year.

THRESHER (115). At the farm of Enoch Little, in Haywood county, near Milan, Tenn., the boiler of a steam thresher exploded on July 22d. Peter Mason and Lloyd Anderson were instantly killed, and several others were wounded.

BREWERY (116). Arthur Widlers was injured, on July 25th by the explosion of a boiler in Poth's brewery, Salt Lake City, Utah. Widlers is a steam fitter, and was working about the boiler when it burst. His face and body were terribly scalded and one of his arms was broken.

Traction Engine (117). On July 26th a traction engine boiler exploded in Butler county, near Cincinnati, O., killing Ambrose Alexander and Perry Holden, and injuring George Weyel, Ed. Taylor, William Schick, and John Kyle. The engine was about twenty years old, and for the past three years had not been used. It was recently purchased by the present owners, and arranged so as to drive a grain separator. The crown-sheet appears to have been weak and thin, for the stay-bolts were drawn, and the sheet bagged down and fractured. A barn near by caught fire and was destroyed, and a considerable amount of grain was also lost. The damage to property was estimated at from $2,200 to $2,300.

Saw-Mill (118). A fearful boiler explosion took place at a saw-mill belonging to Short & Hickering, near Stanley, I. T., seventy-five miles north of Paris, Tex., on July 27th, by which two men were killed outright and four others badly injured, three of whom were, at last accounts, expected to die at any moment. The engineer, Lewis Hardin, was torn almost to fragments. John Brown, the other man killed, was also badly mutilated. The injured men are John Bluebell, John Roller, Edward Potter, and Joseph Harding. Others received slight injuries.

Shingle Mill (119). A diastrous explosion occurred on July 28th in the town of Bagley, on the north shore of Otsego lake, near Gaylord, Mich. The boiler in Hartnell & Smith's shingle mill blew up, demolishing the mill, and killing John Thompson, Irvin Hutchins, Leon Skinner, and Andrew Swedock. William Small was fatally injured, and Frank Davis was severely but not fatally hurt. The mill had been built only about ninety days.

Saw-Mill (120). A young man named Bean was killed on July 28th by the explosion of a boiler in the saw-mill of Redding & Henlee, a few miles below Asheboro, N. C. The fireman was slightly injured also, but will recover.

Steamer (121). On July 30th a boiler exploded on the steamer *Monticello* while she was on the way from Port Angeles to Port Townsend, Wash. The tug *Tyee* picked her up six miles below the latter town. Fred Hutchinson, the fireman, was the only person injured. He was thrown across the fire-room and badly scalded. It is thought that he will recover. [We should judge, from the account, that the trouble was caused by the collapse of a flue.]

Thresher (122). A threshing-machine boiler, owned and run by Henry Bussey, exploded on July 29th on Amos Eubank's plantation, near Antioch church, about eight miles from Edgefield, Edgefield County, S. C. Robert Reynolds and his little brother were killed, and Capt. Bussey and a negro were injured.

The wonderful trotting horse, "Nancy Hanks," has covered half a mile in one minute and one second; and the equally wonderful bicyclist, Zimmerman, has covered the same distance in one minute, one second, and four-fifths. These records are remarkable, both for their excellence, when compared with previous ones, and for their close approach to equality. If the famous but thus far visionary "two-minute horse" ever comes, why may we not also expect the two-minute bicyclist?

Cremation in Cholera Cases.

In view of the possible spread of Asiatic cholera from the vessels in New York harbor to the city itself, and thence throughout the whole country, the following article from *Science* will be of interest to our readers. It was written by Dr. A. S. Ashmead, who was formerly medical director of the Tokio Hospital, in Japan.

Japan, he says, has almost everything, or believes that it has almost everything, to learn from us; but there are a few things that it would be wise for us to consent to learn from Japan. The Japanese, a prey from time to time, like all Oriental countries, to cholera epidemics, and having the cholera always with them endemically, have early found out that the cholera corpses should be burned.

There are in the city of Tokio six crematories. They are not intended for the incineration of cholera corpses alone, for cremation is imposed as a religious duty by a number of Buddhist sects. In the oldest cemetery in Japan, that of Koya-san, near the great water-falls in Wakayama-Ken, 700 English miles south of Tokio, cremation is believed to have been practiced, as a religious rite, for the past 1,200 years.

Naturally, the rite of incineration had no difficulty in that country in passing from the religious conception to a sanitary application. The first sanitary cremation edict was issued by the government in 1718, during an epidemic which seems to have been very destructive. Japanese documents speak of that period with awe; 80,000 persons died each month in the city of Yedo; undertakers could not make coffins fast enough; grave-yards were all filled up. The Japanese are singularly struck by the idea that the men who worked at the cremation furnaces after sunset were themselves changed into smoke before sunrise, and that the tombstone cutters of a day found their own names carved on the morrow's tombstone! Finally the priests of all the sects united in asking for a general application of the cremation rite; ashes alone, they said, should be buried; at every burial-ground mountains of casks discouraged the diligence of the grave-digger; multitudes of corpses (the Japanese documents have the simplicity to add that they were mostly poor persons) remained unburied for weeks. The Japanese have long believed that this was a cholera epidemic, the first that ravaged the *fertile sweet-flag plain;* but that is a delusion. Cholera paid them its first visit more than a hundred years later. It was then that the religious character departed once for all from the cremation rite; for the government, seeing that the fire was too slow, ordered the bodies to be wrapped in mats and quicklime and sunk into the sea. Cremation ever after was only a sanitary operation.

In the past thirteen years there have been 456,080 reported cholera patients in the empire; of these 303,466 died — that is, 66½ per cent. Every one of these corpses has been burned. Under police regulations, in the city of Tokio, there may be eight public crematories (of course, this has nothing to do with the private establishment of each Buddhist burial-place), placed outside of the city limits. The law requires that they shall be constructed of brick, and be large enough to burn at least twenty-five corpses at a time. Each furnace must have a chimney over thirty feet high. Each crematory is expected to have a separate furnace for burning discharges, and a separate disinfecting room. This furnace is to be of brick, and capable of incinerating at least twenty-five casks (bushels) at a time; its chimney must be thirty feet high. The law requires further that the disinfecting compartment shall be divided into two spaces, one a bath-room (not, of course, for the corpses, but for persons suspected of harboring the disease), and the other a fumigating place. Cremation must be performed only at night.

between sunset and sunrise. The corpses are not stripped of their clothing, and each is accompanied by its burial certificate.

In the Buddhist cemeteries cremation is thus performed: The corpse is brought in a square wooden box or barrel (the regular Japanese coffin) in a sitting position, according to the national custom. A hole in the ground with sloping sides awaits it, at the bottom of which are two stones, upright and parallel; and across the top of these stones fire-wood and charcoal are piled. Around the corpse, placed upon the pile, a circular wall is built up, formed of rice straw and chaff, perhaps to a height of five or six feet, and the wall itself is wrapped in wet matting, which is continually moistened during the whole operation. The fire is kept up for twelve hours, after which the ashes and bones are picked up by the oldest representative of the family, enclosed in a funeral urn, and buried after seven days of various religious observances.

It is most regrettable that cremation has not with us that religious origin which recommended it first to the Japanese. Reason and good sense have never proved such strong foundations; otherwise the advisability of the cremation of cholera corpses would have occurred to us long ago. It is useless to object that these precautions do not preserve Japan from cholera epidemics. The disease is kept up there by causes which cannot be reached by cremation. The houses are built in unhealthy places, they are squalid, and in every way insalubrious; the water is wretched, infected by impurities dropping from ill-kept closets. It would be impossible to enumerate all the causes that contribute to the perpetuation of cholera there. None of these causes exist in our western countries, and the cremation of cholera corpses would, in these countries, yield its whole sanitary benefit. If we burned our corpses, the bacillus would be destroyed effectively. In Japan, the dejections of the living (by contaminating the well-water), the system of promiscuous public bathing, etc., keep it alive in spite of the cremation.

Some years back, when the cholera appeared in New York harbor, in the quarantine station, having been brought by an Italian immigrant ship, the dead were buried on Staten Island at the quarantine burying-grounds. If we were as ready to profit by past observation as we ought to be, cremation would have been introduced then and there. For in 1866, when some cholera immigrants had been buried on Ward's Island, an epidemic started almost immediately in the part of the city nearest to the burial-ground; there, in Ninety-third Street and Third Avenue, the first case occurred. This was certainly a fact to be taken into serious consideration. No man interested in the health of his fellows will be content to say that this was only chance. And if it is more than chance, why then has it never been proposed to prevent the propagation of the disease by fire, as other peoples have long been accustomed to do?

There are four rules, by observing which we can absolutely prevent cholera from setting foot on this continent: —

1. Let the drinking water be perfectly isolated; that is, keep the cholera germs out of it.

2. Let the fæces and other discharges from patients be disinfected with quicklime or common whitewash. This is, by the way, what Professor Koch recommended to the Central Sanitary Board of Japan.

3. Let the clothing be disinfected with dry heat at 212° Fah., and afterwards with steam.

4. Finally, let the cholera corpse be cremated instead of buried.

The Locomotive.

HARTFORD, SEPTEMBER 15, 1892.

J. M. Allen, *Editor.* A. D. Risteen, *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. (Any volume can be supplied.)

Papers that borrow cuts from us will do us a favor if they will mark them plainly in returning, so that we may give proper credit on our books.

The report of the nineteenth regular meeting of the Hannover *Verein zur Ueberwachung der Dampfkessel* is at hand.

We have received from the D. Van Nostrand Company, 23 Murray street, New York, a copy of an excellent little work on *The Practical Management of Dynamos and Motors*, written by Francis B. Crocker and Schuyler S. Wheeler. The contents of this work was published in the *Electrical Engineer*, in a series of articles extending from September, 1891, to May, 1892; but the matter has been re-arranged in systematic order, and the headings are printed in heavy type to facilitate reference. The book is divided into two parts, the first of which explains the general principles of dynamos and motors, the points to be borne in mind in selecting them, the installing and testing of them, and the connecting, starting, running, and stopping of them. But the most valuable portion of the book, in our opinion, is the second part, in which there is a large amount of useful information and suggestion relating to what may be called the diagnosis and treatment of the diseases of dynamos and motors. The information here given is clear, concise, and intelligible, and of such a character that it ought to be in the hands of every man who has charge of electric machinery.

The Lick Observatory announces that on September 9th Professor Barnard discovered a fifth satellite of Jupiter. The new-comer is exceedingly small and faint, and close to its primary. It is of the thirteenth magnitude, and its period of revolution is about 12 hours and 36 minutes. Its distance from Jupiter's surface is about 68,000 miles, or 20,000 miles less than the diameter of the planet. This discovery upsets another of the fancied peculiar numerical relations existing among the members of the solar system. "Bode's" law, which was first announced by Professor Titius of Wittemberg (for an account of which see The Locomotive for December, 1889, p. 190), was thrown overboard when Neptune was discovered. The "law" that Professor Barnard has overturned is that of the geometric progression of the number of satellites. Thus, beginning with the earth and going outward in order, we have: Earth has 1 satellite; Mars has 2; Jupiter had 4; Saturn has 8; Uranus and Neptune are so far away that they *may* have 16 and 32, respectively, for all that we can say to the contrary. This law had been verified by the discovery of the moons of Mars, in the same manner that Bode's law was verified by the discovery of the asteroids; and it has now been exploded by the fifth satellite of Jupiter, as Bode's law was exploded by the discovery of Neptune.

The Loss of Heat from Uncovered Steam Pipes.

It is well recognized that there is a material and important loss of heat, by radiation and otherwise, from long lines of unprotected steam pipe; yet many engineers, if asked how great this loss would be in any proposed case, would be unable to give more than a rough guess at it. If the pipe is covered with some approved kind of non-conducting material the loss may undoubtedly be greatly diminished; but pipe-covering costs money, and the owners of factories and mills naturally want to know, before investing in it, how much it will lessen their running expenses, and which of the many kinds of non-conductors will give the best satisfaction in the end. This problem is by no means easy to solve, yet it is coming up all the time, and we propose to present a few general facts that may make a serviceable foundation to base estimates upon.

In the first place, we shall have to look into the phenomena of cooling somewhat. We shall find that however simple it may look at first sight, the problem presented by the steam pipe resembles a great many other heat-problems in its deceptive complexity. A hot steam-pipe, for example, is radiating heat constantly off into space, but at the same time it is cooling also by *convection*. By *convection* we mean that the air in contact with the pipe becomes heated, grows lighter, and flows upward, giving way to a fresh supply of colder air, which then acts in the same way. A good illustration of simple radiation is afforded by the open grate fire, used for heating dwellings. Nearly all of the air that is warmed by direct contact with the fuel passes up the chimney, and the only part of the heat that is available for heating the room is that which is radiated directly. Most of the heat felt by the crowds who delight to gaze on burning buildings is also purely radiant, for the air that is heated by direct contact with the building is free to rise high over their heads, its course being indicated by the sparks and smoke. On the other hand, the heat poured into a room warmed by the "indirect" system is entirely convective.

In addition to the problems presented by radiation and convection, the conducting power of the pipe comes up for consideration; for it is the temperature of the *outside* of the pipe that determines how much heat will be lost by radiation and convection, and unless the pipe is an absolutely perfect conductor, the outside will be cooler than the inside by an amount that depends on a good many things, and is not easy to calculate. In all practical work, however, it may be assumed that the conducting power of ordinary steam-pipe is great enough to keep the temperature of the outside pretty nearly up to that of the inside, so that for most purposes we can consider these two temperatures equal.

When we come to look for experimental data on which to base calculations of the heat radiated and otherwise lost by steam pipes, we find that they are neither numerous nor satisfactory. In his famous article on *Heat* in the Encyclopedia Britannica, Lord Kelvin gives Mr. Macfarlane's measures of the total loss of heat of a copper sphere (including radiation and convection), and no others, apparently thinking that such other measures as have been made are unsatisfactory. Mr. Macfarlane's experiments were made with a copper sphere about 1.6 inches in diameter. The ball was enclosed in a blackened sphere of tin, the temperature of which was kept at 14° Cent., the initial temperature of the copper ball ranging from 19° to 74° Cent. Prof. Tait has also published measures made by Mr. J. P. Nichols; but as there is a marked discordance between the two, we do not need to reproduce the results.

In Box's *Practical Treatise on Heat*, a number of results are given for the amount of heat radiated by different substances when the temperature of the air is 1° Fah.

lower than the temperature of the radiating body. A portion of this table is given below. It is said to be based on Péclet's experiments.

TABLE 1. — HEAT UNITS RADIATED PER HOUR, PER SQUARE FOOT OF SURFACE, FOR 1° FAHRENHEIT EXCESS IN TEMPERATURE.

Copper, polished,	.0327	Sheet-iron, ordinary,	.5662
Tin, polished,	.0440	Glass,	.5948
Zinc and brass, polished,	.0491	Cast-iron, new,	.6480
Tinned iron, polished,	.0858	Common steam pipe, inferred,	.6400
Sheet-iron, polished,	.0920	Cast and sheet-iron, rusted,	.6868
Sheet lead,	.1329	Wood, building stone, and brick,	.7358

When the temperature of the air is about 50° or 60° Fah., and the radiating body is not more than about 30° hotter than the air, we may calculate the radiation of a given surface by assuming the amount of heat given off by it to be proportional *to the difference in temperature between the radiating body and the air.* This is "Newton's law of cooling." But when the difference in temperature is great, Newton's law does not hold good; the radiation is no longer proportional to the difference in temperature, but must be calculated by a complex formula established experimentally by Dulong and Petit. Box has computed a table from this formula, which greatly facilitates its application, and we cannot do better than follow his lead.

TABLE 2. — FACTORS FOR REDUCTION TO DULONG'S LAW OF RADIATION.

DIFFERENCES IN TEMPERATURE BETWEEN RADIATING BODY AND THE AIR.	TEMPERATURE OF THE AIR ON THE FAHRENHEIT SCALE.											
	32°	50°	59°	68°	86°	104°	122°	140°	158°	176°	194°	212°
18° Fah.,	1.00	1.07	1.12	1.16	1.25	1.36	1.47	1.58	1.70	1.85	1.99	2.15
36° "	1.03	1.08	1.16	1.21	1.30	1.40	1.52	1.68	1.76	1.91	2.06	2.23
54° "	1.07	1.16	1.20	1.25	1.35	1.45	1.58	1.70	1.83	1.99	2.14	2.31
72° "	1.12	1.20	1.25	1.30	1.40	1.52	1.64	1.76	1.90	2.07	2.23	2.40
90° "	1.16	1.25	1.31	1.36	1.46	1.58	1.71	1.84	1.98	2.15	2.33	2.51
108° "	1.21	1.31	1.36	1.42	1.52	1.65	1.78	1.92	2.07	2.28	2.42	2.62
126° "	1.26	1.36	1.42	1.48	1.59	1.72	1.86	2.00	2.16	2.34	2.52	2.72
144° "	1.32	1.42	1.48	1.54	1.65	1.79	1.94	2.08	2.24	2.44	2.64	2.83
162° "	1.37	1.48	1.54	1.60	1.73	1.86	2.02	2.17	2.34	2.54	2.74	2.96
180° "	1.44	1.55	1.61	1.68	1.81	1.95	2.11	2.27	2.46	2.66	2.87	3.10
198° "	1.50	1.62	1.69	1.75	1.89	2.04	2.21	2.38	2.56	2.78	3.00	3.24
216° "	1.58	1.69	1.76	1.83	1.97	2.13	2.32	2.48	2.68	2.91	3.13	3.38
234° "	1.64	1.77	1.84	1.90	2.06	2.28	2.43	2.52	2.80	3.03	3.28	3.46
252° "	1.71	1.85	1.92	2.00	2.15	2.33	2.52	2.71	2.92	3.18	3.43	3.70
270° "	1.79	1.93	2.01	2.09	2.22	2.44	2.64	2.84	3.06	3.32	3.58	3.87
288° "	1.89	2.03	2.12	2.20	2.37	2.56	2.78	2.99	3.22	3.50	3.77	4.07
306° "	1.98	2.13	2.22	2.31	2.49	2.69	2.90	3.12	3.37	3.66	3.95	4.26
324° "	2.07	2.23	2.33	2.42	2.62	2.81	3.04	3.28	3.53	3.84	4.14	4.46
342° "	2.17	2.34	2.44	2.54	2.73	2.95	3.19	3.44	3.70	4.02	4.34	4.68
360° "	2.27	2.45	2.56	2.66	2.86	3.09	3.35	3.60	3.88	4.22	4.55	4.91
378° "	2.39	2.57	2.68	2.79	3.00	3.24	3.51	3.78	4.08	4.42	4.77	5.15
396° "	2.50	2.70	2.81	2.93	3.15	3.40	3.68	3.97	4.28	4.64	5.01	5.40
414° "	2.63	2.84	2.95	3.07	3.31	3.51	3.87	4.12	4.48	4.87	5.26	5.67
432° "	2.76	2.98	3.10	3.23	3.47	3.76	4.10	4.32	4.61	5.12	5.33	6.04

The use of this table will be made plain by the following illustration. EXAMPLE. How many heat units will be radiated in one hour by an iron pipe, 10 feet long and $2\frac{11}{32}$ inches in external diameter, carrying steam at a temperature of 355° Fah., the air and surrounding objects being at 32° Fah.? *Ans.:* The circumference of this pipe is $2\frac{11}{32} \times 3.1416 = 7.363$ inches = 0.614 feet. Hence the area of its surface is $10 \times 0.614 = 6.14$ sq. ft. We see by Table No. 1 that one square foot of such a pipe will radiate about 0.64 of a heat unit per hour, for one degree difference in temperature. Hence the proposed piece of pipe will radiate $6.14 \times 0.64 = 3.93$ heat units per hour, for one degree difference in temperature. The real difference in temperature being 355° — 32° = 323°. Newton's law gives us $3.93 \times 323 = 1{,}269$ heat units as the amount of heat radiated by the pipe in one hour. But Newton's law is not accurate for any such range of temperature, and we have to look in Table No. 2 for the proper correction factor to reduce this result into conformity with Dulong's law of radiation. The temperature of the air being 32°, we look in the column headed 32°, and opposite 324° we find the factor 2.07. Then, multiplying our previous result by this we have $1{,}269 \times 2.07 = 2{,}627$, which is the number of heat units the pipe may be expected to lose in one hour, by radiation alone.

The loss of heat by *convection* appears to be independent of the nature of the surface, that is, it is the same for iron, stone, wood, and other materials It is different for bodies of different shape, however, and it varies with the position of the body. Thus a vertical steam pipe will not lose so much heat by convection as a horizontal one will; for the air heated at the lower part of the vertical pipe will rise along the surface of the pipe, protecting it to some extent from the chilling action of the surrounding cooler air. It is for a similar reason that the shape of a body has an important influence on the result, those bodies losing most heat whose forms are such as to allow the cool air free access to every part of their surface. The following table from Box gives the number of heat units that horizontal cylinders or pipes lose by convection per square foot of surface per hour, for one degree difference in temperature between the pipe and the air.

TABLE 3. — HEAT UNITS LOST BY CONVECTION FROM HORIZONTAL PIPES, PER SQUARE FOOT OF SURFACE PER HOUR, FOR A TEMPERATURE DIFFERENCE OF 1° FAH.

External diameter of Pipe in Inches.	Heat Units Lost.	External diameter of Pipe in Inches	Heat Units Lost.	External diameter of Pipe in Inches	Heat Units Lost
2	0.728	7	0.509	18	0 455
3	0.626	8	0.498	24	0 447
4	0.574	9	0.489	36	0.438
5	0.544	10	0 482	48	0.434
6	0.523	12	0.472	..	.....

The loss of heat by convection is nearly proportional to the difference in temperature between the hot body and the air; but the experiments of Dulong and Péclet show that this is not exactly true, and we may here also conveniently resort to a table of factors for correcting the results obtained by simple proportion.

TABLE 4.—FACTORS FOR REDUCTION TO DULONG'S LAW OF CONVECTION.

Diff. in Temp. between Hot Body and Air.	Factor.	Diff. in Temp. between Hot Body and Air.	Factor.	Diff. in Temp. between Hot Body and Air.	Factor.
18° Fah.	0.94	180° Fah.	1.62	342° Fah.	1.87
36 "	1.11	198 "	1.65	360 "	1.90
54 "	1.22	216 "	1.68	378 "	1.92
72 "	1.30	234 "	1.72	396 "	1.94
90 "	1.37	252 "	1.74	414 "	1.96
108 "	1.43	270 "	1.77	432 "	1.98
126 "	1.49	288 "	1.80	450 "	2.00
144 "	1.53	306 "	1 83	468 "	2.02
162 "	1.58	324 "	1.85	....	....

The use of these tables may be illustrated by referring once more to the example in radiation already given. To find the amount of heat lost by convection by the same pipe we proceed as follows: According to Table No. 3, a pipe 2 inches in external diameter would lose 0.728 of a heat unit per square foot of surface per hour for a temperature difference of one degree Fah. The corresponding number for a pipe 3 inches in external diameter is 0.626. Hence we infer that a pipe 2 11-32 inches in outside diameter would lose about 0.693 heat units per square foot of surface per hour, for one degree of temperature difference. (For the difference between .728 and .626 is .102, and 11-32 of .102 is .035. Then .728 — .035 = 0.693.)

The area of the pipe has already been found to be 6.14 square feet. Hence 6.14 × .693 = 4.26 heat units per hour would be lost by convection by the whole pipe, if its temperature were 1° higher than that of the air. As a matter of fact, its temperature exceeds that of the air by 323°; hence the total loss per hour by convection would be 4.26 × 323 = 1,376 heat units, if the convection loss were strictly proportional to the temperature difference. As it is not so, we must take the proper correction factor from Table 4. We find this factor to be 1.85; hence 1,376 × 1.85 = 2,546, which is the number of heat units we may expect the pipe to lose, in one hour, by convection. Hence, finally, we have —

Total loss of heat = total radiation loss + total convection loss

= 2,627 + 2,546 = 5,173 *heat units per hour.*

As a final example of the calculation of the loss of heat by steam pipes let us find the amount of heat lost in one hour by a naked steam-pipe 2 11-32 inches in external diameter and one foot long, conveying steam at a pressure of 55 lbs. by the gauge, the temperature of the air and surroundings being 80° Fah. The temperature of the pipe will be found to be about 302° Fah. We have already found the surface of such a piece of pipe to be 0.614 of a square foot. The calculation, then, is as follows:

Temperature difference = 302° — 80° = 222°.

Radiation loss per hour by Newton's law =

0.614 (area) × .64 (see Table 1) × 222 = 87.2 heat units.

Same reduced to conform with Dulong's law of radiation =

87.2 × 1.98 (see Table 2) = 173. heat units per hour.

Convection loss per hour (considered proportional to temperature difference) =

0.614 (area) × .693 (see Table 3) × 222 = 94.6 heat units.

Same reduced to conform with Dulong's law of convection =
94.6 × 1.70 (see Table 4) = 160.8 heat units per hour.
Then the total loss of heat per hour = loss by radiation + loss by convection =
173.0 + 160.8 = 333.8 heat units per hour.

It is not claimed that the results obtained by this method of calculation are strictly accurate. The experimental data are not sufficient to allow us to compute the heat-loss from steam pipes with any great degree of refinement; yet it is believed that the results obtained as indicated above will be sufficiently near the truth for most purposes. We shall return to this subject in a later issue.

Bismuth.

The metal bismuth was first accurately described by Pott in 1739; for although it had been obtained before that time, it was confounded with antimony and zinc, which it resembles to some extent. The origin of the word "bismuth" is not known, though several highly improbable origins have been suggested. For example, miners often call it "wismuth," and Mathesius suggests that this word comes from *Wisse*, or *Wiese*, meaning a meadow; because, he says, in the mines it is often found covered with incrustations of various colors, resembling a meadow covered with brilliant flowers.

Bismuth occurs in nature in the metallic form, and several ores of it are also found from which the metal may easily be obtained by roasting and smelting. The principal supply comes from Saxony, though it is also found in Austria, Norway, Cornwall, Spain, California, New South Wales, and parts of South America. The total consumption of the metal ranges between twenty-five and fifty tons a year, and the demand for it is so variable that the price has ranged all the way from fifty-five cents to five dollars a pound.

Bismuth is of a peculiar light reddish color, highly crystalline, and so brittle that it can readily be pulverized. It melts at 510° Fah., and boils at about 2,300° Fah. Its specific gravity is 9.823 at 54° Fah., and 10.055 just above the melting point. Its specific heat is about .0301 at ordinary temperatures, and .0363 just above its melting point. Its coefficient of expansion is about .000736 per degree Fahrenheit. Its conductivity for heat is only about $\frac{1}{56}$ that of silver, and its electrical resistance at 32° is 1.153 times that of mercury at the same temperature. It is readily recognized by the spectroscope, for it has a large number of characteristic lines in its spectrum. Its chemical symbol is Bi, and its atomic weight is 207.523 (Clarke), or, in round numbers, 208. Its tensile strength is 6,400 pounds per square inch. It has been believed that the specific gravity of bismuth is *diminished* by great pressure, but Spring has shown that this is not the fact. He subjected a sample whose specific gravity was 9.804 to a pressure of 20,000 atmospheres, and found that the specific gravity rose to 9.856. A second compression increased it still further, to 9.863. Bismuth expands in cooling, and Tribe has shown that this expansion does not take place until after solidification. Bismuth is the most diamagnetic element known, a sphere of it being repelled by a magnet; and on account of its marked thermo-electric properties it is much used in laboratories in the construction of delicate thermo-piles.

In the arts bismuth is used chiefly in the preparation of alloys. By adding a small amount of it to lead that metal may be hardened and toughened. An alloy consisting of three parts of lead and two of bismuth has ten times the hardness and twenty times the tenacity of lead. The alloys of bismuth with both tin and lead are extremely fusible, and take fine impressions of casts and molds. An alloy of one part bismuth, two parts tin, and one part lead is used by pewter workers as a soft solder, and by soap-makers for molds. An alloy of five parts bismuth, two parts tin, and three parts lead melts at 199° Fah., and is somewhat used for stereotyping, and for metallic writing pencils. Thorpe gives the following proportions for the better known fusible metals:

Name of Alloy.	Bismuth.	Lead.	Tin.	Cadmium.	Mercury.	Melting Point.
Newton's	50	31.25	18.75	.....	.....	202° Fah.
Rose's	50	28.10	24.10	.....	.....	203° "
D'Arcet's	50	25.00	25.00	.....	...	201° "
D'Arcet's with mercury	50	25.00	25.00	.....	250.0	113° "
Wood's	50	25.00	12.50	12.50	.....	149° "
Lipowitz's	50	26.90	12.78	10.40	.....	149° "
Guthrie's "Entectic"	50	20.55	21.10	14.03	.....	"Very low."

The action of heat upon some of these alloys is remarkable. Thus, Lipowitz's alloy, which solidifies at 149° Fah., contracts very rapidly at first, as it cools from this point. As the cooling goes on the contraction becomes slower and slower, until the temperature falls to 101.3° Fah. From this point the alloy *expands* as it cools, until the temperature falls to about 77° Fah., after which it again contracts, so that 32° Fah. a bar of the alloy has the same length as at 115° Fah.

Alloys of bismuth have been used for making fusible plugs for boilers, but it is found that they are altered by the continued action of heat, so that one cannot rely upon them to melt at the proper temperature. Some of them have also been used in tempering steel.

In medicine bismuth has been largely used, principally as the basic nitrate, which is given for chronic diarrhœa and cholera. It was largely used in the field hospitals during the war, and the French army now uses some 2,700 pounds of it per annum. It is also used in considerable quantities as a cosmetic.

A Tribute to Seth Decker.

The death of Mr. Seth Decker, of Salem Depot, New Hampshire, which occurred at an early hour last Sunday morning, removed from the world's activity a man that could not be easily spared. It is true that Mr. Decker had not accomplished much in his chosen field of labor, that of invention, when compared with some men, but he had done enough to show that his genius was unique and that great things might be expected of him. But though dead at the early age of thirty years, the name of Seth Decker will still take its place in our nation's history beside that of Robert Fulton, Eli Whitney, and Professor Morse as the inventor of the Decker Vagrant Utilizer.

The great inventive problem of the age is the utilization of stored-up energy or force. Thus the latent energy in coal is made to produce steam and the steam used to drive machinery directly, or in turn, to generate electricity, which may be converted into light or be used as the motive power for machinery. But in these processes there is a great loss of energy; only a small percentage of the latent force in coal can be developed by the best steam engine. This waste of energy annoyed Mr. Decker, and he determined to turn his efforts in a direction where it could be avoided. Naturally, the first thing he did was to look about for the greatest available reservoir of stored-up energy. He found this in the American able-bodied tramp. The fact that the tramp never on any occasion shows any energy was, of course, in Mr. Decker's favor, as all of the latent force in him remained to be extracted and put to commercial use. Of course the idea that first occurred to Mr. Decker was to treat the tramp as coal is treated and produce steam with him; but the great loss of energy in this process soon caused him to abandon the notion. He then determined to utilize the tramp directly by mechanical means. This plan would also have the additional advantage of preserving the tramp alive for future political and social purposes. The result was the Decker trampomotor.

The trampomotor consists essentially of a set of front door steps of from ten to twelve steps. They resemble any ordinary steps leading up to a high stoop, but are, in fact, constructed on the principle of a treadmill, and really consist of twenty or twenty-four steps, and revolve around shafts at the top and bottom, one half of the steps constantly ascending at the back and out of sight while the other half in front descends. Mr. Decker usually baited the trampomotor with his grandmother. Her practice was to sit on the stoop wearing a most benevolent and motherly expression, which never failed to attract a tramp if he came within sight. Approaching and making his wants known, the old lady would invite him to come up the steps and get something to eat. The steps would be locked, but when the wayfarer whose latent energy it was proposed to utilize was about half way up, she would touch a spring which would release them and cause the subject to begin sinking back towards the street. At the same time the mat at the foot of the steps would turn over and a dozen pitchfork tines and three or four old army bayonets would spring up and stand at an angle of fifty degrees, pointing directly towards the vagrant. As a consequence he would continue to rush up the stairs at a furious rate, although, of course, he never got any nearer the top. A belt under the stoop from the top shaft transferred the power thus developed to the rear of the building, where Mr. Decker carried on a prosperous wooden-ware and wagon-spoke factory. One tramp would last from three to six hours, and when he showed signs of collapse, Mrs. Decker (who had been calmly knitting the meantime) would touch another spring which would lock the steps and turn down the pitchfork tines and bayonets, and allow the tramp to roll to the sidewalk. The local authorities would then carry him to the station-house in a patrol wagon, where he would be fined $10 for vagrancy. The motor has seldom been without tramps, owing to the charitable aspect of the old gentlewoman, and a careful calculation by Mr. Decker showed that a fraction over 94 per cent. of the latent force in a tramp is brought out and turned to practical account by the motor. It should be noted also, as Mr. Decker was never tired of pointing out, that the tramp remains practically as good as before use, and after he has worked out his fine on the village stone-pile may be again utilized in some other town if he can once more be allured up the steps.

It is the lives of such men as Seth Decker which should furnish the true inspiration for our youth. It is such men that make America truly great, and Decker's untimely departure is a national loss.—*N. Y. Tribune.*

The Locomotive.

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Flues in Boilers.

A boiler shell, with the pressure acting on it from within, is in a state of stable equilibrium; for if any small deformation is produced in it, from any cause, the pressure tends to remove the deformation and restore the boiler to the form of a true cylinder. A flue, however, with the pressure on the outside, is in a state of unstable equilibrium, for the pressure tends to magnify all deformations and to cause the flue to depart more widely from the cylindrical form. In other words, pressure tends to keep the shell of a boiler in its strongest shape, and tends to force a flue into its weakest shape. Flues, therefore, are elements of weakness in a boiler, and it is particularly important that proper attention be paid to them.

The U. S. Treasury rules for finding the strength of lap-welded flues are as follows (see *Amended Steamboat Rules and Regulations* for 1891): If the diameter of the flue is not less than 7 inches, and not more than 16 inches, and the length not over 18 feet, multiply the thickness of the flue, in inches, by the constant number 4,400, and divide the product by the radius of the flue in inches. The quotient will be the pressure allowable. "For every foot or fraction thereof over 18 feet, deduct 3 pounds per square inch from the pressure allowable on an 18-foot flue; or, add .01 of an inch to the thickness of material required for a flue 18 feet in length for every three feet or fraction thereof over 18 feet." The thickness of such a flue as is described above is to be determined by the following rule: Multiply the radius of the flue in inches by the pressure per square inch that it is desired to carry, and divide the product by the constant number 4,400. The quotient is the required thickness, in inches. "The thickness of lap-welded flues, however, shall in no case be *less* than the diameter of the flue multiplied by .022."

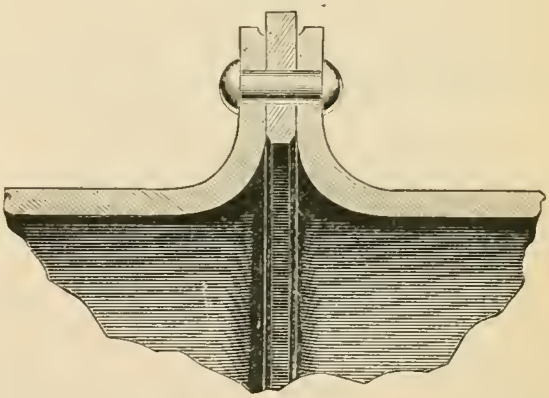


FIG. 1. — THE ADAMSON RING.

It is further provided by the Treasury department that "Lap-welded flues 7 inches and not over 16 inches in diameter, shall be made in lengths of not over three (3) feet, and fitted one into the other and substantially riveted; or in lieu thereof shall be corrugated to a depth of not less than three-fourths of an inch outwardly and at a distance of not over three feet between such corrugations: *Provided*, such corrugations are made without in any manner reducing the thickness of the material in the flue at the points of corrugation to less than the least thickness of the material in the body of the flue, or that such flues are made in sections of not over three (3) feet in length, and flanged to a width of not less than two (2) inches, and riveted substantially together with a wrought-iron ring [see the cut of the Adamson ring], having a thickness of material of not less than the thickness of material in the flues, and a width of not less than two (2) inches riveted between such flanges."

Flues whose diameter is more than 16 inches and less than 40 inches are separately considered. Of such flues it is required that they "shall be made in lengths of not over three (3) feet, fitted one into the other and substantially riveted; or flanged to a depth of not less than two (2) inches and riveted together with a good and substantial wrought-iron ring between each joint; and no such ring shall have a thickness of less than half an inch nor a width of less than two (2) inches." The steam pressure allowable on such flues is to be determined by the same rule as that given above for the smaller flues, *except* that in the place of the constant number 4,400 that is given above, we must use the constant number 2,840.

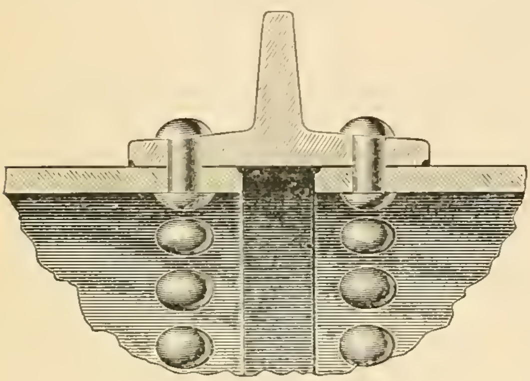


Fig. 2.— T-Iron Ring.

In the *Amended Steamboat Rules and Regulations* for 1892 there appears the following modification of the rule given above as applying to lap-riveted flues not over 16 inches in diameter: "But when such flues are used under a pressure of over 60 pounds and less than 120 pounds to the square inch, they may be made in sections of not over 5 feet in length and connected in the manner prescribed for sections 3 feet in length; and all lap-welded flues and tubes using 120 pounds of steam, and under, shall have a thickness of material of not less than the standard thickness. The following shall be the standard thickness of lap-welded flues and tubes from 1 to 16 inches in diameter using steam under 120 pounds to the square inch:

Outside Diameter.	Thickness.	Outside Diameter.	Thickness.	Outside Diameter.	Thickness.	Outside Diameter.	Thickness.
1 in.	.072 in.	2¾ in.	.109 in.	5 in.	.148 in.	12 in.	.229 in.
1¼	.072	3	.109	6	.165	13	.238
1½	.083	3¼	.120	7	.165	14	.248
1¾	.095	3½	.120	8	.165	15	.259
2	.095	3¾	.120	9	.180	16	.270
2¼	.095	4	.134	10	.203		
2½	.109	4½	.134	11	.220		

Although the foregoing regulations of the Treasury department relate to lap-welded flues, they would doubtless be also applied to rolled flues when used in the marine service, notwithstanding the fact that the rolled flue is somewhat stronger, on account of its more perfectly cylindrical shape. Rolled flues are used in land boilers to some extent in this country, and very generally in England and other parts of Europe. Until recent years it was not found practicable to roll them in lengths of more than three feet or so, and where they were fitted together at the ends, and riveted, the double thickness of metal at the joint served as a sort of stiffening ring, and unless the pressure to be carried was high, engineers did not consider it necessary to provide additional rings for securing the necessary stiffness and resistance to collapse.

The method of joining the sections of the flues that is referred to in the Treasury rules above given is illustrated in Fig. 1, which shows what is technically known as the "Adamson ring," from its having been first introduced by Mr. Adamson, in 1851. The ends of the sections are flanged outward, as shown, and are securely riveted together with a ring of wrought-iron or steel between. This ring, which should be not less than half an inch thick and not less than two inches wide, is caulked on the outer side of the joint, and, if the flue is large enough to admit of it, it is also caulked on the inside, as indicated in the cut. One of the important features of this joint is that both the flanges and the rivets are entirely protected by water. There is also no thickening of the flue by overlapping pieces, so that the joint is not likely to burn out. Mr. Adamson has submitted these flanged joints to severe experimental tests, which they withstood remarkably well. The only serious objection that has been urged against them is, that in case one of the segments of the flue should burn out, either on account of scale or for any other reason, it could not be replaced without removing the head of the boiler. This objection does not seem to us to have any great weight, because in many cases the flue comes so close to the shell that it is almost impossible to do a satisfactory job of riveting on any kind of a joint, without removing the flue from the boiler; and if there are projections of *any* sort upon it, it will be necessary, in removing the flue, to take out one of the heads.

Fig. 2 shows a method of uniting the parts of a built-up flue, which may be used with advantage in some cases, though we should prefer the Adamson joint shown in Fig. 1. Fig. 2 shows a ring of T-shaped wrought-iron, which is preferably made in one piece and shrunk on the ends of the segments to be united; though it may be made in halves, if necessary, the two parts being riveted firmly together when in position, by running straps along the web of the flange on both sides near the joint, and riveting through both straps and the web. When the flue is large enough to admit of it, the joint should be caulked both inside and out, as indicated in the cut. If the flue is too small for this, there is no necessity of having the abutting ends of the flue as far apart as they are shown in the cut. T-shaped wrought-iron rings, similar to that shown in the figure, and made in halves, are sometimes riveted directly to the flue, midway between the joints, when the flue, either through age, through increase of pressure, or through faulty design, requires more stiffening than the builder has given it. Rings of angle-iron are also used for this purpose.

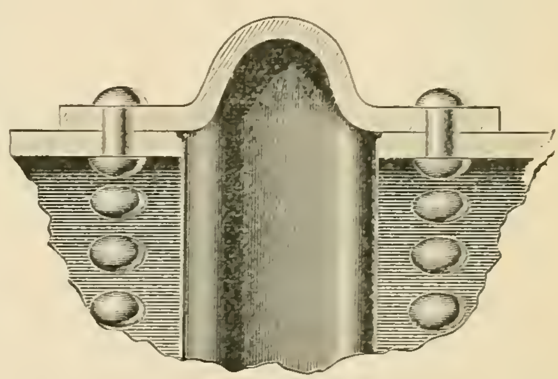
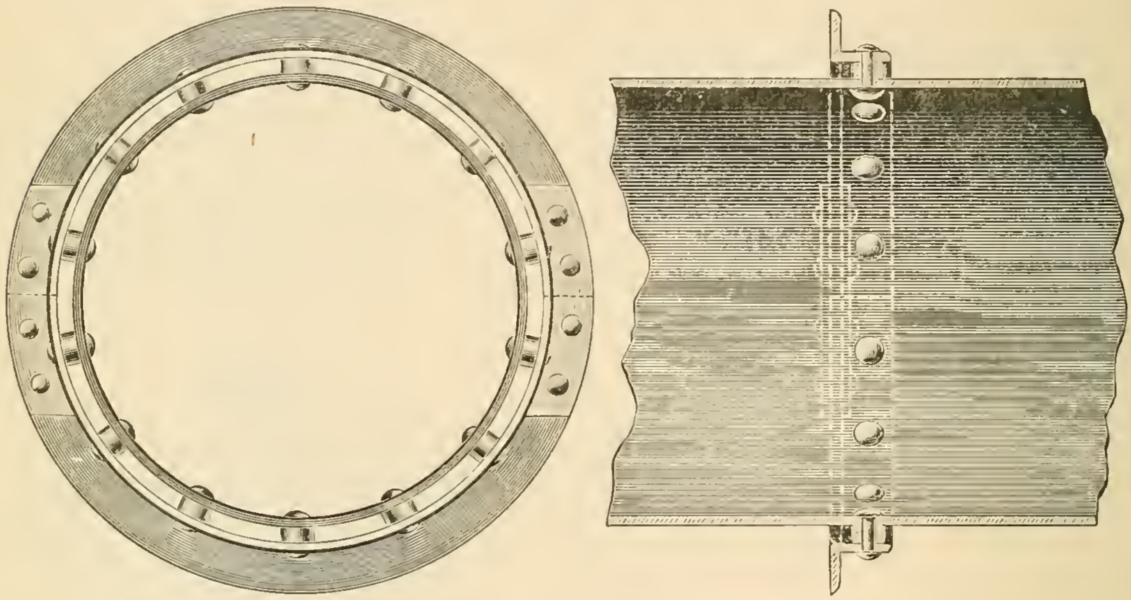


Fig. 3. — Steel Hoop.

Fig. 3 shows a ring of steel, hoop-shaped in section, which is sometimes used in building up flues in the place of the T-iron ring illustrated in Fig. 2. The advantage claimed for this form of joint is, that it has a certain amount of elasticity, and that it yields sufficiently to prevent any very severe strain from unequal expansion and contraction in the flue and boiler. This form of ring should be made in one piece and be shrunk on, and then riveted. It should be caulked on the outside, and on the inside also if the flue is large enough to admit of it.

At the present time, flues are rolled of all lengths up to 18 feet. If a longer boiler is required, 21 feet long for example, it is customary to use a rolled flue 18 feet long, pieced out with an additional section three feet in length. The joint where the flue sections come together gives stiffness enough, ordinarily, to prevent the collapse of the shorter segment; but the long section should be supported by some additional means.

Rings of angle-iron, or of T-iron like that shown in Fig. 2, may be riveted around the flue at intervals of from 3 to 5 feet, to give the necessary stiffness, or the device shown in Figs. 4 and 5 may be adopted. There is some liability to overheating when the angle-iron is riveted directly to the flue, yet this is often done without giving rise to any such trouble. The ring shown in Figs. 4 and 5 seems superior to the plain ring, however, because water can circulate freely between the rivets, cooling both the rivets and the flue, and greatly lessening the likelihood of overheating. It consists of a ring of angle-iron or U-iron, made in halves, with the ends riveted together by a double strap, as indicated in the cuts. There is a free space of about one inch between the ring and the flue, all around, and the two are kept apart by thimbles that are spaced 5 or 6 inches apart. The ring and the flue are secured to one another by rivets which pass through the thimbles, as shown, and are headed over inside of the flue and outside of



FIGS. 4 AND 5.—RING OF ANGLE-IRON, WITH THIMBLES.

the angle-iron or U-iron. These rings are used in England much more than in this country, because flue boilers are much more common there than here. It will be interesting, therefore, to quote the opinion of Mr. Henry Hiller, Chief Engineer of the National Boiler Insurance Company with regard to them, as he is thoroughly familiar with the best English practice. "The angle-iron," he says, "should not be less than 3 in. × 3 in. × $\frac{9}{16}$ in. The ferrules between the hoop and the plate should be about one inch thick [*i.e.* one inch long], and the rivets should be spaced about six inches apart. With the exception of the part that requires riveting over, the rivet should be as cool as possible when it is inserted, as otherwise the excessive contraction in so long a rivet will be likely to induce such a strain as to fracture the head. The ferrules should fit tightly between the hoop and the flue, and the rivets should fill the ferrules." These rings are made in halves, as explained above, and the ends of the halves are made to butt together, and are secured by securely riveting a double strap to the web of the ring where the joint comes, in the manner indicated in the cuts.

Mr. Hiller does not recommend this form of ring for new boilers, nor do we, unless there is some special reason for it. It is often serviceable, however, when the flues of a boiler were originally made too weak for the pressure it is desired to carry. For new work we strongly recommend Mr. Adamson's joint, shown in Fig. 1, or the steel hoop shown in Fig. 3. A few years ago a ferry-boat plying about New York city was built with rings of this sort around her flues, except that in place of the angle-iron shown in Figs. 4 and 5 half-round iron $2\frac{3}{4}$ inches wide and $1\frac{1}{2}$ inches high was used. The rings were placed along the flues at intervals of about 20 inches, and the rivets were spaced 8 inches apart. This stiffening proved insufficient, and a vast amount of trouble resulted. In our opinion the rings used in this case were much too small, and were weak in shape. The flue was 36 inches in diameter, and if this form of strengthening ring was to be used at all, a heavy ring of angle-iron should have been employed in the place of the weak, half-round strips. If we remember rightly the trouble was removed by the substitution of corrugated flues for the plain ones.

It may be well to say in this place that we do not approve of flue boilers, as a general rule. There seems to be no especial advantage in them, and they are inherently weaker than the tubular form. We believe that greater safety and economy, and more general satisfaction, can be had from tubular boilers than from any other form. Flue boilers are used in some parts of the country in saw-mills, where refuse is burned for fuel; and we have known the owners of these mills to object to tubular boilers because they *were* economical. It was necessary, they said, to burn all their refuse, and if the boiler wouldn't do it, it was necessary to have separate furnaces constructed for the purpose. Nowadays, when all things are put to use and the word "waste" is nearly obsolete, we seldom hear this objection urged.

There are other points that should be mentioned in connection with flues, and we shall return to the subject in a later issue.

The causes of the St. Gervais disaster are being gradually elucidated. A very interesting paper describing a visit to the small Téte-Rousse Glacier is contributed to *La Nature* (August 20) by M. Vallot, director of the new Mont Blanc Observatory. At the end of the glacier, on a steep face of rock, he and M. Delebuque found an enormous arching cavity, filled recently, it would appear, with ice which had been shot out by some internal force. They entered the cavern, and observed traces of an interior lake. A passage, strewn and overhung with blocks of ice, led up to an open space, a sort of huge crater, with walls of white ice, absolutely vertical. It was about 270 feet long and 133 feet broad and deep. M. Vallot and his friend returned by the way they entered, and examined this crater from above. Their opinion is that a lake had been formed at the bottom of the glacier, and the crater, gradually accumulating through obstruction of the orifice of outflow, had undermined the ice-crust over the upper cavity. This at length collapsed, exerting enormous pressure on the water, which pressure, transmitted to the lower grotto, burst the glacier, throwing out the anterior part on the steep rocky slope. Thus is explained the enormous quantity of water precipitated into the valley, carrying in its passage the soil of the banks, and forming a torrent of liquid mud mixed with ice blocks and rocks. M. Vallot estimates that about 100,000 cubic meters of water and 90,000 of ice issued from the glacier. On reaching the Baths the torrent may have been 300,000 cubic meters. He supposes that the sub-glacial lake may form again, and the remedy would be to blast the rocky bottom so as to provide an escape for the water; a work which should be done speedily to be of use. —*Nature.*

Inspectors' Report.

JULY, 1892.

During this month our inspectors made 5,887 inspection trips, visited 11,866 boilers, inspected 6,591 both internally and externally, and subjected 455 to hydrostatic pressure. The whole number of defects reported reached 11,352, of which 1,153 were considered dangerous; 45 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	998	57
Cases of incrustation and scale,	1,866	74
Cases of internal grooving,	83	15
Cases of internal corrosion,	524	34
Cases of external corrosion,	912	67
Broken and loose braces and stays,	157	58
Settings defective,	312	29
Furnaces out of shape,	453	26
Fractured plates,	234	44
Burned plates,	225	48
Blistered plates,	355	20
Cases of defective riveting,	1,437	29
Defective heads,	102	21
Serious leakage around tube ends,	2,075	443
Serious leakage at seams,	412	36
Defective water-gauges,	311	38
Defective blow-offs,	119	31
Cases of deficiency of water,	10	6
Safety-valves overloaded,	51	9
Safety-valves defective in construction,	58	19
Pressure-gauges defective,	569	45
Boilers without pressure-gauges,	4	4
Unclassified defects,	85	0
Total,	11,352	1,153

Boiler Explosions.

AUGUST, 1892.

PORTABLE BOILER (123). By the explosion of a portable boiler in Ohio City, near Van Wert, O., on August 1st, the fifteen-year-old son of John Butler was fatally scalded.

COAL WHARF (124). On Aug. 8th, a boiler in the engine room of Currier's coal wharf, off Merrimac St., Haverhill, Mass., exploded. Fragments were thrown high up in the air, and in landing crashed through and demolished the roof of an adjacent shed, and also wrecked one of the larger coal wagons housed in the shed. Dennis Brennan, the fireman, escaped with a few cuts on his face, but was terribly frightened.

SAW-MILL (125). By the explosion of a boiler in the saw-mill of Joseph and Jacob Eaton, in Middlecreek Township, Somerset Co., Pa., on Aug. 9th, William Payne and William Griffith, two of the off-bearers, were killed. The force of the explosion was tremendous. Large pieces of the boiler were found 400 feet away, and one tree three feet in diameter was cut down as neatly as it could be done with an axe.

Planing Mill (126). Shortly after six o'clock p. m., on Aug. 15th, just when the workmen had left for home, the boiler exploded in W. T. Winter's planing mill, on East Grove St., Bloomington, Ill. The upper part of the building was demolished, and the fire department was called out. Fortunately, it appears that nobody was hurt.

Saw-Mill (127). The boiler of the steam saw-mill owned by Joseph and Jacob Eaton, one and one-half miles west of Trent Post-office, near Johnstown, Pa., exploded on Aug. 16th, killing William Payne, one of the employes, and slightly injuring a number of other workmen.

Locomotive (128). A switch engine exploded on the Central road, on Wall St., Atlanta, Ga., between Broad and Whitehall streets, on Aug. 18th, injuring five people, namely: John Smith, engineer; J. T. Reynolds, fireman; G. W. Parrot, yard superintendent; John Hazlewood, switchman; and William Woodall, coupler. All the men were thrown some distance from the engine by the explosion, and all received severe scalds from the escaping steam and boiling water. Hazlewood, the switchman, was thrown sixty feet, and the engineer was wedged in his cab so that he had to be extricated by the hands on the wrecking train. The escape of all the men from instant death was marvelous.

Factory (129). William W. Higgins was killed on Aug. 19th by a boiler explosion in the factory of the Rittenhouse & Embree Co., corner of Thirty-Fifth and Tilman streets, Chicago, Ill. Higgins, who was the fireman, is said to have been an inexperienced man.

Thresher (130). On Aug. 20th, the boiler of a threshing machine exploded on a farm near Huntington, Ind., killing Oliver Scott, a farmer, and seriously, but not fatally, injuring his son.

Locomotive (131). Engineer James Blunderfield and Fireman Robert Carter were killed on August 21st by the explosion of a locomotive boiler on the Iron Mountain Railway. The accident occurred on a spur track leading to the bridge between Iowa and Virginia Avenues, Memphis, Tenn. The locomotive was wrecked, and fragments of it were scattered 500 yards about.

Saw-Mill (132). Mr. John R. Smedley, a prominent citizen of Harrison Township, near Chillicothe, O., was killed by a boiler explosion on Aug. 23d. Mr. Smedley had been operating a saw-mill in Harrison, and on the day mentioned the boiler burst with terrible force, completely demolishing the building.

Cotton Gin (133). The steam boiler running Mrs. S. A. Williams' gin in Brenham, Tex., exploded on Aug. 26th, tearing the machinery all to pieces, and causing a number of teams around the gin house to run away, demolishing several vehicles. There were some narrow escapes from serious injuries.

Steam Yacht (134). The boiler in the steam yacht of H. D. Sears exploded on Rock River, near Harlem Park, Rockford, Ill., on Aug. 27th, and the occupants, Mr. Sears, Mrs. Lawrence, and Mrs. George F. Penfield and child, were thrown out into the stream a distance of twenty feet. They were rescued by parties in small boats, but had a narrow escape from drowning. They were badly bruised also.

Electric Light Station (135). The boiler in the Electric Light Station at Brandon, Vt., exploded at 9.45 p. m., on Aug. 27th. Adolphus Germond, 50 years old, was instantly killed, and his son, Joseph Germond, the engineer, and Charles Hayles, the assistant engineer, were very badly injured. The noise of the explosion aroused the whole town. The village was in total darkness, and, for a time, there was almost a panic. The damage to property is estimated at $5,000.

Steamer (136). About seventy engineers of the New York, New Haven & Hartford Railroad, together with their firemen, were carried by the steamer *Messenger*, on Aug. 28th, from New Haven, Conn., to Lighthouse Point, for a clam bake. After the excursionists had left the steamer, she was taken to the dock of the Pequot Club, at Morris Cove, and while moored at that place a stop-valve failed, and Engineer Cyrus Stevens, who was in charge, was severely scalded. A tug carried the *Messenger* back to New Haven.

Power Station (137). Joseph Deisinger, a fireman, was killed in the power house of the Rapid Transit Company, on Boyd St., Newark, N. J., on Aug. 30th. The power house contains a battery of nine boilers, and it appears that the pipe connecting the north boiler with the steam main had been leaking, and that Deisinger and three other men had climbed up on the setting to caulk it. It is always dangerous to caulk joints when pressure is on, and in the present case the 8-inch pipe burst, and Deisinger received the steam from it full in the face. He was blown through a window, and probably died instantly. The other men were not hurt.

Steam Yacht (138). One of the tubes in the boiler of the steam yacht *Sappho*, owned by Henry Alexander, failed on Aug. 31st, while the vessel was lying at Sixtieth St., Brooklyn, N. Y. The engineer, George Rohder, and the fireman, John Walsh, were seriously injured by burns and scalds. Ambulance Surgeon McCann attended them and Walsh was taken to the Methodist Episcopal Hospital. Rohder went to his home.

The Loss of Heat from Steam Pipes.

In the September issue of The Locomotive a rule was given for computing the loss of heat from unprotected steam pipes, and the following example was given and solved: It is required to find the number of heat units that will be lost in one hour by a naked steam pipe one foot long and $2\frac{1}{32}$ inches in external diameter, the steam pressure in the pipe being 55 lbs. by the gauge, and the temperature of the surrounding air being 80° Fah. The result was found to be 333.8 heat units per hour.

This example was chosen because an experimental determination of the actual loss under similar conditions was available. In the *Transactions* of the American Society of Mechanical Engineers, fifth volume, page 73, there is a paper written by Prof. John M. Ordway, and presented to the society by Mr. C. J. H. Woodbury, entitled *Experiments upon Non-Conducting Coverings for Steam Pipes*, and it will be found that the fifty-first experiment therein described was made with a naked pipe, under conditions not greatly different from those assumed above. We learn by a personal letter from Mr. Woodbury, however, that the steam pressure in the experimental pipe was 60 lbs., and that the temperature of the air in the room was 68 degrees Fah. For the sake of accuracy it will be well to re-compute the loss of heat with these somewhat modified data.

The computation is as follows: Temperature corresponding to a pressure of 60 lbs. = 307°. Then

Temperature difference = 307° — 68° = 239°.

Radiation loss per hour by Newton's law =

0.614 (area) × .64 (see Table 1, in September issue) × 239 = 93.9 heat units.

Same reduced to conform with Dulong's law of radiation =

93.9 × 1.93 (see Table 2, in September issue) = 181.2 heat units per hour. This is the total loss of heat per hour by radiation. To find the total loss per hour by convection we proceed as follows :

Convection loss per hour, considered proportional to temperature difference, =

0.614 (area) × .693 (see Table 3, in September issue) × 239 = 101.7 heat units.

Same reduced to conform with Dulong's law of convection =

101.7 × 1.73 (see Table 4, in September issue) = 175.9 heat units per hour.

Then the total loss of heat per hour = loss by radiation + loss by convection =

181.2 + 175.9 = 357.1 heat units per hour.

On page 98 of the *Transactions* referred to above, it is stated that the actual observed loss of heat in the experiment with this pipe was such that, under the conditions we have assumed in making the computation, 181.0 grammes of steam was condensed per hour. Now 181.0 grammes is equal to about 0.399 of a pound, and one pound of steam at 60 lbs. gauge pressure, condensing into a pound of water at the corresponding temperature, gives out about 899 heat units. Therefore 0.399 of a pound would give out 0.399×899.=358.7 heat units per hour; and this must have been the amount of heat actually lost by the pipe in question during the experiment.

We are now in position to compare the results of experiment and calculation. We have —

Result of experiment = 358.7 heat units lost per hour.

Result of calculation = 357.1 heat units lost per hour.

The agreement between these results is surprisingly close, for the difference is less than half of one per cent., and everyone who has experimented with heat knows that discrepancies as large as ten per cent., or even twenty or thirty per cent., are often met with in problems of this character. The difference usually arises from the fact that it is impossible to take all the facts into consideration, so that certain assumptions have to be made, which are probably not accurately true. In the present case, we should consider the close agreement between the calculated and the experimental results to be, to a certain extent, accidental: it is not probable that the rule would apply to other examples with equal accuracy. Nevertheless, the present example should serve to give us some considerable degree of confidence in the rule, and to indicate the care with which Prof. Ordway's measures were executed.

In referring last month to the possible advent of the "two-minute bicyclist," we did not suppose him to be so near at hand. The ink on The Locomotive had hardly dried when word came that Johnson had covered a mile in the extraordinary time of 1 minute and 56⅘ seconds. Then came the news that he had ridden behind a running horse, and that he was protected from the wind by a shield of sail-cloth attached to the sulky. It was also said that he had ridden a wheel with an elliptical sprocket. No doubt these are what might be called "extenuating circumstances," and we cannot say to what extent they are responsible for the marvelous speed that Johnson developed. But whatever the judgment of experts may be with respect to the merits of the record, it seems to be the opinion of competent and disinterested mechanics that the elliptical sprocket will hereafter abide with us.

The Locomotive.

HARTFORD, OCTOBER 15, 1892.

J. M. Allen, *Editor*. A. D. Risteen, *Associate Editor*.

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We read in a local paper that "the Bourse was depressed yesterday owing to Professor Koch's pessimistic cholera views. The Professor believes there will be a recrudescence of cholera in the spring." Whew! We had feared that it might break out again, but we hadn't supposed it would be "recrudescent."

As the steamer *Mont Blanc*, plying on Lake Geneva, Switzerland, was lying at her pier at Ouchy, on July 9th, her boiler exploded, and nineteen of those on board were killed, and many others were injured. The victims were chiefly English and French visitors, and women and children.

The report for 1891 of the chief engineer of the Engine, Boiler, and Employers' Liability Insurance Company of Manchester, Eng., is at hand. It contains an exhaustive descriptive list of the casualties during the year in the company's field of business, and also an extensive account of some evaporative trials made upon three-flued Lancashire boilers.

Discipline. — The true soldier obeys orders faithfully, no matter at what sacrifice. A company of a British regiment was once sent on some duty, in time of peace, to a remote village in Ireland, and left there for several weeks, quite separated from its usual base of supplies. During this period some general orders, applicable more especially to men in barracks, were sent to the commander of the company. One clause of those orders was as follows:

"All men in the command shall change their shirts at least twice a week."

The captain gave orders to the orderly sergeant to see this command put into execution.

"But, captain," said the sergeant, "there's only a shirt apiece to every man in the company. How can they — "

"Silence!" exclaimed the captain; "orders are orders, sergeant. Let the men change shirts with one another."

So the sergeant saw to it that, as long as the company remained in the place, on every Sunday and Wednesday morning the soldiers swapped shirts one with another.

— *Youth's Companion.*

The Midvale Steel Company have issued the third of their serial illustrations of remarkable steel castings made by them. The subject of the present illustration is a roller path for an eight-inch disappearing gun carriage, made for the United States army. The casting, as shipped, weighed 7,995 pounds, or practically four tons. The specifications called for a tensile strength of 65,000 lbs., and an elongation of 20 per cent. The official test of the casting showed a tensile strength of 73,000 lbs., an elastic limit of 35,500 lbs., an elongation of 33.2 per cent., and a reduction of area of 47.18 per cent.

Twenty-Five Years.

The Hartford Steam Boiler Inspection and Insurance Company passed the 25th anniversary of its active existence on the 1st of October. The Company secured its Charter from the Connecticut Legislature, at the May session of 1866. The Company was the outcome of a conference among manufacturers of Connecticut, Massachusetts, and Rhode Island, the object being to form a corporation that should primarily devote its time and energies to the inspection of steam boilers, and guarantee the same from explosion: also to study the causes of boiler explosions and the best methods of preventing the same. It was further intended that the Company should investigate the different types of boilers, and especially boiler construction, with reference to safety and economy, so that its patrons could secure the information bearing upon these points that would be of benefit to them in connection with their own steam plants. The Company was organized in October, 1866. The presidency was then tendered to Mr. J. M. Allen, but other engagements made it impossible for him to accept the position. Mr. E. C. Roberts was elected president, and H. H. Hayden, who had been active in the organization of the company, was elected secretary. Very little was done the first year, and before its close Mr. Roberts resigned the presidency. In September, 1867, the office of president was again tendered to Mr. J. M. Allen, and on the 16th of that month he was elected to the office and accepted. Mr. Allen entered upon his active duties October 1, 1867. The field was a new one. No such company had before been thought of in the country. Its growth was slow, and a good deal of missionary work was necessary to convince steam users that such a company was needed. The officers rigidly adhered to the principles originally set forth, laying a broad foundation for the future superstructure. Statistics of boiler explosions were gathered and their causes carefully studied. As the company's field of operations was extended, comparative tests of the efficiency of boilers of various types and construction were made, also the plan of properly setting boilers with a view to securing safety and economy was investigated. Early in the Company's history its monthly periodical, the Locomotive, was started. In this was given the results of the Company's investigations, and also much practical information obtained from the Company's daily work. This paper grew rapidly in favor until at the present time its monthly issue is 25,000. The company has devoted its efforts to the one business of improving the construction, care, and management of steam boilers. It has from time to time added new departments in order to keep fully to the front of the rapid progress in the use of steam power. It has a draughting-room and a well equipped chemical laboratory. Plans are being constantly made for new boiler plants, and some of the largest and best equipped plants in the country have been erected under its supervision. Water is analyzed with reference to its fitness for use in boilers, and advice is given in regard to the treatment of water carrying troublesome ingredients in solution, in localities where a good water cannot be easily obtained. The improvements in the steam engine, compound and triple expansion, have made high pressures necessary. This problem has been carefully studied. The strength of riveted joints has received special attention; and the joints recommended by the company have been subjected to careful tests, and their calculations of the strength fully maintained.

This, then, in brief, is the work in which the company has been engaged during the past twenty-five years. The field is not covered yet. There are questions arising daily bearing upon safety and economy, and these questions will arise so long as steam power is used. As stated above, the company has adhered strictly to one class of business. We regard it as a business that cannot be treated lightly nor subordinated to various other kinds of business. The proper arrangement and care of the motive power of a manufacturing establishment is all important. In these days of competition and narrow margins, the manufacturer must have the best machinery and the most economical steam plant.

While we stand to-day for a moment and look back over the twenty-five years of our history, we see much to encourage us in our start on the new quarter of a century, and we set our face to the future with the firm determination to follow in the same lines of investigation that have brought the company to its present position of strength and influence.

In January, 1869, Theodore H. Babcock succeeded H. H. Hayden as secretary. He held this position until February, 1873, when he was appointed manager of the Company's New York department, where he still remains. Mr. J. B. Pierce, the present secretary, was elected in February, 1873. The present officers of the company are: President, J. M. Allen; Vice-President, Wm. B. Franklin; 2d Vice-President, Francis B. Allen; Secretary and Treasurer, J. B. Pierce.

President Allen's 25th Anniversary.

Mr. J. M. Allen was elected President of this company on September 16, 1867, and on the sixteenth day of last month he was pleasantly reminded of this fact. Mr. Allen had been spending his vacation at Falmouth Heights, Mass., and was to return to Hartford after spending a few days in Boston. On the day mentioned, however, he received a telephone message calling for his immediate presence in this city, to meet Mr. R. K. McMurray, Chief Inspector of our New York department, who, it was explained, desired to see him at once, presumably for urgent business reasons. Nothing was said with regard to the nature of the business, but the call was of such a nature that Mr. Allen was not entirely free from a feeling of apprehension lest some unforeseen calamity had befallen the company. The event proved that, although the "business" was hardly of a calamitous nature, it *was* truly unforeseen and unprovided for, at least so far as President Allen was personally concerned.

Mr. Allen returned to Hartford at once, on the limited express that reaches this city at 7.10 p. m., and as he alighted at his residence he was surprised, for a moment, to find it all lighted up. Then he thought that probably the servants had planned to make things cheerful for him on his return. When he entered the house, however, he saw Mr. Theodore H. Babcock, Manager of the Company's New York department, awaiting him in the parlor, and as he removed his hat and coat his eye caught Mr. McMurray, and when he entered the room, behold! there were also Messrs. Corbin & Goodrich of the Philadelphia office, and Mr. J. B. Pierce, secretary of the company! Surely, nothing less than a dozen losses could call together such an ominous gathering of officials! When he entered the room all the gentlemen present arose, shook hands with him, and expressed the hope that he was well, and that his vacation had been a pleasant one. (How skillfully they were preparing him for the discouraging news!) Then the visitors seated themselves again, Mr. Babcock alone remaining standing. Mr. Babcock then formally addressed Mr. Allen, referring to him as founder of the company, and stating that the records showed that "on that very night he had completed twenty-five years as president, having been elected to that position on September 16, 1867, although he did not assume the active duties of the office until the first day of the following October." Continuing, Mr. Babcock said that the officers, general agents, agents, chief inspectors, clerks, and other employes of the company all over the country had deemed the silver anniversary of Mr. Allen's presidency an appropriate time to testify to the universal esteem with which they regard him.

Mr. Allen replied in fitting terms, expressing his grateful appreciation of the sentiments that had been expressed, and Mr. Babcock then drew aside the portieres that had separated the parlors, and exhibited the gifts that the visiting committee had brought. The largest was a handsome mahogany case, about 30 inches long, 18 inches high, and 15 inches deep, containing a silver tea service, gold lined, with a large salver, and complete sets of dinner, dessert, and tea cutlery and spoons, also of silver. In a separate case of plush were a number of special pieces — pie knives, a salad fork and spoon, and other articles, the purpose of which the present writer cannot describe with any degree of confidence. The entire present consists of 101 pieces of choicest workmanship and exquisite design. In the center of the salver the monogram, "J. M. A.," is engraved in ribbon type, and each piece of the silver service bears the initial "A." A plate on the front of the case bears the following inscription :

1867. 1892.

Presented to J. M. Allen,

By Officers, Agents, Inspectors, and Employes

of the

Hartford Steam Boiler Inspection and Insurance Company.

Accompanying the silver service was an album, which Mr. Allen prizes highly. It contains photographs and autograph tributes of friendship and esteem from nearly fifty officials of the company. It is of blue Russia leather, lined with white satin. In the center of the outside cover is the monogram, "J. M. A.," in silver letters, interwoven with "25," and at the corners are designs in silver with the dates, "Sept. 16, '67," and "Sept. 16, '92," respectively. The album was made by Messrs. Tiffany & Co., of New York.

The first page of the album contains a cabinet photograph of Mr. Allen and a magnificently engrossed address in illuminated text, illustrated with pictures of a boiler, a locomotive, a steam valve, a gauge, and a gauge tester, and other things symbolic of the company's business. The address is as follows:

September 16, 1892.

To Mr. J. M. Allen: —

Your associates and officers, general and special agents, chief inspectors and inspectors of the Hartford Steam Boiler Inspection and Insurance Company, call to mind that this day marks the completion of twenty-five years of your presidency of the company. Reviewing the pleasant intercourse between you and themselves, it is deemed appropriate that, at this time, they should manifest the deep-seated friendship with which they regard you, as well as to congratulate you, through the undersigned, upon the splendid results obtained by your untiring efforts, deep devotion, skill, and kindly bearing in lines which, as pioneer, you have laid out and with which you have led, while we have followed.

That you may have ever in sight a more lasting token of their esteem and good will, we have been commissioned to present on their behalf, the silver service which this volume of kindly words accompanies.

H. D. P. Bigelow,
Corbin & Goodrich, } *Committee.*
Theodore H. Babcock,

R. K. McMurray, *Treasurer.*

In addition to the testimonials described above, Mr. Allen received many telegrams of congratulation, and he feels deeply the assurances of good will and esteem from his associates in the company. It seems proper to add that although considerable time was occupied in making the necessary preparations, and a large amount of correspondence was necessary, the entire affair was so well planned and so skillfully executed that Mr. Allen had not the least suspicion of the whole treacherous plot. (A very good account of the presentation will be found in the Hartford *Courant* of September 22d.)

Each of the men who are represented in the album will receive a cabinet photograph of President Allen, together with an 8×10 photograph of the silver service; and a copy of the following letter of acknowledgment, printed in silver letters on a white ground, will also be sent to every one who contributed towards the gift:

Hartford, Oct. 1st, 1892.

To Messrs. H. D. P. Bigelow, Theo. H. Babcock, Corbin & Goodrich, R. K. McMurray, and those whom you represent as contributors to the elegant testimonial presented to me on the 16th of September, the 25th anniversary of my election to the Presidency of the Hartford Steam Boiler Inspection and Insurance Company, I desire to express my deep appreciation of your confidence and respect, and my sincere thanks for such distinguished consideration. The splendid and beautiful Silver Service is in itself a princely gift. Nothing could be more artistic and chaste in design and finish and certainly nothing more befitting the occasion. But in addition to this, the sentiment that lies back of it, so kindly and feelingly set forth in the priceless album of photographs and personal letters, makes the whole a rich and invaluable possession. These faces and letters call up many reminiscences of earlier years — years of hopes and disappointments, failure and success, until a foundation was laid upon which a superstructure could be erected that should ultimately rank high among the mechanical and insurance enterprises of our land. This gratifying result has been achieved largely through the aid of earnest, energetic, and loyal associates, and to them a due share of the credit belongs. I am proud of my associates, proud of their friendship and esteem, and as we enter on a new quarter century I could wish that we might go on in an unbroken line to its end. But that is impossible, for there are set bounds for each of us, and ere another twenty-five years is completed, some of us will have dropped out of the ranks. But that probability should not relax effort while life and health continue. There is yet much to be done in enlarging the field of our operations, and with the same harmonious action that has characterized the past, the Hartford Steam Boiler Inspection and Insurance Company shall stand higher, and its influence be wider than ever before. With sentiments of high esteem, I remain, gentlemen,

Sincerely yours, J. M. Allen.

The Death Valley Monster.

That marvelous monster which was seen in the Death Valley Desert, about twenty miles from Daggett, by E. W. Spear and Henry Brown of Daggett, at separate times while out on prospecting trips, has occasioned a wonderful interest in scientific circles, especially those who have made paleontological research. Oscar W. Clark, who saw this gigantic monster, has sent the result of his experiences to the Smithsonian Institution with a view to having a party sent here to endeavor to capture the monster.

"The announcement of the experiences of Messrs. Spear and Brown rather anticipated me," said Mr. Clark. "This animal is the most wonderful living proof of the exact authenticity of the researches made by savans into the field of paleontological study.

"This animal is really the only living link between prehistoric times and the present. It is virtually a marvel of the ages, an eighth wonder of the world, a marvelous illustration of the profound economy of nature. It was six weeks ago that I had the pleasure of seeing this remarkable animal. I was some thirty miles distant from Daggett, and stopped at 6 o'clock in the evening to rest, having made some valuable additions to my collection of fossil remains.

"Happening to glance to the southwest through the haze peculiar to the desert, I saw a strange body moving along about one mile away. I went toward it and was soon both elated and horrified by seeing an animal fully thirty feet long that differed from any of the known forms of the present epoch. It was an immense monster, walking part of the time on its hind feet, and at times dragging itself through the sand and leaving tracks of a three-toed foot and a peculiar scratchy configuration in the sand whenever it changed its form of locomotion and dragged itself. The fore limbs of the animal were very short, and it occasionally grasped the nearest shrub and devoured it. The thumb of the three-pronged forefoot was evidently a strong conical spine that would be a dangerous weapon of attack. Whenever the animal stood upright it was fully fourteen feet high. The head was as large as a good-sized cask and it was shaped like a horse, while the body was as large as that of an elephant, with a long tail extending from the hindquarters something like that of an alligator. When I saw it, the strange animal was on the edge of a great sink hole of alkaline water — a sink hole, by the way, that my guides told me was a bottomless pit, and evidently a remnant of the days when Death Valley was an inland sea. I approached within 300 yards of the monster, crawling cautiously over the sand, and watched it for fully half an hour. Suddenly the beast began to bellow, and the sound was of a most terrifying and blood-curdling character. Its immense eyes, fully as large as saucers, projected from the head and gleamed with a wild and ferocious fire, while from the enormous mouth of the monster streams of steamlike vapor were exhaled, and, as they drifted toward one, the effluvia were something awful. The animal was liver color, with bronze-like spots. The monster dragged itself to the edge of the sink hole and lashed its tail, and finally fell off into a quiescent condition. I left the scene and attempted to secure the assistance of my guides in an effort to capture the monster, but they were absolutely terrified and refused to do anything.

"From what I saw of the animal I am perfectly satisfied that it is one of the species of the iguanodon bennissantensis of the European Jurassic, an animal presenting many points of structure in common with the iguana of to-day. In fact, that is the report I have sent in, and knowing full well the geological environments of the Pacific Slope and the very remarkable and peculiar conditions regarding the Death Valley section, I am satisfied that my deductions are correct, and that there is to-day living in the desert of Death Valley one of the most remarkable animals now on the face of the globe, none other than one of the monsters of the prehistoric epoch — a wonder of the centuries."— *Manchester (N. H.) Saturday Telegram.*

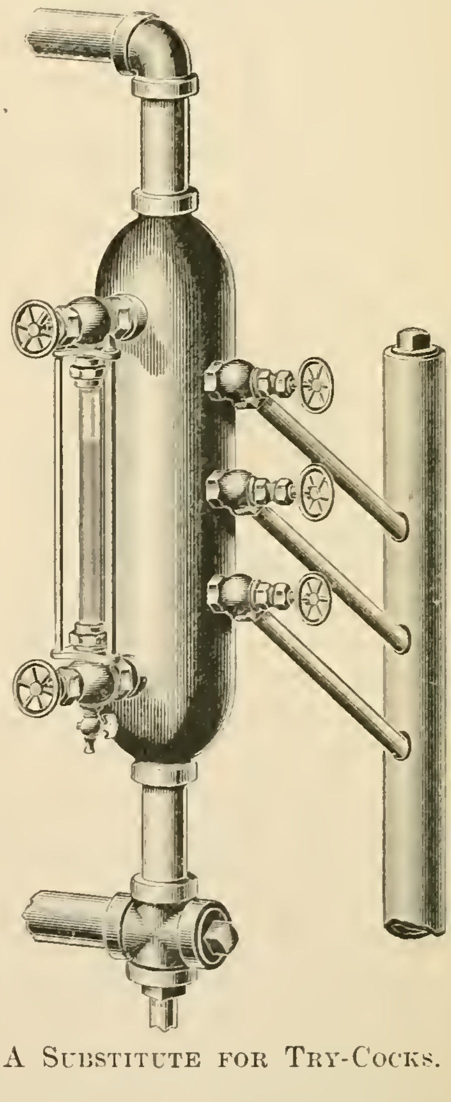
The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

NEW SERIES—VOL. XIII. HARTFORD, CONN., NOVEMBER, 1892. No. 11.

Concerning Try-Cocks.

Try-cocks are important things, and should be so designed and arranged that they can be used with facility, and without the inconveniences and annoyances that they ordinarily give rise to. As they are usually made, they are apt to leak continually. This in itself is a sufficient annoyance to call for some remedy, and the remedy that is too often applied is to stop up each leaking one by driving a pine plug into it. The wooden handles with which they are provided crack under the influence of the heat and moisture to which they are subjected, and eventually fall off, so that the fireman has to use a pipe-wrench, perhaps, to open them. Even when they are in good condition, and the fireman tries them faithfully, he is probably rewarded by seeing a voluminous spray of mud blown all over his boiler-front; for mud will collect in the connections, even if there is none elsewhere. This trouble is avoided, in some places, by providing a copper waste-pipe, which receives the discharge from the try-cocks through small funnels brazed into it on the upper side. Such an arrangement proves very effective and satisfactory when the try-cocks are connected directly with the boiler, but when a water-column is used, and the cocks are directly over one another, it is not easy to arrange such a waste-pipe so that it shall be effective without being unsightly.



A SUBSTITUTE FOR TRY-COCKS.

The lead or composition seats with which try-cocks are usually provided soften up under the influence of the heat to which they are subjected, especially when high pressures are used; and the fireman, in attempting to close the cocks tightly enough to prevent leakage, often jams the seats out of shape. Part of the seat is forced into the steam opening, forming a nipple, which greatly obstructs the flow of steam. In some cases these nipples are of such length that it becomes necessary to turn the cock till it nearly comes out of the thread before steam will blow through it freely. It is true that the seats can be replaced, but this will usually have to be done on Sunday or a holiday, when the plumber's irons are cold. Moreover, it requires some time and patience to tin the recess for the filling and get a good job.

Another very annoying trouble is frequently experienced. Owing to the smallness of the nozzles of the cocks (usually about $\frac{5}{32}$ or $\frac{3}{16}$ of an inch), a slight deposit in them of scale or other similar substance will materially check the free flow of steam that should take place. The stems are usually not packed, and the threads are apt to fit loosely. The result of these various circumstances is that when the fireman opens the cock a spray of hot and muddy water blows out through the loose thread, and he receives it, perhaps, in his sleeve. At all events, he finds it unpleasant to use such try-cocks, and the result is apt to be that he trusts implicitly in the glass gauge, and leaves the try-cocks to themselves, plugged up, perhaps, to keep them from leaking.

There seems to be no good reason why $\frac{3}{8}$-inch or $\frac{1}{2}$-inch angle valves may not be used in the place of the conventional try-cock, for there are many advantages in such an arrangement, and there is practically no difference in the expense. The cut shows one way in which this idea may be carried out in practice. The angle valves are merely substituted for the ordinary cocks, and nipples, running off at an angle, are screwed into them. A two-inch waste-pipe (shown in the cut on the right) may receive the ends of the nipples, provided the fireman is a man of sufficient experience and intelligence to know the difference between steam and water by the sound it makes, *but we should neither advise nor approve of the use of such a waste-pipe in average practice.* In most cases we should advise that the nipples from the angle-valves should open freely into the air.

By the use of angle-valves many of the annoyances incident to the common try-cock can be avoided. The stems of the valves can be kept packed, so that no trouble from leakage in this direction need be feared. A small deposit of scale makes but little difference in the efficiency of the arrangement, on account of the enlarged area of discharge; and if a troublesome deposit should collect, the bonnet of the valve may be removed, and the pipe, being of conveniently large size, can be cleaned out by a small rod or a stout wire. Another point of material advantage in the proposed arrangement is that the seats of the angle valves can be easily removed and replaced by new ones in a few minutes, so that the valves can be kept tight. (It is true that these small valves usually have solid seats, but they can be had with removable seats, if desired.) Under these conditions there will be no temptation to the fireman to neglect the try-cocks.

There is one objection to the use of angle valves that should be considered, though it does not appear to us to be very weighty. In removing and replacing the bonnet of the valve the fireman is apt to use too large a wrench, and to screw the bonnet up with more force than is necessary. The result is apt to be that, after removing and replacing it a few times, the hexagonal nut becomes sheared all out of form, so that it is neither hexagonal, nor square, nor round, nor any other particular shape. Then he is apt to call loudly for a new valve. This has been the experience of some few of those who have used angle valves as suggested above, but we think this trouble can be avoided by a few words of caution to the fireman.

We may mention, in this connection, another point that applies equally to angle valves and try-cocks. The tendency in these days is very noticeably towards the use of higher steam pressures than have been used in the past, and along with the higher pressures we must necessarily have higher temperatures to contend with. Thus saturated steam of 60 pounds pressure has a temperature of 307° Fah., while steam of 100 pounds has a temperature of about 338°, and at 125 pounds its temperature becomes 353°. Many alloys that will resist a temperature of 307° for long periods of time soften up so much at 340° or 350° that they soon become unfit for use as valve-seats. In such cases it is found that pure, soft copper can be substituted for the more fusible metals with good results.

Inspectors' Report.

August, 1892.

During this month our inspectors made 5,610 inspection trips, visited 11,066 boilers, inspected 4,708 both internally and externally, and subjected 779 to hydrostatic pressure. The whole number of defects reported reached 9,619, of which 908 were considered dangerous; 37 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	690	48
Cases of incrustation and scale,	1,330	61
Cases of internal grooving,	55	12
Cases of internal corrosion,	392	36
Cases of external corrosion,	589	51
Broken and loose braces and stays,	125	29
Settings defective,	258	18
Furnaces out of shape,	359	23
Fractured plates,	178	43
Burned plates,	198	28
Blistered plates,	249	13
Cases of defective riveting,	2,069	155
Defective heads,	72	12
Serious leakage around tube ends,	1,593	170
Serious leakage at seams,	327	16
Defective water-gauges,	346	68
Defective blow-offs,	120	30
Cases of deficiency of water,	10	4
Safety-valves overloaded,	60	20
Safety-valves defective in construction,	75	21
Pressure-gauges defective,	421	44
Boilers without pressure-gauges,	6	6
Unclassified defects,	97	0
Total,	9,619	908

It appears from the latest calculations by Prof. Boss that we shall miss a collision with the new comet by about eight hours — that is, we shall pass the comet's node on Nov. 27, eight hours before the comet gets there. The apparent motion of the comet since its discovery has been so slight, however, that it is not yet possible to compute a good orbit of this hazy visitor from space. When the time comes, we shall probably find that we give it a wider berth than the present calculations indicate.

Boiler Explosions.

SEPTEMBER, 1892.

SAW-MILL (139). On Sept. 2d a boiler exploded in William Lieshman's saw-mill on Black's Fork river, Utah, near Evanston, Wyoming. Tom Scott, engineer, was killed and badly mutilated. Miss Jennie Leishman, daughter of the proprietor, was just coming out of the boiler-room with some hot water at the time of the explosion. She was killed almost instantly. William Dawer, who was in the log yard, sixty feet away, had one leg crushed and one arm broken. He died later in the day.

SAW-MILL (140). A boiler exploded on Sept. 3d in A. F. Page's saw-mill, near Aberdeen, Moore Co., N. C. The building was torn to pieces, and Robert Adams was instantly killed. Another employe was seriously and perhaps fatally scalded.

STEAM YACHT (141). As Mr. E. S. Noble and wife, B. F. Davis and wife, Sam B. Owen and wife, S. H. Nelson and wife, Miss Farrand, and Miss Minnie Noble, of Detroit, were leaving the dock at Elk Rapids, Mich., on Sept. 4th, for a trip up Elk Lake, the boiler of Noble's steam yacht *Cora* exploded, tearing the machinery to pieces, breaking one of Mr. Noble's legs, and cutting the other one considerably. Miss Farrand was injured slightly, being burned by escaping steam, and receiving a slight cut. Mr. Owen was burned and cut on the left arm. The rest of the party were uninjured. It was fortunate they did not reach the lake before the explosion, or they would all have been drowned.

PAPER MILL (142). On Sept. 5th a flue collapsed in one of the boilers in the Massillon paper mill, Massillon, Ohio. The entire front of the boiler-room was blown out, but nobody was hurt.

LOCOMOTIVE (143). On Sept. 5th a locomotive blew up near Hollister, Cal., on the Cienega Motor Railroad. The engine left Tres Pinos Sunday afternoon, and had gone but a few miles when it was found necessary to stop and make repairs. J. J. Burt, the owner of the road, was on board. He instructed the engineer to make the necessary repairs and to proceed to the lime kiln early Monday morning. Instead of obeying instructions the engineer concluded to run at night, and feeling somewhat indisposed turned the engine over to the fireman. At the time of the explosion the engine was at a watering station, and the engineer was lying down, some distance away, so that he escaped injury. The fireman, W. H. Maynard, was not so fortunate; he was thrown a great distance, and instantly killed. "The boiler was blown to atoms," says the account, "and not a particle of it could be found in the immediate vicinity of the explosion."

SAW-MILL (144). A fatal boiler explosion occurred on Sept. 7th in Salters & Kelner's saw-mill, about four miles west of Bessemer, Ala. James Salters, Jacent Waldrop, and Hiram Taylor were killed outright, and Kirk Franklin, the only other man about the mill, was injured so badly that he died during the night.

SAW-MILL (145). The boiler in Joel Mullen's large saw-mill, at Ashland, four miles east of New Castle, Ind., was demolished by a boiler explosion on Sept. 8th. Several workmen were standing near the engine, when suddenly the boiler let go, and the mill was torn to pieces, and three men were buried under the débris, badly scalded. One of the workmen, named Frank Williams, was scalded about the face almost beyond recognition, while his arms and legs were terribly burned.

Cotton Gin (146). Mr. Charles Miller, a young man about eighteen years old, a son of Mr. J. R. Miller, was instantly killed on Sept. 15th, by the explosion of the boiler of an engine used for running a cotton gin on Mr. S. T. Hurst's plantation, about five miles west of Perry, Ga. Mr. J. R. Miller, the father, and a negro man were near the boiler when the explosion occurred, and their escape from death was almost miraculous. Both were injured. Mr. Miller being scalded and his leg being broken, while the negro received a slight wound in the head.

Lumber Mill (147). Two 40-horse-power boilers exploded in the Clatsop lumber mill, Astoria, Oregon, on Sept. 17th, fatally scalding and bruising David Campbell, and severely but probably not fatally injuring George Ralston and Thomas Eccles. The entire west end of the mill was destroyed, and considerable débris was blown into the bay, several large fragments narrowly missing the steamer *Tonquin*. Fragments of the exploded boilers were scattered about, many of them being only a foot or two long. The Clatsop mill is one of the oldest and largest on the coast. The property loss was estimated to lie between $15,000 and $20,000. It is said the company will not rebuild in Astoria, but may do so in Flavel.

Stave Mill (148). A terrible boiler explosion occurred on Sept. 17th in Force & Dickinson's stave mill at Staples, a small village on the Leamington & St. Clair Railroad, four miles from Comber, Ont. John Ewing, Michael Dupuis, Joseph Papineau, Isaiah Chauvin, and his brother, Jerome Chauvin, Peter Daust, and Moise Ouillette, were instantly killed, and Zachariah Boone was fatally scalded and otherwise injured. Robert Sophie, Albert Shelson, John Riley, V. Tassier, Chris Riberdie, Nicholas Chauvin, and his youngest son, Charles, and a man named McGilles, were badly hurt.

Dye House (149). On Sept. 17th a boiler exploded in Mrs. A. J. Pyle's dyeing establishment, on Fifth Street, between Broad and Marshal, in the city of Richmond, Va. The boiler went up through the roof of the building and fell into Sixth Street. There was great excitement in the neighborhood, but fortunately nobody was hurt.

Cotton Gin (150). The boiler of a cotton gin exploded on Sept. 20th on a plantation nine miles north of Comanche, Tex., killing a young man named Ray, and probably fatally injuring another by the name of Ross.

Saw-Mill (151). A boiler exploded in Allen Miller's saw-mill, on Flat Lick, near Somerset, Ky., on Sept. 20th. Pleasant Whitson, the fireman, was killed instantly, and Sol Randall, George Whitson, William Randall, Allen Miller, and a man named Gragg, were badly injured, some of them fatally so. The saw-mill yard was swept as clean as a kitchen floor, and the explosion was heard for several miles.

Threshing Engine (152). On September 20th, a threshing engine boiler on the farm of Martin Miner, eleven miles east of Walla Walla, Wash., exploded, killing one man and wounding four others, two seriously. The dead man is C. Wickersham, the engineer, who was struck in the head by a piece of the boiler, and instantly killed. Ambrose Rainey, the fireman, was badly scalded on the front part of his body and face, and his left leg was broken near the knee. It is thought that he will die. A man named Eggers was struck by a piece of the boiler and his left arm was fractured, the bone being crushed and driven through the flesh, necessitating amputation. He will probably recover. Two other men were only slightly injured. There were about twenty men working near the engine when the explosion occurred. Rainey, who was just stoking the furnace, was thrown over fifty feet.

LOCOMOTIVE (153). In Baldwin County, across the bay from Mobile, Ala., a locomotive on the Loxley Logging Railroad, blew out its crown sheet on September 22d. The locomotive was thrown from the track, and the log train of eight cars ran down a grade for a mile until the level was reached. There were five men in the cab of the locomotive at the time of the explosion, and all were terribly scalded, two probably fatally. The victims are Rufus Dunham, engineer, severely scalded; Charles Grubber, dangerously scalded, will probably die; Duncan Orrid, severely hurt by wreckage of locomotive; Samuel Little, probably fatally scalded; James Roberts, severely scalded.

CANNING FACTORY (154). The boiler in J. W. Carson's canning factory, Clayton, Del., exploded on September 22d, fatally injuring one man and severely injuring several others. The injured were Oliver Brown, engineer, of Havre de Grace, Md., terribly scalded, and taken to Wilmington, Del., where he died; Jacob Keathley, Harford County, Md., badly scalded and both legs and left hip broken; J. C. Garner, scalded about face and arms; Mrs. Thomas Timms, Mrs. J. W. Ennis, Miss Clark, J. W. Carson, and Levi Ransom, slightly scalded. The boiler was a small upright one, and the crown sheet probably gave way. The upper section of the boiler was blown straight up through the roof of the building and fell in a field across the road, nearly one hundred feet from the factory. The roof of the building was badly wrecked. There were between eighty and one hundred people at work in the building when the explosion occurred, the most of whom were women and children. Some of these people were very close to the boiler, but escaped unhurt. This could hardly have occurred if the boiler had not gone straight up through the roof. At the inquest held over Mr. Brown's body, the jury returned the following verdict: "*Resolved*, That Oliver Brown came to his death by the explosion of a boiler in the canning factory of John W. Carson & Co., at Clayton, Del., on Thursday, Sept. 22, 1892, and from the evidence, this jury censures the firm for not employing a practical inspector to inspect the boiler."

THRESHING MACHINE (155). Mr. Davering's threshing-machine boiler blew up on September 23d, in Spanishtown, San Mateo Co., Cal., seriously injuring James Lodge and John Roach.

LOCOMOTIVE (156). On September 26th, the boiler of locomotive No. 5, of the Tennessee Coal, Iron & Railroad Co., exploded at shaft No. 3, in Coalberg, near Birmingham, Ala. The locomotive was torn to pieces and Engineer John Elmore was killed outright, while the fireman, Ben Garner, was injured so severely that he died in a short time. Sam Estes, John Kelly, and conductor W. R. Lambert were also seriously injured. The locomotive was only three years old, and was considered one of the best on the road.

SAW-MILL (157). A boiler exploded on September 28th, in a saw-mill owned by Jas. Lalonde, of Embrum Village, three miles from Russell, Ont. Pierre Stone and J. B. Lazure were killed instantly. A. Grigore, F. Lalonde, A. Primican, D. Petre, X. Goyette, were badly injured. The mill is a total wreck.

THRESHING MACHINE (158). The boiler of a steam thresher exploded in Indiana, Pa., on September 30th, on the premises of County Commissioner A. C. Rankin. Harry Myer, aged fourteen, was blown to pieces. Aaron, John, and Frank Gromley, all prominent citizens, were probably fatally injured.

COTTON GIN (159). Harry Sprecht was instantly killed, and James Coppage seriously injured on September 30th, by a boiler explosion at Jack Smith's cotton gin, sixteen miles east of Gilmer, Tex. Several other persons were slightly injured.

Locomotive (160). On September 30th, the boiler of locomotive No. 72, on the Buffalo, Rochester & Pittsburgh Railroad, exploded at Grove Summit, near Dubois, Pa. The engine was blown to pieces, and so also were the engineer, L. R. Wise, and the fireman, Charles Flynn. The engine was used for pushing coal trains from the yards at Dubois, over the small summit. A run had just been completed, and the enginemen were awaiting orders to return.

Iron Works (161). At 6.30 on the morning of September 30th, just after the night turn had left the mill and before the day turn had reported for work, two large boilers in the Carbon Iron Works, at Thirty-second and Smallman streets, Pittsburgh, Pa., exploded with terrific force, scattering sections of boilers, bricks, etc., throughout the mill, in which several hundred men are employed during working hours. The mill was also filled with scalding steam. The natural gas which escaped from broken pipes then exploded, causing nearly as much damage to the building and machinery as did the collapse of the boilers. The damage to the works was estimated at $10,000. No one was killed, and, so far as known, no person was seriously injured. The narrow escape from a terrible calamity is remarkable.

On the Loss of Heat from Steam Pipes.

This subject has been discussed, so far as naked pipes are concerned, in the September and October issues of The Locomotive. General rules for finding the loss of heat under given circumstances were stated in the September number, and in October these rules were applied to a concrete example, and the result of the calculation was compared with the result of a careful experiment made by Prof. Ordway. The discrepancy between theory and experiment, in this case, was found to be less than half of one per cent., and it was stated that such an unexpectedly close agreement indicated (1) that Prof. Ordway's experiment was accurately made, and (2) that considerable reliance could be placed on the rules we had given.

When Prof. Ordway's experiment was selected as a test, it was without the least reference to its possible agreement with the formulæ. It was chosen because we knew something about the circumstances under which it was made, and we believed it to have been executed with the greatest care.

It would be easy to quote experimental results that disagree with our rules. It would be easy to find measurements showing a discrepancy of twenty, forty, or even sixty per cent. The reason for this is not hard to find. Heat measurements are troublesome to make with any great degree of accuracy, because there are sources of error, in work of this character, that are likely to be overlooked, and which are hard to allow for, with any degree of precision, even when they are recognized. A slight amount of moisture in the steam produces a great difference in the result when the condensation method is used; and when the calorimetric method is used, radiation from the calorimeter introduces serious errors unless the instrument is properly handled. These are merely instances of a large class of sources of error, and other instances will readily occur to the reader.

In many cases in which experimental results are published, the data upon which these results rest are not given with sufficient fullness to enable one to estimate the value of the results intelligently. Good measures are liable to be rejected by critical men for no other reason than this, and the experimenter who does not publish the details of his work cannot expect his results to be accepted by the engineering world with any degree of confidence; for there is no way of knowing measures to be good unless the fullest particulars of the experiments are given, so that each one may judge for himself whether the experimenter recognized all the errors to which he was liable, and took proper precautions to free his results from their effects.

Returning to the numerical results obtained in the October issue, let us consider the amount of heat that would be lost in the course of a year by 100 feet of naked two-inch pipe, carrying steam at 60 pounds pressure, the temperature of the air being 68° Fah. The loss per foot per hour was found to be 358.7 heat units. A pipe 100 feet long would, therefore, lose 358.7 × 100 = 35,870 heat units per hour, or 35,870 × 10 = 358,700 heat units per day of ten hours, or 358,700 × 300 = 107,610,000 heat units in a year of 300 working days. It will be safe to assume that, with the average amount of attention and care, a good boiler will absorb about 7,000 heat units from each pound of coal, so that a loss of 107,610,000 heat units corresponds to a waste of 107,610,000 ÷ 7,000 = 15,370 pounds of coal, or about 7.7 tons. In places where coal costs $4.00 a ton 7.7 tons would cost $30.80. That is, it will take $30.80 per year to pay for the waste of heat, through radiation and convection, from 100 feet of two-inch pipe, carrying steam at 60 pounds pressure, the temperature of the air being 68° Fah., and coal being worth $4.00 a ton.

If the water of condensation is not utilized for some purpose, the true loss will be greater than this; for we have considered only the latent heat given out as the steam condenses. After condensation has taken place the resulting water has a temperature due to the pressure of 60 pounds to the square inch (that is, about 307° Fah.), and if this water is merely removed from the pipe without being put to any useful purpose, we shall lose an additional amount of heat, equal to the quantity of heat that this water of condensation would give out in cooling from 307° down to the temperature of the feed-water that is used. This waste can be calculated quite accurately, but since it is not really waste heat unless the drip is thrown away, we may properly defer further discussion on this point to a future article. It will be sufficient, for present purposes, to say that we can take account of it approximately by adding 25 per cent. to the calculated loss by radiation and convection.

Retaining, for the present, our estimate of $30.80 as the annual loss from the 100 feet of 2-inch pipe under consideration, let us next see how much the owner of such a pipe can afford to pay for a covering for it. To decide this point we must take four things into account: (1) The cost of the heat lost from the naked pipe, per annum. We have estimated this, in the present case, at $30.80 per hundred feet of pipe, or $0.308 per foot. (2) The number of years the covering will last. This varies greatly for the different kinds of covering. Some kinds will last indefinitely, and some will char out, or become otherwise defective, in a couple of years, or even less. An accurate estimate certainly cannot be given unless the character of the covering is known, and also the conditions under which it is to be used; but in the absence of such knowledge, let us assume that the covering to be selected will last for 10 years. (3) The rate of interest that invested money will command. This varies widely, according to the locality and the nature of the investment. For present purposes, however, we shall assume it to be six per cent. (4) The efficiency of the covering. By this expression we mean the *percentage of the loss from the naked pipe* that the covering will save. It is evident that this percentage will vary greatly, according to the nature of the covering. Perhaps .70 is as close an estimate of the efficiency of a good covering as can be made without having the character of it specified.

The data that we shall assume in the following illustrative example will be, in accordance with the foregoing paragraph: (1) Annual waste from the naked pipe =$0.308 per linear foot; (2) Duration of the covering = 10 years; (3) Prevalent rate of interest = .06; (4) Efficiency of the covering = .70.

The general fact on which we shall base our estimate is that the total cost of the covering must not exceed the total saving it will effect during its lifetime. Now, the total cost of the covering includes both the first outlay and the interest on this outlay during the life of the covering, and the total saving it effects is equal to the saving in the coal bill that it produces, plus the interest on this saving.

Each dollar invested in the covering would amount to $1.06 at the end of the first year, $1.12 at the end of the second year, $1.19 at the end of the third year, $1.26 at the end of the fourth year, and $1.79 at the end of the ten years; so that to find out what the original investment would have amounted to if placed at interest for ten years, we must multiply it by 1.79.

To find out what the total saving that the covering effects is worth, we must proceed somewhat differently. Thus let us suppose that the covering saves $1.00 each year. Then at the end of one year it has saved $1.00, and this dollar, put at interest for the remaining nine years, will amount to $1.69, which is the value of the saving effected by the covering during the first year. During the second year another dollar is saved, and this, if put at interest for the remaining eight years, will amount to $1.59, which is the value of the saving effected by the covering during the second year. In a similar way we find that the values of the savings effected during the third, fourth, fifth, sixth, seventh, eighth, ninth, and tenth years, respectively, are $1.50, $1.42, $1.34, $1.26, $1.19, $1.12, $1.06, and $1.00. The sum of all these amounts is $13.17; so that it appears that if a pipe covering saves one dollar's worth of heat in one year, in ten years it will effect a saving which may fairly be valued at $13.17, and hence, to find the value of the saving effected by such a covering during ten years, we must multiply the saving effected during one year by 13.17.

Now, the saving effected by a covering in one year is equal to the loss from a naked pipe, multiplied by the decimal that expresses the efficiency of the covering; that is, in the present example the annual saving effected by covering one foot of the pipe is $0.308 × .70 = $0.216. And, according to the preceding paragraph, a saving of $0.216 each year for a period of ten years amounts to $0.216 × 13.17 = $2.84. This is the total saving effected by each foot of the covering during its lifetime of ten years, and in order that the investment may be a good one, this saving ought to be greater than the original outlay with interest added. We have found that each dollar of outlay for covering amounts to $1.79 at the end of ten years, so that the original investment would, at the end of ten years, amount to

1.79 × the original investment.

Hence, if it were an even thing whether the covering would pay or not, we should have

Amount of saving for ten years = original cost, *plus* interest.

That is,

$2.84 = 1.79 × the original investment.

Therefore, if the original investment does not exceed $2.84 ÷ 1.79 (= $1.58) per foot of pipe, it will pay to have the pipe covered; but if the covering is going to cost more than $1.58 per foot, it would not pay. It seems needless to say that any reasonable covering will come far within this limit, so that it follows that it is a wise plan to cover such a steam pipe as we have assumed in this example.

The question next arises, Which one of the many coverings on the market is the best? It is easier to ask that question than to answer it. Any reasonable covering is better than none at all, but some are more efficient than others, and some cost more than others. If two or more coverings are submitted in competition, an estimate of their comparative durability should be made, and their efficiencies may probably be fairly estimated by consulting Prof. Ordway's experimental results as given in the fifth volume of the *Transactions* of the American Society of Mechanical Engineers. A calculation similar to the one given above will then give the commercial value of the covering.

For the benefit of those who may wish a formula for facilitating the calculation we give the following: First multiply the cost of the heat lost from each foot of the naked pipe in one year by the efficiency of the proposed covering, and divide by the decimal representing the current rate of interest. Call this result A. Then

$$\left\{ \begin{array}{l} \text{Maximum advisable price of} \\ \text{covering per linear foot} \end{array} \right\} = A - \frac{A}{(1+i)^t}$$

where i is the current rate of interest and t is the probable lifetime of the covering in years. This formula may be expressed in words in the following

RULE: (1) Find A in the manner explained above. (2) Find the amount of $1.00 when placed at compound interest, at the current rate of interest, for a period of years equal to the probable lifetime of the covering. (3) Divide A by the amount of $1.00, as found in accordance with section two of this rule, and subtract the quotient from A. The result will be the greatest amount the prospective buyer can afford to pay for the proposed covering, per running foot.

The problem presented in this article becomes quite complex in its practical applications. Thus a high-priced covering might be a better investment than a low-priced one, under one set of circumstances, on account of its greater efficiency, or its greater probable durability; and yet, under other circumstances, the cheaper covering might be the better of the two. For example, if a line of pipe is used continuously, and is exposed constantly to the weather, it will pay to cover it with the greatest care; but if it is used only occasionally, it would not pay to lay out very much on a covering, and it might be found to be cheaper not to cover it at all. It does not seem necessary to discuss these points at length in the present article, because the rules we have given cover all of them; and if it will not pay to cover a pipe at all, the fact will appear when the case is analyzed by the method suggested in this article.

In addition to the cost and efficiency of a covering, and its probable deterioration from ordinary causes, there are other points to be thought of. A good appearance is not beneath consideration, and the ease or difficulty of applying the covering will become important in case repairs become necessary. An excessively bulky covering is often objectionable, epecially where there are many pipes near together; but the weight per running foot is usually much more important, since a heavy covering materially increases the difficulty of supporting the pipe. We must also consider the possibility of the covering becoming wet through leakage or other cause. A wet covering may corrode the pipe if there is any corrosive substance used in making it, and hair coverings are apt to give out an offensive odor after being wet, if they come in direct contact with the pipe. Some coverings containing organic substances are apt to be gnawed by rats and mice, becoming disfigured, or, in bad cases, so loosened as to lose somewhat in efficiency. In case the pipes are not accessible to these creatures, or are protected against them, this objection loses its force. Lastly, the question of inflammability should receive careful attention. By long exposure to heat the covering becomes very dry, and although there is little likelihood of its taking fire from the heat of the pipe itself, it may catch very readily from a chance spark falling upon it, or from candles or lamps used by the fireman. The danger from this cause may be greatly lessened by impregnating the covering, or painting it, with suitable chemicals. Borax has been recommended for this purpose, and so also has water-glass.

"Old Times on the Mississippi."

In a recent interview with a Detroit *Free Press* reporter, Mr. D. Crail of Cincinnati told some of his recollections of the early steamboat days on the Mississippi River.

"Before the war," he said, "I used to run on the Mississippi River, and you may depend times were red-hot in those days. The stories that you hear about the exciting occurrences that were daily happening on the big boats in *ante-bellum* days are not the least exaggerated. On the contrary, I have seen livelier times there than I have ever read and heard about. Gambling! W-h-e-w! Well, I should rather say so, and, to tell the truth, I was right in it myself. I have sat in poker games day after day and night after night where bowie-knives and seven-shooters were to be seen on every side, and where negro slaves were the stakes. I am no slouch of a card player, and have fingered the pasteboards with the cream of the profession; and yet when I recall some of those old times it makes the shivers run up and down my spinal column.

"Passengers on the river boats in the days referred to lived high, I assure you, and such a thing as having water on the table for drinking purposes was unheard of. Wine and whisky flowed freely, and it was a mark of great effeminacy to be seen drinking Adam's ale. To give you something of an idea how they used to do in the '50s, I will relate an incident that I witnessed on the steamer *Monarch* in '56. A passenger walked up to the clerk's desk one morning, threw down a $20 bill, and said: 'Take what I owe you out of this.' The clerk — all such functionaries were important feeling fellows aboard a Mississippi River steamboat — glared at the bill and threw it back, with the remark, 'That's bad.' 'It can't be,' replied the passenger; 'I just drew it out of the bank.' One word led to another, until finally the clerk called the passenger a liar. Quick as a flash the passenger drew a gun and fired, shooting the clerk through the head, killing him instantly. The boat's crew seized the passenger, tied him to a chair, and threw him overboard; and, sir, do you know, not a man playing poker in the cabin at the time left his chair through the entire scene. Such a trivial occurrence as two human beings losing their lives was not deemed of sufficient interest or importance to warrant the gamblers stopping their game.

"Steamboat races? Well, I guess so. Time and time again I have seen hams and barrels of pork thrown into the furnace during a steamboat race; and while the passengers on both boats were standing on the brink of eternity, you might say, the boats shivering and groaning under the awful strain like a couple of suffering animals, the gamblers would stand calmly by, and lay wagers as to which boat would win the race, or as to the likelihood of one or both of them blowing up."

The Locomotive.

HARTFORD, NOVEMBER 15, 1892.

J. M. ALLEN, *Editor*. A. D. RISTEEN, *Associate Editor*.

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Papers that borrow cuts from us will do us a favor if they will mark them plainly in returning, so that we may give proper credit on our books.

A SHORT time ago a violent explosion took place in Berlin, Germany, in the building occupied by Herr Ritter's extensive drug store. The place was wrecked, and immediately after the explosion a fire broke out, and what the explosion had left was destroyed by the flames. Two men were killed, and the property loss was estimated at 250,000 marks. It was at first supposed that the explosion was due to the ignition of some of the chemicals stored in the building, but an examination of the ruins showed that the boiler in the basement was blown to atoms.

IN the course of an interesting article an *Uncle Sam's Pussy Cats*, printed in a recent issue of the Hartford *Times*, René Bache says: "The origin of the tailless cats of the Isle of Man is a puzzle. It may be that they were derived from ancestors who happened to have their tails cut off. Such mutilations are sometimes reproduced by heredity, as has been the case with the short-tailed sheep-dog." Mr. Bache is usually very well informed, but in this case we fear he is sadly mistaken. Herr Weismann, the famous German essayist, has given great attention to the possible inheritance of mutilations, because if such inheritance can be proven in any single case, his theory of heredity must be unsound. He has looked into numerous alleged cases of the inheritance of mutilations, and has experimented personally with successive generations of mice, whose tails he cut off; but the evidence has all been negative. If Mr. Bache can produce any facts to substantiate his remark about the short-tailed sheep-dog, Herr Weismann would be glad to hear from him, no doubt.

THE following account of a sad elevator accident is clipped from a contemporary: Mrs. E. D. Shields, wife of a traveling man, was killed at the Richelieu Hotel, St. Louis, Mo., on Sept. 21st. Mrs. Shields went to the elevator to go to the dining-room. There is no glass in the door leading to the elevator, and Mrs. Shields, after ringing the bell, put her head through the opening to see if the elevator was coming up. At that moment it was descending, and struck the back of her head, crushing it badly. Strange to say, she was not knocked down the shaft, but staggered back into the hallway. Then ensued a most horrible scene. A chambermaid and a porter had witnessed the accident, and ran to her. She fled from them; and, notwithstanding that she was practically decapitated, ran to a speaking tube, and apparently tried to call to some one below. Then she ran, or rather staggered, to her room, a few feet away, and fell dead.

Mrs. Shields was only twenty-three years old, and a daughter of Col. Campbell, Clerk of the Court of Appeals of Arkansas. Her home was in Little Rock.

We have received from Messrs. John Wiley & Sons of 53 East Tenth Street, New York, a copy of *Modern Locomotive Construction*. The author, Mr. J. G. A. Meyer, was formerly chief draughtsman at the Grant Locomotive Works, and is now associate editor of the *American Machinist*, in which periodical the papers that formed the basis of the present work first appeared. Mr. Meyer has edited his papers carefully and with good judgment, and has made extensive additions in preparing them for republication. The book contains over a thousand excellent cuts, made from working drawings; and we have no hesitation in saying that it forms a very valuable addition to engineering literature.

The New Star in Auriga.

Although most of the stars in the heavens have for ages remained so steady in brightness and position that they have long been called "fixed stars," to distinguish them from the planets, which wander about, there are numerous cases on record of stars having blazed out suddenly where no star was known before. In the year 125 B.C. Hipparchus detected a star of this character, which was so bright that it could be seen in the daytime, but which afterwards faded away. In the year 389 A.D. a similar star appeared in the constellation Aquila; and, although it remained as bright as Venus for three weeks, it afterwards died out and disappeared entirely. In the years 945, 1264, and 1572 brilliant stars appeared temporarily in the northern heavens, in the vicinity of Cassiopeia; and these have been thought by some to be successive reappearances of the same star, which may shine out, perhaps, at intervals of 312 years or so. If this inference is correct, we should expect a reappearance of the star in the near future, for if its average period is 312 years, it should have burst forth again in 1884. The star of 1572 appeared so suddenly that when Tycho Brahe's attention was called to it, he was confident that it was not visible half an hour before. It was then as bright as Sirius, and it grew brighter until it could be seen in the sky at noon. In March, 1574, it had faded into invisibility again. Other stars have appeared temporarily in 1604, 1670, 1848, and 1866.

The new star in Auriga, which has recently stirred up the astronomical world, has, therefore, had many illustrious predecessors. It was discovered by Mr. Thomas D. Anderson, an amateur, who was armed only with a star atlas and a pocket spy-glass magnifying ten diameters. Mr. Anderson is confident that he saw the star at 2 A. M. on January 24th of this year, but he mistook it at that time for a neighboring star shown on his map. He saw it twice during the following week, making the same mistake each time; but on the morning of January 31st he satisfied himself that he was in error, and that the star he had seen was a stranger. Supposing it to be known to the astronomical world, he modestly sent an anonymous postal card to Prof. Copeland, Scotland's astronomer royal, calling his attention to it. The information was telegraphed abroad, and very soon the telescopes of the world were aimed at it.

It happened that numerous photographs of this region of the heavens had been made at the Harvard College Observatory at about the time of Anderson's discovery, and a subsequent examination of the negatives showed that the star had "unobtrusively recorded itself" upon twelve of them, on days ranging from Dec. 10, 1891, to Jan. 20,

1892. At the time of its discovery by Mr. Anderson it was of about the fifth magnitude, and plainly visible to the eye. A subsequent careful examination of star maps showed pretty conclusively that nothing had been seen in that place by earlier observers. The Harvard photograph of Dec. 10th shows it as a star of the fifth magnitude, while a photograph of the same region made in Germany on Dec. 8th by Max Wolf fails to show it, although other stars of the ninth magnitude (40 times fainter than stars of the fifth magnitude) are shown.

Careful measures of the brightness of the new star were made from day to day, and it was found to go through a remarkable series of fluctuations, corresponding, no doubt, to disturbances to which the star was subjected. After the beginning of March the fluctuations died away, and the star faded rapidly and with considerable regularity, so that some one suggested that it might furnish us with a test of the accuracy of Dulong's law of the radiation of heat — though, as we shall see later, it is by no means certain that the star grew faint on account of loss of heat. So rapidly did it fade that on March 20th it was fourteen times as faint as it was on March 8th. On April 1st it was down to the thirteenth magnitude, or perhaps the fourteenth; and on April 24th it was seen at Mt. Hamilton, and was of the sixteenth magnitude.

It had gone the way of all other "new" stars, and astronomers had given it up as a phenomenon that was past. But nearly four months later, on August 17th, it was again seen at the Lick Observatory, appearing as a star of the 10.5th magnitude; and when Prof. Barnard examined it he perceived that it was really "a small, bright nebula, with a tenth magnitude nucleus." The brighter part of the nebula was 3″ in diameter, and outside of this was a fainter nebulous extension that was perhaps 30″ in diameter.

The phenomena so far described are as follows: On Dec. 8, 1891, no star as bright as the ninth magnitude was visible in this part of the heavens. On Dec. 10th a star of the fifth magnitude, distinctly visible to the naked eye, was there. From this time until about the 1st of March, 1892, the newcomer fluctuated greatly in brightness, but from the 1st of March onward it faded away with considerable regularity until, when it was last seen, on April 26th, it was, perhaps, of the sixteenth magnitude. It was then supposed to have permanently disappeared; but on Aug. 17th it was again seen, far brighter than it was on April 26th, and it was found to consist of a tenth magnitude star, surrounded by a nebulous envelope. This in itself is a sufficiently remarkable cycle of changes, but let us see what the spectroscope had to tell us. When the star was first seen it had a complicated spectrum, composed of bright lines, on the violet side of which were dark lines looking like shadows of the bright ones. This was interpreted as meaning that the star really consisted of two bodies of similar chemical composition, one of which was approaching us and the other receding from us. Measures of the displacement of the lines showed that the body giving the dark lines was approaching us at the enormous speed of 300 miles per second, while the one giving the bright lines was receding at the rate of 420 miles per second! * These velocities were maintained for at least a month, during which time the distance between the two bodies must have increased by an amount equal, at least, to twenty times the earth's distance from the sun.

After the reappearance of the star in August, its spectrum was found to be entirely changed. It had taken on an appearance characteristic of the nebulæ; and a couple of days later Mr. Barnard saw it nebulous, as explained above. Professor Campbell of the Lick Observatory has also found indications of tremendous changes in the velocities of

* For an account of the principles on which this conclusion is based, see THE LOCOMOTIVE for June, 1890.

the two bodies composing the star; but this needs verification before we can accept it as a fact.

Astronomers have proposed various theories to account for the remarkable outburst of light from the new star. The first explanation that occurs to one is that two comparatively dark stars, coursing along through space, have come into collision with one another, and that so much heat has been developed by the consequent slackening in speed, that the bodies have been heated up to strong incandescence. It is also held by some that the phenomenon was produced by the crashing together of two vast clouds of meteoric stones. (This supposition is in accordance with Lockyer's famous "meteoritic hypothesis.") Others point out that it is not necessary to suppose that an actual *collision* took place, but that the two stars approached each other so closely that enormous tides were raised in both of them, the resulting friction of these tides being the cause of the heat that was generated. This theory seems fanciful, but it is undoubtedly tenable. The strongest objection to it is the suddenness with which the star burst forth.

Whatever theory we adopt concerning the cause of the sudden brilliance of the star, we have to face a far more difficult question when we consider the reasons for its fading away so quickly. Those of us who know how long it takes a large ingot of metal to cool will be slow to believe that a body at least comparable in size and heat with the sun could possibly cool down in a few months to the extent to which this new star has cooled. In fact, it appears very doubtful if temporary stars *do* cool appreciably during the short time that we see them. Is it not more likely that they become so highly heated as to lose the power of giving out light-rays that can affect our eyes?

The position of the new star has been determined with precision by Burnham and Barnard, with an intervening period of six months. During this interval there has been no measureable change in position, and it, therefore, appears probable (1) that the star has no measurable parallax, and (2) that it has no sensible proper motion. It follows that the light that has just reached us from this star has been on the way for a century at least, coming all the time at such a pace that it would go around the world eight times in every second. How much longer the news has been in getting here we do not know; but the marvelous phenomenon that we have just seen certainly must have happened before the battle of Bunker Hill was fought.

Two years ago a Chicago drummer stopped at Decatur, Ala., and while sitting on the broad hotel piazza talking with the proprietor of the hostelry noticed a fine looking cock strutting about the street.

"Pretty fine bird," remarked the Chicagoan, sententiously.

"Yep," replied the hotel-heeper. "Best in these parts, I reckon."

"I'm something of a chicken fancier myself," continued the drummer.

"So? Glad to know it, sah."

"Tell you what'll do — I'll play you a game of seven-up for that rooster," said Chicago.

"Do it with pleasure, sah," replied his host.

The cards were produced, and the drummer won. The rooster was turned over to him and was brought to the World's Fair city.

A few days ago the Chicagoan again registered at the same hotel in Decatur. The proprietor immediately recognized him. "Aren't you the man who played me a game of cards two years ago for a rooster?" he asked.

"Yes, sir."

"Wall, I've been thinking about you, sah, quite a powerful lot since that time. Do you know, sah, I've never been able to remember what you staked against my rooster, sah, on that occasion. That was the first real Yankee trick I ever experimented with, sah, and you will oblige me now by nominating the sort of poison you prefer." — *The Review.*

The Locomotive.

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Smoke Consuming Devices.

We have been frequently called upon for devices for abating the so-called "smoke nuisance," which has in recent years become a serious problem, particularly in large manufacturing centers. Until within a few years Pittsburgh was so objectionable on account of the smoke poured forth by its thousands of chimneys that it became known throughout the English speaking world as the "Smoky City"; and although in this instance the trouble has been largely removed by the general substitution of natural gas for coal in the manufactories, in other cities less fortunately situated the problem has

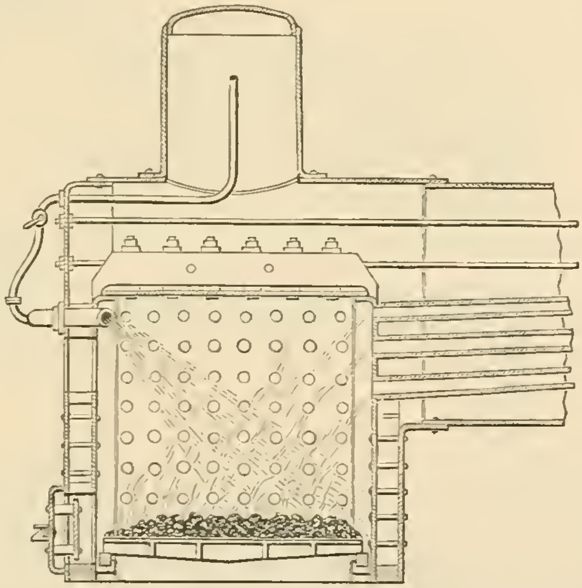

FIG. 1.—M. THIERRY'S SMOKE CONSUMING DEVICE.

to be considered, and the health and comfort of the inhabitants of these cities require that some solution of it should be found.

Commissions have been appointed at various times by organized bodies of engineers and others, to consider the smoke problem, and devise means for its solution, if possible. The most recent of these committee reports was submitted to the Engineers' Society of Western Pennsylvania at its meeting in Pittsburgh on November 15th. This committee made but few specific recommendations, but dwelt somewhat on mechanical stokers and the use of steam jets. Both of these methods are old and well-known, and it therefore appears that the committee in question did not succeed in finding out much that was new.

The mechanical stoker is a device for feeding the furnace continuously, spreading it over the fire and in thin layers. They are used in England more than in this country, and many of them work very well when properly cared for. The theory upon which they are based is that by feeding the fire slowly and uniformly with thin layers of fuel, it is possible to burn the products of distillation as they pass off, the surface of the fire always remaining bright and clean. The chief objection to these stokers seems to be their first cost; for although they work well and are usually efficient, it cannot be denied that they are expensive to put in.

Steam jets have been used for many years for the lessening of smoke, and two devices based upon the use of such jets were exhibited at the Paris Exposition of 1867. Fig. 1 shows M. Thierry's device, and following is the report of the United States Commissioner upon it: "He places within a boiler furnace, and over the door, a horizontal pipe having connection with the steam dome. Several holes, each $\frac{1}{16}$ of an inch in

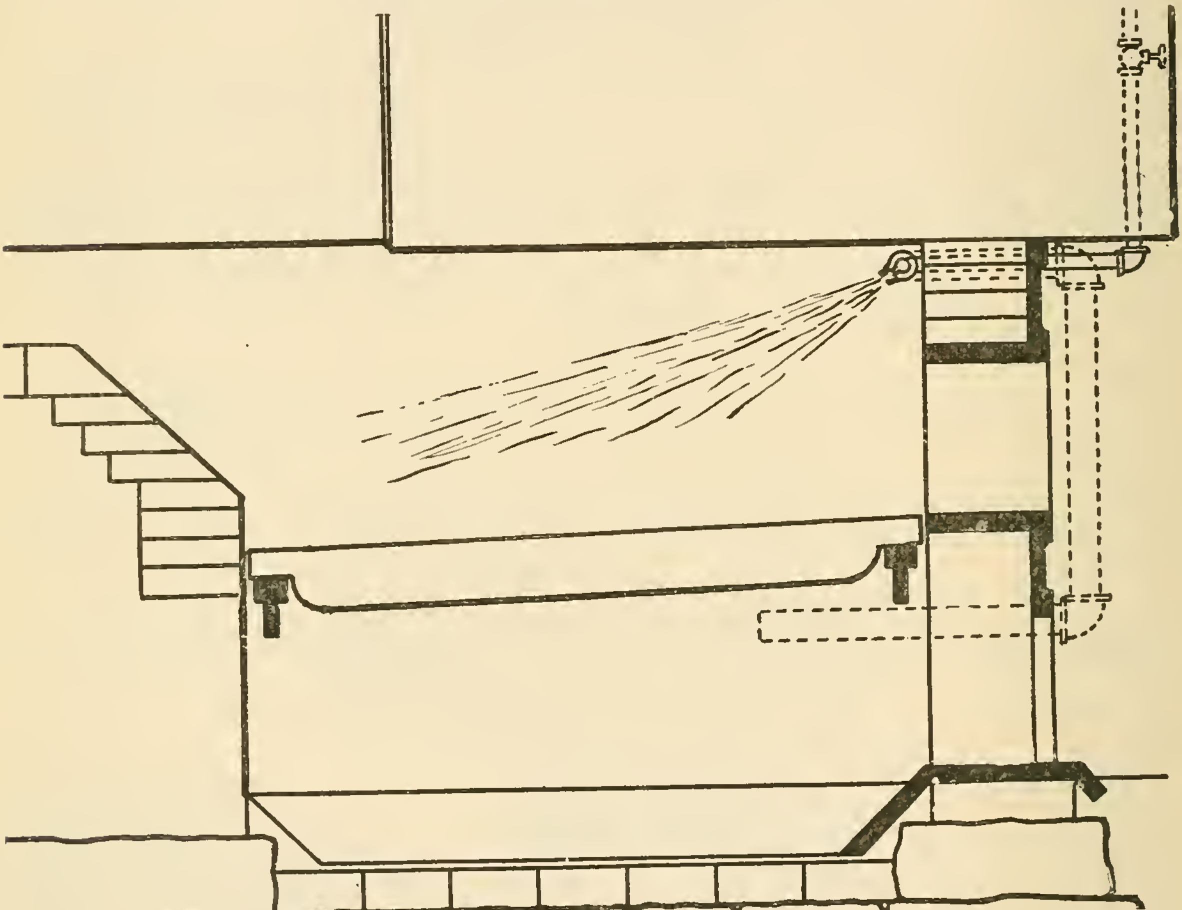

FIG. 2.—MR. J. M. ALLEN'S DEVICE—SIDE VIEW.

diameter, are drilled in this pipe, and are so located that the escaping steam will be projected into the furnace, to which a sufficient quantity of air is admitted through a damper in the furnace door. M. Thierry has introduced his device in England, Austria, Spain, Portugal, Turkey, Italy, and Belgium, and in all instances he guarantees a saving of from eight to twelve per cent."

Concerning the other device that was exhibited (but of which he gives no illustration), the Commissioner continues: "M. Grandperrin aims at the same result with his invention. He dispenses with the horizontal pipe, and screws in through the plates of the water space an apparatus shaped like a conical shell. This is formed with two inner cases which divide the interior into three compartments, the central one of which opens to the atmosphere at one end, while small pipes piercing the other spaces form channels for the air to the furnace. The first annular space surrounding this inner shell has a pipe connection with the steam dome, and connects with the furnace by small tubes. Through the second annular space hot water from the boiler circulates freely. A shell for a boiler of 100 horse-power is about five inches in diameter, with sixteen steam jets (each $\frac{1}{16}$ of an inch in diameter), and fourteen air jets (each $\frac{1}{4}$ of an inch in diameter) intermingled on the upper surface of the shell. Such a disposition of the holes fills the upper part of the fire-box with heated air and steam, instead of projecting it directly upon the fire."

A device somewhat similar to M. Thierry's was constructed and tried by this company many years ago. Fig. 2 shows a section of a furnace fitted up with this device, and Fig. 3 is a corresponding view of the boiler front. A piece of two-inch pipe runs

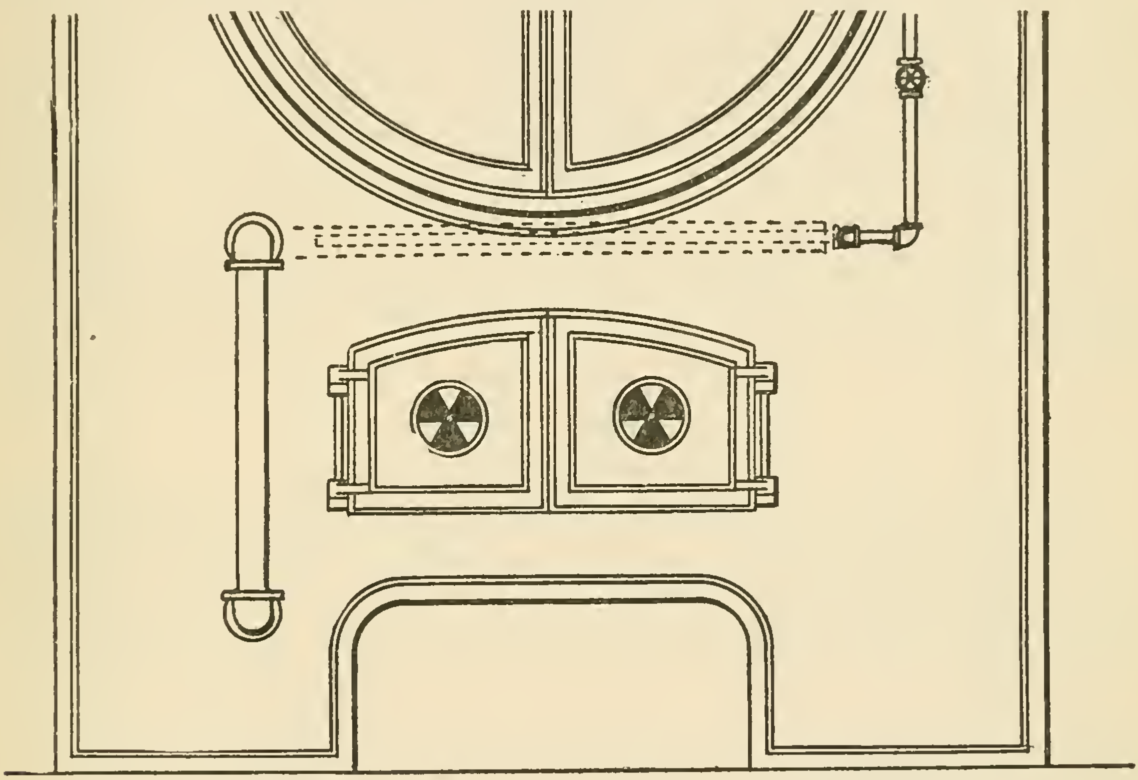

Fig. 3. — Mr. J. M. Allen's Device — Front View.

horizontally along the front wall of the furnace, just under the boiler. At one end it is capped, and at the other it turns outward through the front wall, then passing downward and through the front again, into the ash-pit. The lower and of this pipe should be well to one side of the ash-pit, so that it may not be in the way of the fireman; and it should open under the grates so that it may receive air that has been warmed by the downward radiation from the furnace. Inside of the upper horizontal part of this pipe a piece of half-inch steam-pipe is secured, which comes out through the setting at the side opposite to that on which the air pipe makes its exit, and then passes upward and enters the boiler at its highest part, so that the steam drawn through it may be as dry as possible. Small nozzles, with holes $\frac{1}{16}$ of an inch in diameter, and six inches or so apart, are attached to that part of the steam pipe which is enclosed in the air pipe in the furnace, and these come opposite similar but larger nozzles fitted to the air-pipe itself. When the valve shown in the cut is opened, steam blows out through these nozzles, drawing air along with it by a kind of ejector-like action, and the nozzles are so placed that the discharge of mixed air and steam is directed towards the angle formed by the bridge wall and the grates. The air-pipe should be provided with a valve or damper for regulating the flow of air through it.

This device was based upon the theory (which the subsequent tests amply verified) that in order to prevent smoke it is necessary to mingle a proper supply of air with the unconsumed gases that rise from the fire when combustion is incomplete, and to force this mixture of air and gases back upon the fire so that it may be ignited. In the early experiments with the apparatus these results were found to be attained so perfectly that if the steam valve shown in the cuts was opened just after firing, and while a dense column of smoke was issuing from the chimney, the production of smoke could be stopped so suddenly and completely that the column rising from the chimney appeared to be cut squarely off, as if by a knife.

Two objections may be urged against the use of steam jets for suppressing smoke. One is, that it may take so much steam to effect the combustion that the method might become too expensive to be practicable. The steam jets need not be used, however, when the fire is bright and little or no smoke is being produced without them. They should be used only when occasion may require; and it does not appear that this would call for an extravagant amount of steam under ordinary circumstances. The other objection is, that the jets produce more or less noise; but in a manufacturing establishment the noise produced by such a device as we have illustrated ought not to be troublesome, though in hotels and dwelling-houses it might be annoying.

We have in this office drawings and models of the device shown in Figs. 2 and 3, and any of our patrons who desire to investigate this question further can do so by calling upon us.

Inspectors' Report.

SEPTEMBER, 1892.

During this month our inspectors made 6,447 inspection trips, visited 12,335 boilers, inspected 5,090 both internally and externally, and subjected 761 to hydrostatic pressure. The whole number of defects reported reached 9,782, of which 857 were considered dangerous; 56 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	720	27
Cases of incrustation and scale,	1,236	41
Cases of internal grooving,	45	7
Cases of internal corrosion,	331	21
Cases of external corrosion,	636	23
Broken and loose braces and stays,	121	20
Settings defective,	280	15
Furnaces out of shape,	376	16
Fractured plates,	148	40
Burned plates,	217	47
Blistered plates,	245	8
Cases of defective riveting,	1,771	17
Defective heads,	85	17
Serious leakage around tube ends,	2,011	358
Serious leakage at seams,	423	34
Defective water-gauges,	316	39
Defective blow-offs,	119	33
Cases of deficiency of water.	23	10

Nature of Defects.	Whole Number.	Dangerous.
Safety-valves overloaded,	53	13
Safety-valves defective in construction,	73	28
Pressure-gauges defective,	448	36
Boilers without pressure-gauges,	7	7
Unclassified defects,	98	0
Total,	9,782	857

Boiler Explosions.

October, 1892.

Threshing Engine (162). A terrible accident, which resulted in the immediate death of one man and the bruising of several others occurred on October 1st, on the farm of Frank Whitaker, in the town of Torrey, near Penn Yan, Pa. The boiler of the threshing machine exploded while the men were at work about it. Both heads were blown out, and a heavy piece of timber struck a Mr. Raplee in the chest, crushing the life out of him almost instantly.

Threshing Machine (163). The boiler of a threshing engine exploded about 15 miles northwest of Garner, Iowa, on October 1st. The front part of the engine was blown over the separator, striking and killing a young man named Barth in its descent. Three other men received fatal injuries. The stack took fire and was consumed, together with Mr. Barth's body.

Cotton Gin (164). The boiler of a steam cotton-gin exploded on October 3d, in Warren County, near Weldon, N. C. A man, a woman, and two boys were killed.

Iron Works (165). On October 6th a boiler exploded at the Star Iron Works in Lima, Ohio. D. E. Jones and O. G. Guss, machinists, were badly injured. Jones was the more seriously hurt of the two men, and at last accounts it was feared that he would lose his left arm. The roof of the shop was torn away, and it is wonderful that no one was killed and no more injured.

Quarry (166). An old steam boiler that used to furnish steam for a steam drill in Ervin's stone quarry, in Cedarville, near Dayton, Ohio, exploded on October 6th. The engineer had fortunately just left the boiler, and nobody was hurt. The boiler had not been used for some years, and it is said that it had been pronounced unsafe. The report says that it was carrying 120 pounds of steam when the explosion occurred.

Quarry (167). The Burlington (Vt.) *Free Press* says that the boiler at the Bettell quarry in Weybridge exploded on October 10th, killing Patrick Desmond instantly, and seriously injuring James Henderson and Albert Davis. At the time of the explosion Desmond was in charge of the engine used in running the derrick and the drills. The adjoining powder house was shattered into splinters, but, although there was considerable powder and dynamite in the house, none of it exploded. The boiler was a second-hand one, formerly belonging to the Lincoln Iron Works of Rutland.

Grist Mill (168). The boiler of Ketcham's grist mill in Chenoa, near Bloomington, Ill., exploded on October 11th. Nobody was hurt.

Pulp Mill (169). Two large digesters in the Bangor Pulp and Paper Company's mill at Orono, Me., exploded on October 11th, causing the loss of two lives and the injury, more or less serious, of six persons. One of the mammoth digesters was thrown 300 feet into the air. Huge iron beams, timbers, and bricks were scattered hundreds of feet from the site of the buildings. Richard Zine was killed outright. William Eddy of Orono was terribly injured, and died soon after he was taken from the ruins. Walter Smith, Austin Whittmore, and William Buchanan were taken out with serious injuries. Wilson Crosby, H. Garrett, and James McQueen were badly bruised. The loss is estimated at $100,000.

PUMPING STATION (170). On October 12th a flue collapsed in a boiler in the McKeesport (Pa.) pumping station. The explosion wrecked a portion of the building and did considerable damage. The other boilers in the station were being repaired at the time, so McKeesport and Reynoldton were left without a water supply for a couple of days.

BRICK AND TILE WORKS (171). The boiler of the Charlotte Brick and Tile Company, Charlotte, N. C., exploded on October 14th, killing William Hunsucker, a young man of 24, and injuring J. B. Clanton and a colored man. Hunsucker was the engineer. His body was picked up fifty yards from the engine shed.

THRESHING ENGINE (172). The steam boiler in Samuel Wood's threshing machine, in Sherman, N. Y., blew up on October 14th. The explosion blew the whole engine directly into the barn, against the separator. William Wilkes, who was feeding the machine, was struck, and so badly hurt that he was unable to move. The barn was on fire in an instant, and it was impossible to extricate Wilkes, who was burned alive. The barn and its contents were destroyed. Wilbur Hunt had his arm broken, and was badly burned about the face and hands. Erastus Dorman was badly burned about the face, and scalded about the abdomen. His recovery is doubtful.

SAW-MILL (173). A saw-mill boiler exploded on October 14th, at Thorpe's Switch, on the Santa Fé road, near Montgomery, Tex. Alexander White and a boy whose name we have not learned were instantly killed. A section of the boiler cut a freight car near by into halves.

WOOD-WORKING FACTORY (174). A double explosion took place on October 20th in Phillips & Co.'s factory at Fenton, near Flint, Mich. The first boiler exploded at about 9 o'clock A.M., and the other one at noon. The second explosion set fire to the shaving-bin, but the fire department responded promptly and the flames were soon under control. The damage was not great.

——— (175). A boiler exploded about October 15th in the town of Wesley, near Algona, Iowa. A son of Mr. P. Madden was injured, but we have been unable to learn further details.

IRON WORKS (176). Two boilers in the rolling mill of the Burgess Steel and Iron Works in Portsmouth, Ohio, exploded on October 15th. The building was completely wrecked. Richard Fleming, fireman, was killed outright; George Bressler, an employe, had his back broken and his skull crushed, and has since died. Twelve others were seriously and some probably fatally injured. A score of others were more or less injured. The shock shook the city, and many windows were broken. At the time 400 men were at work in the mill, and the mammoth rollers were thrown twenty feet from the foundations. The loss was estimated at $10,000.

THRESHING ENGINE (177). The boiler of a threshing machine engine exploded on Brill's farm, eleven miles west of Sutner, near Aberdeen, S. D., on October 21st, killing a man named Lewis Horton, who was running the engine at the time. Three others were badly hurt. One man named Garrett Barry was probably fatally injured.

SHOP (178). On October 22d William H. Patterson, a boilermaker, was employed at the lower shops in West Albany, N. Y., repairing the leaky condenser attached to the engine which furnishes power for the shops. No one was with him at the time, and consequently it cannot be stated just how the accident occurred, but an explosion was heard, and Patterson's body was seen whirling through the air. Patterson struck on the roof of what is known as the shavings shop and then rolled off to the ground. The amublance was sent for and he was taken in a semi-conscious condition to the city hospital, where it was found that his left arm was broken and badly mangled. His right wrist was broken, and there were bad wounds and burns and bruises nearly all over his body. It was found necessary to amputate the right arm. Hopes were entertained of his recovery, but he failed to rally and died shortly before 12 o'clock on the following night. Patterson was 45 years old, and leaves seven children.

HOSPITAL (179). A serious explosion occurred in Ottawa, Kan., on October 23d, in the boiler-room of the Santa Fé Hospital, by which Dr. Wright, the surgeon, and W. E. Bliss, an attendant, were very painfully injured. The regular engineer was confined to his room by sickness, and Dr. Wright and Mr. Bliss were trying to start up the boilers for the first time since spring. The front head of one of them blew out, wrecking the boiler-room and hurling the two men out of doors with great force. Both were terribly cut and bruised, but they will recover.

PICKLE FACTORY (180). The village of Nunda, near Elgin, Ill., was considerably excited on October 24th over a boiler explosion. The account says that "before the excitement an innocent looking boiler stood in J. J. Wilson's pickle factory. When the excitement was at its height the boiler was hustling through the roof. It had burst, and the crowd that gathered thought some one had been killed. The man in charge had left it but a moment before the wreck.

LOCOMOTIVE (181). At Palos, a small station on the Kansas City, Memphis & Birmingham Railroad, nineteen miles west of Birmingham, Ala., two men were blown to atoms at an early hour on the morning of October 27th by the explosion of a locomotive boiler. The local freight stopped there as usual, and the cars were switched to a side-track. Suddenly the boiler exploded with a loud report. Harry Monroe, the engineer, and William Church, the fireman, were both instantly killed. Conductor Black was slightly hurt.

COTTON GIN (182). A boiler exploded on October 24th at Frank Barringer's cotton gin, in Stanley County, near Richmond, Va. Barringer was standing in front of the boiler at the time, and had just opened the fire door. The explosion broke one of his arms, tore the flesh from the other, broke his jaw-bone and collar-bone, scalded the upper part of his body, and threw him on a pile of hot coals. At last accounts he was expected to die.

FLOUR MILL (183). Clendenning's extensive flour mill in Carman, Man., was completely wrecked about six o'clock A.M. on October 28th, by the explosion of the boiler. No one was seriously injured, the engineer having just left the engine-room a few moments before the explosion. The building, as well as the engine and boiler and other machinery in the mill, is an utter ruin and cannot be repaired. Pieces of the boiler were blown a distance of 300 feet, and immense beams and iron shafts were broken like pipe stems. The engine-house was blown out of existence. The engineer says he only had sixty pounds of steam on at the time. Mr. Clendenning's loss was very heavy, as the mill and machinery were first-class in every respect. There is no other flour mill in the neighborhood, and the loss was a serious one to the farmers, who had to depend on this mill for their flour. Had the explosion taken place later in the day more serious results might have had to be reported, as employes and others would have been in the mill. There were 500 feet of siding over the boiler in process of drying. Not even a sliver of this lumber could be seen near the place after the explosion. Mr. J. A. Gillies, miller, and Mr. Clendenning's son were in the mill at the time, but both escaped without any serious injury.

MANUFACTURING WORKS (184). On October 28th the bursting of a steam-pipe in the Webster Manufacturing Works, at Fifteenth street and Western avenue, Chicago, Ill., fatally scalded John Mulvaney, a laborer, and badly burned four other men employed in the establishment. The men injured in addition to Mulvaney were Thomas Dobbs, Patrick Moran, William Dee, and Morris Laneto, who was additionally injured by being thrown through a skylight. Mulvaney, who was standing near the pipe when the explosion occurred, was terribly torn and lacerated, and was removed to the county hospital. The other men were taken to their homes.

ASBESTICON WORKS (185). A serious fire broke out on the evening of October 30th in the Chicégo Asbesticon Company's building, 2640 Shields avenue, Chicago, Ill. Just before the flames broke out a loud noise was heard, which is believed to have been caused by the explosion of the boiler. A large amount of damage was done, but no lives were lost.

STEAMER (186). On October 30th a boiler exploded on the river steamer *Wakefield*, of the Washington (D. C.) Steamboat Company, while the steamer was rounding Maryland Point, forty-five miles down the Potomac River from Washington. The *Wakefield* carried 42 passengers and a load of miscellaneous freight. The fireman, Alexander Tolson, and the assistant fireman, James Johnson, were in the fire room and were killed. Two deck hands, William Motley and William Carley, who were forward of the engine-room, were badly scalded, and Assistant Engineer E. L. Germond was slightly scalded. William Clark was thrown into the river and drowned. The steamers *Holly* and *Arrowsmith* came to the assistance of the *Wakefield*, the *Arrowsmith* towing her up to Washington.

On Certain Peculiarities of Jets of Steam.

At a recent meeting of the Royal Society Mr. John Aitken read a paper entitled "On some Phenomena connected with Cloudy Condensation," which contains the results of some very interesting observations made by him. The paper is thus summarized by *Nature:*

It has been known for a considerable time that when a steam-jet is electrified it at once assumes a very dense appearance. Experiment showed that other causes can produce this same effect, and Mr. Aitken has enumerated and investigated, in all, five such causes.

1st. *Electrification.* It was shown that the mere presence of an electrified body in the vicinity has no influence on the steam jet. In order to produce the increased density the water particles in the jet must be electrified, either by direct discharge, or by an inductive discharge, effected by means of either a point or a flame. The increased density produced by electrification is due to an increase in the number of water particles in the jet, by the electrification preventing the small drops from coming into contact, by the mutual repulsion it produces, in the same manner as the water drops in Lord Rayleigh's experiments with water jets, which scatter more when electrified than when not electrified. The coalescence of the drops in water jets takes place only under the disturbance produced by the presence of an electrified body, while such a disturbance produces no effect on steam jets. Other experiments point to the conclusion that the increase in the density is due to an increase in the number, and not to an increase in the size, of the drops. For instance, if steam is blown into a receiver full of air in which there are many dust particles to serve as nuclei of condensation, the clouding is dense; and if there are few nuclei the clouding is not dense. The same statement holds good for the clouding produced by expanding moist air. If many dust particles be present, the clouding is dense; if few, it is not dense. The explanation of the effect of electrification seems to be, that since the particles in the jet are in rapid motion there are frequent collisions among them under ordinary circumstances, and a consequent coalescence of the small drops into larger ones; whereas, when the small drops are electrified they repel one another, and coalescence is in some degree prevented. The jet, upon becoming dense, emits a peculiar sound, which is the same whatever be the cause of the increased density. But when it is electrified, along with this sound there is another, due to the discharge of the electricity, which causes the electrified jets to appear to make a louder noise.

2d. *Presence of Dust.* Flame was not found to have any influence on the steam jet, but on bringing the products of combustion to the jet, it at once becomes dense, and remains dense so long as the supply is kept up, and the jet has exactly the same appearance as if electrified. When in this condition electricity does not increase its density any further. The increased density is here due to the large number of dust particles present. Condensation takes place about these particles as nuclei, and hence the jet contains a much larger number of water particles when dust is present than when it is absent, and it accordingly appears more dense.

3d. *Low Temperature of the Air.* When a steam jet condenses in air at ordinary temperatures it has but little density; but if the open end of a metal tube cooled to 45° be held near the origin of the jet, the condensation at once becomes dense, and neither electrification nor an increased supply of dust nuclei makes it any denser. In a room at a temperature of 46° the jet is always dense, and neither electricity nor the products of combustion have any effect on it; but when the temperature rises to 47° the jet begins to get a little less dense, and electricity now increases its density slightly. At 50° the jet is much thinner, and both electricity and the products of combustion have a marked effect on it. The change produced by the cold air cannot be entirely due to the lower temperature causing more vapor to be condensed, as a slight fall in temperature produces a great change in density. The increased density may be shown to be due to a change which takes place in the surface films or skins of the small drops with the fall of temperature. When the temperature is above a certain point the surface films have no repulsive action, and the drops coalesce on collision; whereas when cooled below a certain temperature the well-known repulsion comes into play and prevents coalescence. This was proved by repeating Lord Rayleigh's experiments with water jets. When the temperature of the water was over 160° the drops had no tendency to scatter, and the presence of an electrified body had no influence on the jet. It was only when the temperature fell that scattering began, and the electrical disturbance produced coalescence. The effect of the low temperature is the same as that of electrification; both of them prevent the water drops from coming into contact, one by electrical repulsion, and the other by the repulsive action of the water films, and the result is the same, namely, an increase, or rather a prevention of the decrease, in the number of the particles, and a consequent increase in the density of the clouding. [A good example of the repulsive action that exists between the surface films or skins of water drops may be seen when rowing leisurely on a smooth stream. Most of the drops that fall from the oars plunge down into the river and are lost; but many others may be seen floating away on the surface of the stream, as though they were made of cork. If a repulsive action of some kind did not exist between the river and these floating drops the two would merge into each other instantly. — ED. LOCOMOTIVE.]

4th. *High Pressure of the Steam.* Below a temperature of 46° the jet is dense at all pressures, and as the temperature rises the density decreases; but the density may be made to return by increasing the pressure. The increased density of the high-pressure steam jet is due to an increase in the number of drops produced, (1) by the jet being more cooled by the greater amount of air that is drawn into it; (2) by a larger supply of dust nuclei from the same cause; and (3) because since the condensation is more rapid, a larger proportion of the dust particles present are forced to become centers of condensation.

5th. *Obstructions and Rough Nozzles.* Rough nozzles and obstructions in front of the nozzle are found to act in the same way as increase of pressure; they aid pressure in producing its effects with a less velocity of steam. They act by producing eddies which mix more air with the steam, with the result that the temperature of the jet is lowered, the number of dust nuclei is increased, and the rate of condensation is quickened.

The seat of sensitiveness to all these influences causing condensation to become dense is near the nozzle. Both low temperatures and obstructions have an effect only when they act very close to the nozzle. Electricity and increase in the number of dust nuclei have an influence which is greatest at the nozzle, but which is felt with rapidly diminishing intensity up to a distance of an inch or so from the nozzle.

After speaking of the density of the steam jet as affected by the causes mentioned above, Mr. Aitken went on to speak of certain color phenomena that have been observed. Color has been seen by Principal Forbes and others in the steam escaping from steam boilers, but these color phenomena have as yet been but little studied. For observing the color in steam jets Mr. Aitken has found it to be a great advantage to enclose the jet in a tube, and examine the effect through some length of condensing steam. Steam by itself has no color in moderate lengths, but when mixed with a certain amount of cold air, and a certain quantity of dust, very beautiful colors are produced. In his method of experimenting a jet of steam is allowed to blow into the open end of a tube, and the amount of dusty air entering with it is regulated at pleasure. When the jet is condensing under ordinary conditions, the color of the transmitted light varies from greens to blues of various depths, according to the conditions. The color may be made very pale or very deep by varying these conditions. If the condensation in the jet is made to change and become dense by any of the five influences mentioned above, the color generally becomes of a yellowish-brown. This yellow color, seen through steam when the jet is electrified, has been observed by previous experimenters. It was thought that the color was due to the electricity, and that the experiment explained the lurid color of thunder-clouds. There does not, however, seem to be any connection between the electrification and the color, as the transmitted light becomes of the same lurid hue when the jet is made dense by any of the other influences. The yellow colors seen through steam are not usually so beautiful as the greens and blues, but when the density is due to *high pressure*, the yellow is very fine.

Mr. Aitken next touched upon the colors observed when cloudy condensation was produced by expansion. No colors had been seen, previously, in the light transmitted directly through the cloudiness produced by expanding saturated air in a receiver. Mr. Aitken thought this was owing to the slowness with which this process is generally made to take place in the expansion experiments. On arranging an experiment to make the rate of condensation rapid, beautiful colors were seen on looking through the clouded air. An air pump was connected with a metal tube provided with glass ends. The capacity of the tube was small compared with the capacity of receivers that had generally been used in these experiments. When the air in the tube was suddenly expanded by working the pump, the light passing through it became beautifully colored, and the color and the depth of the color varied with the conditions. When there were but few dust particles in the air, a slight expansion made the transmitted light blue; a greater expansion changed it to green, and then to yellow; and when the expansion was still further increased the color changed again and a second blue made its appearance, followed by a second green and yellow. But if very many dust particles were present, the same amount of expansion which had before produced the second yellow now gave only a very deep blue. When it is desired to produce these color phenomena on a large scale a vacuum receiver is used. This receiver is connected with the experimental tube or flask by means of a pipe fitted with a stop-cock. After a partial vacuum has been made in the receiver, the cock between it and the flask or tube in which the colors are to be shown is suddenly opened, and the color-producing condensation is seen at once. These color phenomena fade rapidly away. The spectroscope shows that when the light is blue there is a general darkening of the whole spectrum, but the absorption is greatest in the red end, and the red end is also much shortened. When the transmitted light was yellow, the blue end was cut out, and the yellow part of the spectrum was much the brightest.

When the condensation in the steam jet is dense, some of the yellow color in the transmitted light is due to some of the particles being so small that they reflect and scatter the blue rays. This blue reflected light is polarized. The colors, however, seem in most cases to be produced in the same manner as the colors in thin plates; only a few of the colors of the first order or spectrum are visible, while those of the second and third orders are very distinct.

It is thought that the color phenomena described above give the explanation of the "green" or "blue" sun seen in India and elsewhere in September, 1883, and also on other occasions. The eruption of Krakatao had taken place a few days before the green sun was observed in India. The volcano threw into our atmosphere a great quantity of water vapor, and a vast amount of dust, the very materials necessary for producing a green sun by small drops of water. Prof. C. Michie Smith's observations made in India show that there was a great amount of vapor present in our atmosphere at the time, and most observers frequently refer to a fine form of haze that covered the sky on the days the green sun was seen. It is therefore in the highest degree probable that, under the conditions existing at the time, this haze was chiefly composed of water.

The color phenomena produced when air is suddenly expanded has led to the construction of a new instrument for indicating roughly the amount of dusty pollution in the air. This instrument has been called a "koniscope," and it is hoped it will be found useful in studying sanitary questions. It consists simply of an air pump and a tube provided with glass ends. The air to be tested is drawn into the tube, where it is moistened and expanded. The depth of color seen on looking through the tube indicates the amount of impurity in the air. When there are about 1,200,000 particles of dust per cubic inch the color is very faint; 22,000,000 particles per cubic inch give a fine blue; and 58,000,000 give an extremely dark blue. These colors are for an instrument having a tube twenty inches long. By means of this instrument it is easy to trace the pollution taking place in our rooms by open flames and other causes. We can also trace, by means of it, the pure and impure currents in the room, and note the rate at which the impurity varies.

The Locomotive.

HARTFORD, DECEMBER 15, 1892.

J. M. ALLEN, *Editor*. A. D. RISTEEN, *Associate Editor*.

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*

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Papers that borrow cuts from us will do us a favor if they will mark them plainly in returning, so that we may give proper credit on our books.

THE present issue completes the thirteenth volume of THE LOCOMOTIVE, and the indexes and title pages for this volume are now ready, and will be sent to any address upon application to this office in writing. The indexes of the ninth and tenth volumes of THE LOCOMOTIVE (*i.e.* the volumes for 1888 and 1889) have been out of print for some time. A new edition of these indexes will be ready shortly, and we shall be pleased to send them to whoever may need them for binding. We call attention to this fact because we have received numerous applications for them that we have been unable to fill.

CURIOUS things often happen when inexperienced persons attempt to improve on the designs of competent engineers. A simple and stupid illustration of this fact came to our notice recently. An engineer had been called upon for advice concerning cylinder drain-cocks, and had made a sketch in which a drip pipe was shown connected to each end of the cylinder. Each of the drips was to have a small valve in it, and on the waste side of these valves the drips were to come together by means of a tee, and a single pipe was to run from the junction to a convenient place for discharge. If the outfit had been put in in this manner, there would have been no trouble ; but someone conceived the idea that there was a superfluity of valves in those pipes, and took it upon himself to order that both of them should be discarded and in place of them a single one should be put in *below* the tee. Of course, the result was, that a by-pass between the two ends of the cylinder was formed, and the engine would not work well, for reasons that were quite mysterious until the expert was called upon for further advice.

This reminds us of another case that came to our notice recently, in which the conditions were reversed, and *more* valves were put in than were necessary; although in this instance the work was done under the direction of a boiler-maker. There were two boilers set in one battery, and in each of the risers running from the individual boilers to the steam main, *two* stop-valves had been placed. When we asked why the second pair of valves was put in, we were told that it was to provide against a possible failure of the first pair. Now, if a pair of boilers really are safer with two valves in the risers instead of one, we should like to be satisfied of the fact, for we are great believers in all things that are conducive to safety; but up to the time of writing, we have not been able to see it. If the steam main bursts, one valve on each of the feeders ought to be sufficient to stop the flow of steam; and if one of the feeders or one of their valves should burst, the extra valve would be of no use, since it would be impossible to approach it on account of the steam that would envelop it. If one of the boilers were out of use, and one of its stop-valves should fail, the valve on the working boiler could be closed as quickly as the extra one on the cold boiler, so that the gain in safety in this case would also be questionable. There is one advantage that the double arrangement would have, and that is, that an inspector, inside a boiler fitted up in this way, would be more secure with two stop-valves closed behind him than he would be with only one; but we do not think this consideration would have much weight with the majority of mill owners. Several objections could be urged against the use of the double valves, but the extra expense involved is probably the weightiest one. Blow-off pipes need double valves much more than steam pipes do, for fragments of scale are apt to lodge in them in such a way as to keep them from being closed tightly. If plug valves with full openings are used, it is almost always possible to blow out these obstructions by opening the valve again momentarily; but in case this cannot be done readily, a second valve comes very handy. We have also known cases in which the blow-off valve was obstructed by a foreign substance when the fireman did not notice it, and thought he had closed it tightly. In several such cases the boiler was badly burned before the leakage was discovered. Such accidents are much more frequent when globe valves or other valves with tortuous or constricted passages are used than they are with plug cocks having an opening equal to the full diameter of the pipe, and for this reason we always recommend the plug cocks for blow-offs.

Mr. Frank Chaese.

We regret to announce the death of Mr. Frank Chaese, which occurred in Hartford on the 5th day of the present month. Mr. Chaese was a faithful and highly esteemed employé of this company, and his marked inventive and constructive talents had indicated a bright and prosperous future for him. He was born in Egremont, in Cheshire, England, on June 20, 1862, and was therefore only 30 years of age. He received his early education in a private school in London, and he afterwards studied in the commercial schools of Manchester. At the age of 17, he entered a machine shop at Salford, Manchester, and three years later received the appointment of third engineer on the steamship *Yucatan* of the West India Steamship Company, plying between Liverpool and the West Indies. Afterwards, he was third engineer on a coasting steamer running from Liverpool to the Cape of Good Hope ; but when he reached Hamburg on his first trip out, he received an injury to his hand which obliged him to return to England. In 1886, he came to the United States, and after spending a short time in the shops of the Schuyler Electric Light Company, he became an inspector for the Hartford Steam Boiler Inspection and Insurance Company. He was married in 1889.

Of the many evidences that he gave of his adeptness in mechanical matters, the most remarkable was undoubtedly his model of a modern disconnective quadruple expansion marine engine, which was described in The Locomotive for July, 1891. It is a working model, and although it stands only about 14 inches high and weighs only thirty pounds, it contains some three thousand six hundred parts, each one of which Mr. Chaese made with his own hands. Notwithstanding the smallness of the model, it embodies numerous improvements that we believe to be new to marine engineering, some of which are noticed in the article referred to above. At the time of his death, Mr. Chaese was constructing a petroleum engine, which he believed would be superior to those now in use.

Mr. Chaese was of a retiring disposition, and there were few with whom he was truly intimate. He was phenomenally considerate of the wishes of others, and spared himself no pains in fulfilling them. He will long be remembered for his integrity, his gentleness of spirit, and his untiring devotion to the interests of his employers and his friends.

Boron.

Boron is a non-metallic element, resembling sulphur in this respect, though it differs widely from sulphur in its properties. It is one of the components of the substance known familiarly in every household as *borax*, and from this circumstance it takes its name. In nature it is never found in the uncombined or elementary state, though it occurs abundantly in combination with other things, especially in regions that are, or have been, volcanic. The principal substances in which it occurs native are borax and boric, or boracic acid. It is a constituent of numerous other minerals also, but these have little commercial importance, and are of interest chiefly to the mineralogist. Boric acid occurs in the waters of the lagoons of Tuscany, from which place most of the boric acid and borax used in Europe are obtained. It is also found along the western coast of South America, throughout Atacama and the recently acquired parts of Chili. Of the deposits in South America those to the north of Copiapo have been worked more successfully than the others, commercially. Boric acid is also found in California, Nevada, and Nova Scotia, and a compound of boron and lime that is found on the western coast of Africa, has been used somewhat in England as a source of borax. Borax itself was first obtained from the basins of dried-up lagoons in Central Asia, but these have long ceased to be an important source of this substance, which is now largely prepared in Europe from the boric acid of Tuscany. In this country, the famous borax lake of California yields enough borax to supply the whole demand of the United States.

Concerning the discovery or isolation of the element boron, Roscoe says: "The name *borax* is found in the writings of Geber and other alchemists. It is, however, doubtful whether they understood by the word the substance that we now denote by it. Nothing satisfactory was known concerning the chemical nature of this salt for a long time. Homberg first prepared boric acid from borax in the year 1702, and he termed it *sal sedativum*, for he was unacquainted with the composition of the acid. It was not till 1747–8 that Baron showed in two memoirs read before the French Academy that borax is a compound of *sal sedativum* and soda. After the establishment of the Lavoisierian system of chemical philosophy, the name boracic acid was given to *sal sedativum*, and it was then assumed that this acid contained an unknown element, for the isolation of which we are indebted to Gay-Lussac and Thénard, as well as to Sir Humphrey Davy, who about the year 1808 obtained elementary boron." Gay-Lussac and Thénard prepared elementary boron by heating boric acid very strongly until all its water was expelled; and then re-heating the resulting substance (now known as boric oxide) with metallic potassium. The potassium removed the oxygen from the boric oxide, setting the element boron free.

When thus prepared, boron is an opaque, amorphous powder, of a greenish-brown color. It has neither taste nor odor, but it stains the fingers strongly. Owing to its finely divided condition it is apt to take fire spontaneously; but if it is consolidated by pressure it is not affected by the air at common temperatures, though it burns with a reddish light when heated. It is not affected by water, save that water will dissolve a slight amount of it when it is freshly prepared. Strong nitric acid will dissolve it in the cold, and hot sulphuric acid attacks it also. It is one of the few substances that will combine directly with nitrogen, which it does when heated in that gas. The atomic weight of boron has not been determined with satisfactory precision, but Clarke gives 10.97 as the best result obtainable from the existing data. The amorphous boron described above is soluble in melted aluminium, from which it crystallizes out on cooling. The crystals so obtained were formerly thought to consist of pure boron, but it has been shown that they always contain a definite amount of aluminium. These crystals may be obtained of such hardness that they will scratch both corundum and the ruby, the diamond being the only substance that exceeds them in this respect. The specific gravity of amorphous boron has not been satisfactorily determined, but it appears to exceed 1.84. The specific gravity of the crystals obtained as described above is said, by Miller, to be 2.68. The specific heat of boron varies considerably with the temperature. At 250° C. it is .37, and at 1,000° C. it is probably .5. Boron is a non-conductor of electricity. The chief lines in its spectrum have the wave-lengths 2,496.3, 2,497, and 3,450.1 (Hartley).

There are but few compounds of boron used in the arts besides boric acid and borax. Borate of ammonia has been used to render light fabrics non-combustible. Borate of copper (obtained by mixing cold solutions of borax and sulphate of copper) has a beautiful green color, and is used to some extent to replace arsenical green in painting and dyeing. Lead borate, obtained by melting lead oxide with boric oxide, makes a nearly colorless glass, as hard as flint glass, and with a much higher refractive power. It has been used somewhat in optical apparatus. Common borax is a borate of soda. Several of the borocitrates (compounds of a very complex constitution) are considered to be valuable remedies in cases of kidney disease and urinary calculi. Thorpe says that they dissolve the urates and phosphates even more readily than lithium benzoate does. The magnesium borocitrates are also said to be powerful antiseptics.

Of the two compounds of boron chiefly used in the arts, boric acid is used for glazing porcelain, for making glass, in the preparation of certain pigments, and in the manufacture of candles, where it is used to render the wicks less combustible. It is also used somewhat for retarding acetous fermentation, though it has little effect in this direction after the formation of acetic acid has once begun. It is a weak acid, and is considered to be non-poisonous. It is used in medicine as a disinfectant, and it is an important component of most eye-washes. On account of its antiseptic properties it has been used for preserving meats, but there is an astonishing difference of opinion among the authorities respecting the value of either boric acid or borax for this purpose. "Endemann finds that boric acid acts as a preservative to fresh meat only, and that previously salted meat cannot be preserved by means of it. Le Cyon states that meat preserved by borax is not diminished in nourishing properties, and that it is more readily assimilated; whereas Le Bon asserts that meat so preserved is useless as food. J. Forster concludes that the use of boric acid in preserving food is of questionable value, as it increases the secretion of the bile and excretion of albuminous matters. Gruber likewise states that the decomposition of albumen in animals is increased by borax. Vigier, on the contrary, concludes from a series of experiments on dogs and men that borax has no injurious effects, even in large doses."

Borax is used for a great variety of purposes. It has the property at a red heat of dissolving many of the metallic oxides; and hence it is valuable as a flux in soldering and welding, and useful in metallurgical operations and blow-pipe analysis. It forms the base of many of the fusible glass fluxes used for enamels and glazes. "An enamelled coating for cast-iron is made by fusing on the metal a mixture of quartz, felspar, clay, and borax, and then covering it with a glaze containing borax. A mixture of one part clay, one part felspar, and two parts borax is used instead of lead-glaze for glazing stoneware." We should not forget the homely use to which borax is put when mixed with sugar and placed in the nooks and corners of places infested with water bugs, these creatures having a singular aversion for it. When mixed with shellac in the proportion of one to five, borax renders the shellac soluble in water, and forms with it a kind of varnish. Borax is also used medicinally, both externally and internally.

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