HARTFORD STEAM BOILER ★ INSPECTION AND INSURANCE CO. ★

HARTFORD,

CONN.

The Locomotive.

PUBLISHED BY THE

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

NEW SERIES.
Vol. VIII.

HARTFORD, CONN.
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NEW SERIES—VOL. VIII. HARTFORD, CONN., JANUARY, 1887. No. 1.

Improved Man-hole Cover for Bleaching Keirs.

Our illustration this month shows an improved form of fastening for man-hole covers of bleaching keirs and similar vessels, which was designed by us some time ago, and has given perfect satisfaction wherever it has been applied.

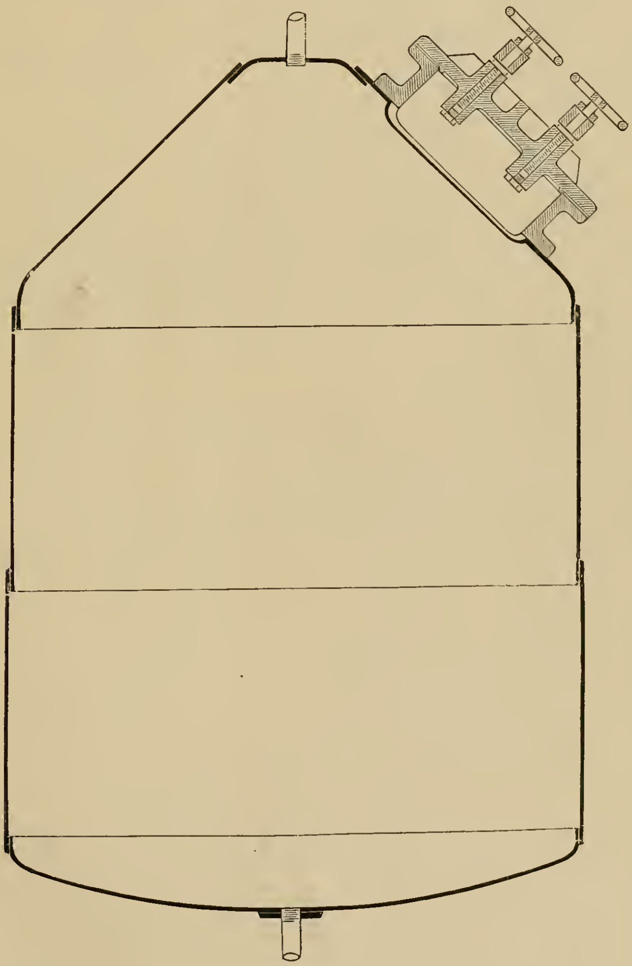

FIG. 1.

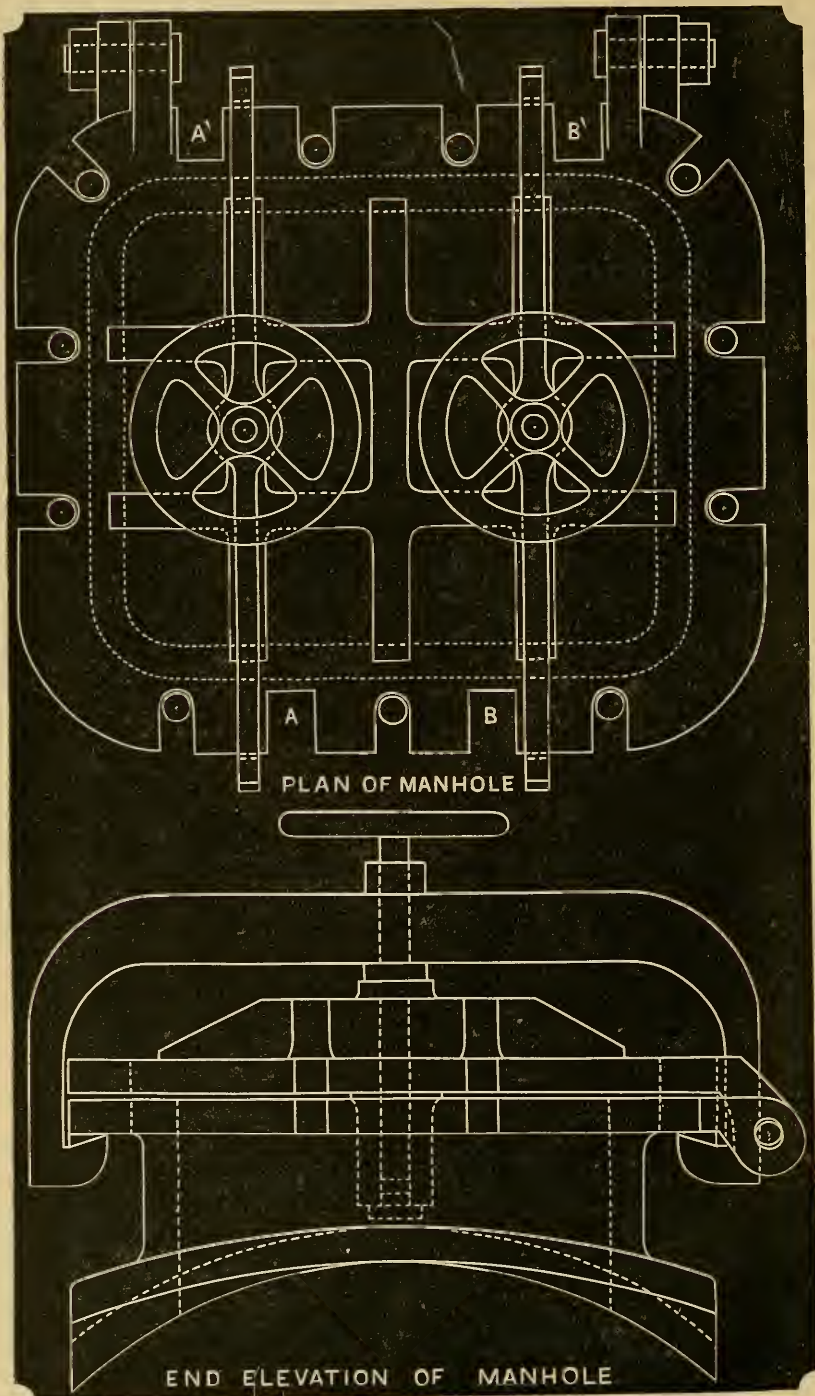

FIG. 2.

In putting on and taking off plates of this sort, there is always need of some sort of provisional fastening which shall hold the plate firmly in place, while the attendant is putting in or removing the bolts which are necessary to sustain the steam pressure. It is usual to make some sort of a detachable yoke, like that used on an ordinary man-hole, but the use of this is attended with inconveniences which it is desirable to avoid. In the fastening shown in the illustration, the man-hole cover is provided with two deep bosses, into which a thread is cut as shown. For greater convenience in use these threads may, and should be, left-handed. Screws, furnished with hand wheels, run into these bosses and carry the yokes, as shown clearly in the cuts. When it is desired to remove the plate, the bolts are taken out in the usual manner and laid aside. The yokes are then loosened by simply giving the screws a turn or two by means of the hand-wheels, and swung around sideways so that the hooks on their ends come into the slots in the frame shown at A A′ and B B′ in figure two. This allows the plate carrying screws and yokes to be swung back on the hinges, and everything is clear. The hinges have holes elongated vertically, to enable the plate to adapt itself to different thicknesses of packing and always come to a firm bearing.

Inspectors' Reports.

NOVEMBER, 1886.

Our usual monthly statement of the work of the inspection department is given below. The inspection trips foot up 3,447, the whole number of boilers examined 6,725 the number inspected internally 2,402, the number tested by hydrostatic pressure 440, while the number condemned was 48. The defects reported foot up 6,807, of which 959 were considered dangerous. Our usual summary follows :—

Nature of defects.	Whole number.	Dangerous.
Deposit of sediment,	421	46
Incrustation and scale,	602	62
Internal grooving,	19	8
Internal corrosion,	148	26
External corrosion,	285	29
Broken, loose, and defective braces and stays,	238	35
Defective settings,	158	19
Furnaces out of shape,	241	12
Fractured plates,	151	65
Burned plates,	111	24
Blistered plates,	257	18
Cases of defective riveting,	2,105	348
Defective heads,	38	13
Leakage around tube-ends,	906	132
Leakage at seams,	682	43
Defective water-gauges,	98	16
Defective blow-offs,	35	10
Cases of deficiency of water,	12	3
Safety-valves overloaded,	25	12
Safety-valves defective in construction,	28	7
Defective pressure-gauges,	208	26
Boilers without pressure-gauges,	2	0
Defective man-hole plates,	1	1
Defective hangers,	33	1
Defective fusible plugs,	1	1
Defective tube-holes,	2	2
Total,	6,807	959

In using oil of any kind to remove scale from steam boilers, and more especially where anything of the nature of kerosene or benzine is employed for the purpose of loosening it to facilitate its removal by mechanical means, great care should be used by the person so employing it, or he may be seriously injured. Accounts of serious accidents of this nature, resulting from carelessness or thoughtlessness, are frequently given in the newspapers, and without doubt many more happen which are not reported. Quite recently we received an account of an especially serious accident of this kind, a description of which may serve as a warning. The engineer and fireman were engaged in cleaning the boiler of the establishment in which they were employed. To loosen the scale they put a large quantity of a mixture of kerosene oil and benzine into the boiler, and then run it full of water, the object being to cover the inside of the boiler with the mixture, and so "cut" the scale. After letting it remain awhile, the water was drawn off, and the engineer lighted a torch and looked through the man-hole to observe the effect. Putting the torch through the man-hole into the boiler to enable him to see the interior, ignited the inflammable gas generated from the volatile mixture adhering to the shell and flues, and it exploded with great violence throwing both men to the floor, and severely burning their hands and faces. At the time the report was written, it was feared that the engineer, who was the more seriously injured, would loose his eyesight, he then being entirely unable to see. It might be considered that the loss of eyesight by a man in ordinary circumstances would be quite as bad as instant death, so it will be seen that too great care cannot be exercised in the performance of such work.

Serious accidents have also occurred from gas explosions of a different sort. Quite a number of cases are on record where boilers having stood empty for a while, with blow-off open, and in connection with a sewer or other foul place, have become filled with gas of some sort, which has ignited with such violence as to resemble an explosion and doing serious damage. An item in our last volume, on page 158, details an accident of this kind which nearly cost one of our inspectors his life. We would again urge, and insist that too much care cannot be exercised in such cases to make sure that everything is all right before introducing a light into the boiler.

Boiler Explosions.

NOVEMBER, 1886.

COTTON MILL (152). — The mud-drum of boilers Nos. 5 and 6 at the Charleston Cotton Factory, Charleston, S. C., exploded November 2d, wrecking the boiler-house and killing William Oakes, colored, fireman, and seriously injuring Arction Richardson, colored, coal roller. Over 500 hands are thrown out of employment temporarily.

STEAMBOAT (153). — The boiler of the steamer *Coxsackie* burst near Poughkeepsie, N. Y., November 3d, killing fireman Matthew Quinn of Coxsackie, and scalding another fireman seriously. Andrew Fitzgerald, another fireman, was on deck at the time and escaped.

LOCOMOTIVE (154). — The boiler of a locomotive on the Texas & Pacific Railroad exploded November 4th, near Davis station, La., killing engineer George De Haven, and a brakeman named Given. Conductor Charles Norton was severely injured.

SAW-MILL (155). — A flue in the boiler in the Valley Lumber Company's mill, near Eau Claire, Wis., collapsed, November 4th, wrecking a portion of the engine-house. Fortunately the boiler-room was vacant at the time of the explosion, and nobody was injured. The prompt arrival of the fire department prevented a costly conflagration.

STEAMBOAT (156). — The little steamer *Dale* blew out a boiler-head November 7th, near Cincinnati, Ohio. Two men jumped overboard and were drowned.

Locomotive (157). — The little engine which has done duty on the Colchester, Conn., branch road, ended its existence November 8th, by bursting the boiler while running down from Turnerville. The boiler seemed to split from the dome toward the front. The force of the explosion was terrific, one large fragment digging a great hole in the earth beside the track, and another cutting the telegraph line so that it was impossible to communicate with New Haven. The engine did not leave the rails. The engineer and firemen were badly cut by flying glass, but fortunately escaped any severe burns or other injuries.

Sugar Plantation (158). — At Myrtle Grove plantation, La., owned by Congressman-elect Theodore S. Wilkinson, the boiler of the draining machine exploded with, fearful force November 9th. The engineer, Gabriel Burroughs, the fireman, and a third man employed at the wheel, were all badly scalded and injured by the debris. The explosion was felt for miles up and down the coast. Medical assistance was promptly rendered to the wounded men. It was found that Burroughs was injured in various portions of the body, and was in a critical condition, his leg being so badly shattered that it became necessary to amputate it. The other men were also severely injured. The explosion was occasioned by want of water in the boiler.

Coal Mine (159). — A terrible accident occurred at Pratt Mines, near Birmingham, Ala., November 10th. At the top slope, No. 1, there were six large boilers which supplied steam for an engine used to draw up the cars loaded with coal from the slope. These six boilers are under one roof and are connected with each other. At 12.20 a. m., the inhabitants and workmen at the mines heard a terrific explosion and saw the fragments of the engine-house thrown to a height of at least thirty feet. After the consequent excitement had subsided, investigation revealed the fact that two of the boilers had exploded and been blown to atoms. The boiler-house was a complete wreck, and many of the fragments were found a quarter of a mile away. The engineer and firemen were in the house at the time of the explosion, and about thirty men were working immediately around the house, all of whom escaped without injury, which was miraculous. Tom Sanford, a white boy of seventeen years of age, who drives a mule to one of the coke-oven carts, was standing fifty feet from the scene of the explosion, and was struck on the head by a piece of the flying debris and instantly killed, the top of his head being blown away. The mule he was driving was also killed. The shock was so great that panes of glass in the windows of Mr. L. M. Johns' house, five hundred yards from the site of the accident, were broken, and every one around the mines experienced a staggering shock. Three hundred men work in and around the slope, and [it is truly a miracle that none of them were killed. It seems that the force of the explosion went straight upward, as even the men who were under the same roof with the boilers escaped uninjured. All of the boilers were damaged and will require repairing.

Box Factory (160). — The boiler in the cigar-box factory of H. H. Sheidt, No. 1,710 Randolph street, Philadelphia, exploded with a terrific report, November 11th, throwing the walls on a number of workmen. The building took fire, and before the hands employed in the place could extricate themselves and escape, the flames were bursting from every window on the Randolph street front. There were nine men and several girls in the factory at the time, and not one of these escaped unhurt. Carrie Bruner, aged eighteen, was killed. Loss $55,000.

Saw-mill (161). — The boiler at Nash's saw-mill, Royston, Pa., exploded November 13th, completely wrecking the mill and killing John Nash, the proprietor, and his son Edward. Their bodies were frightfully mutilated and were hardly recognizable. The detonation was heard several miles. The cause of the accident is unknown. The damage to the mill was $6,000.

Saw-mill (162). — The boiler in Mapes's mill near Sheffield, Pa., exploded with terrific force November 12th, instantly killing Milton Mapes, owner of the mill and his 12-year old son. Three employees named Robert Manross, Link Comstock, and Harry Knowles, were seriously, if not fatally, injured. The cause of the explosion is not known.

Sugar Plantation (163). — A fatal explosion occurred at the Guidry plantation in St. James' parish, La., November 12th, by which two men were instantly killed, and one so badly injured that he is not expected to live. The three men had just been employed to assist in sugar-making. After their run of work was over, the night being cold, they crawled on top of the boiler to keep warm while asleep. In a short time the boiler, from some cause not known, exploded with fearful force, and the sleeping men were hurled from their resting place with great force. One of the men, Nicholas Powell, was found severely injured, but still alive, and was brought to New Orleans for treatment. The other two were picked up in fragments. One of them was literally torn to pieces. His head was blown from the body, and his right arm and leg were also torn off and thrown a considerable distance from the trunk. The other man was almost as badly mutilated. The two men are unknown and their remains are disfigured beyond identification.

Saw-mill (164). — A terrible accident occurred November 16th, at a saw-mill in Newlight township, N. C. John H. Chappell, and William Woodlief were operating the saw-mill. Chappell was attending to the saw, and Woodlief to the engine. Suddenly the boiler exploded. Woodlief was thrown several yards from the spot and was unconscious when picked up. Chappell was thrown on his breast on the circular saw, which was revolving rapidly, cutting him through to the spine. Death was instantaneous. A negro standing near the saw-mill had an eye knocked out by a piece of flying timber.

Salt Works (165). — A terrible explosion occurred at the salt works, Syracuse, N. Y., November 20th, by which two engineers and a fireman were killed. The boiler of an iron filter burst, owing to the pressure of a hundred pounds of steam being put on when it was only fitted to stand fifty. It is said one of the engineers had drank too much beer, and the disaster occurred through his carelessness. Two of the bodies were blown 150 feet away, and the building was totally demolished.

Tug-Boat (166). — The tug-boat *Sunbeam*, lying near the schooner James H. Deputy, of Bath, Me., at an East River pier, blew up, November 25th, killing the owner and four men on board. Edward Bradshaw of Parker Head, Me., and William W. Hodgkins of Hunnewell's Point, Me., carrying lath to the pier from the schooner *Deputy*, were blown into the water. Hodgkins was drowned, but Bradshaw was rescued. The schooner *J. G. Ingraham* of New London, Conn., and the schooner *Gladys* of St. Johns, N. B., were damaged somewhat by the explosion.

Saw-Mill (167). — A lately discharged soldier of Company B, twenty-first Infantry, arrived in Price, Utah, Dec. 25th, from Fort Duchesne, and reported that a saw-mill engine used by the troops of the Uintah agency, burst November 23d, instantly killing private Murphy, and severely injuring two other soldiers.

Ice Factory (168). — The ammonia boiler in the ice factory at Apalachicola, Fla., exploded November 27th, killing C. A. Glazier, and fatally injuring Capt. William Moore, of Columbus, Ga., and seriously cutting several others. The factory was demolished.

The Locomotive.

HARTFORD, JANUARY, 1887.

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

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

A VERY practical test, to ascertain the loss of heat from uncovered steam pipes and those covered with different coverings, was conducted by Messrs. L. A. Upson, Superintendent, and Chief Engineer Steele of the Hartford Carpet Company, with the following result:

First, a room having a very even temperature and free from draughts or air currents was selected, close to the boilers, where steam could be taken from the top of the main pipe, and free from water of condensation. A suitable vessel was arranged to collect the water of condensation, and connected to 120 running feet of two-inch steam pipe. A short section of the pipe was enclosed in a suitable box with a glass in the side for the purpose of reading the rise of temperature, as indicated by a thermometer placed therein.

Steam was first blown through the pipe and receiver until both were free from the water of condensation which was caused by heating the pipe and receiver. The valve was then closed, and ten-hour trials made, the water carefully collected and weighed, with the following results:

FIRST TRIAL — TEN HOURS, 120 FEET OF TWO-INCH PIPE, UNCOVERED.

Average steam pressure, - - - - -	79 pounds.
Average temperature of room, - - - -	70 degrees.
Average temperature of box, - - - -	167 degrees.
Pounds of water condensed, - - - - -	862.

SECOND TRIAL — TEN HOURS, 120 FEET OF TWO-INCH PIPE, COVERED WITH ASBESTOS, HAIR FELT, AND PAPER.

Average steam pressure, - - - - -	77 pounds.
Average temperature of room, - - - -	69 degrees.
Average temperature of box, - - - -	80 degrees.
Pounds of water condensed, - - - - -	222.

THIRD TRIAL — TEN HOURS, 120 FEET OF TWO-INCH PIPE COVERED WITH PLASTIC MATERIAL.

Average steam pressure, - - - - -	80 pounds.
Average temperature of room, - - - -	70 degrees.
Average temperature of box, - - - -	107 degrees.
Pounds of water condensed, - - - - -	480.

It will be seen from the above that the loss by radiation greatly exceeds that usually estimated for uncovered pipes, but it agrees very well with trials made upon machines carrying high steam pressures. The saving by covering the pipes is very satisfactory, and in the second trial the temperature in the enclosed box was but little higher than that of the room.

If the correspondents of the *Scientific American* who are trying to explain the rupture of the water tower at Sheepshead Bay, N. Y., last October, did not show conclusively by their writings that they simply *don't know how* to calculate the bursting stress of a cylinder of given dimensions, their communications might possess some interest. As it is they do not.

Egbert P. Watson & Son, Publishers of the *Mechanical Engineer*, have recently brought out in book form the letters published in their periodical under the title of "The Professor in the Machine Shop." It is interesting reading, and will fill a leisure hour with profitable suggestions.

The Use of Steam.

For years economy in fuel has been the subject of much study, and has caused a vast amount of discussion, and has been primarily responsible for many types of steam generators and attachments, patent settings, and cheap fuels, all possessed of varying degrees of merit, or otherwise, as the case might be. This question seems to the writer to have been studied by engineers and manufacturers to the exclusion of a proper consideration of the economical use of the steam after it is generated, with the single exception, perhaps, of its use in engines for power purposes, which branch has received much attention, in spite of which, any decided improvement in their performance does not appear to have been recently made, and the engine remains a very wasteful machine, although if we glance at a few of the legion of advertisements of as many makers, and read the claims therein set forth, it would appear that little or nothing remained to be accomplished in this direction. But we hear so much said of the amount of fuel used and wasted, and the great cost of furnishing steam in our manufacturing establishments, it will be well to consider where it goes in some of the more ordinary cases, and call attention to the amount absolutely necessary to do certain kinds of work. We shall consider but a few of the many establishments requiring steam in the production of their goods, and first we will consider its use in a paper mill, not for the whole plant, but for one or two principal departments only, and for illustration, we will assume that the mill produces five tons of finished paper daily.

The felted paper, as it passes from the squeezing rolls to the drying cylinders, carries from 60 to 70 per cent. of water by weight; probably the average is not far from 65 per cent. It will therefore be seen that we have to evaporate 6,500 pounds of water per day, and that, too, from a low temperature, to do the drying alone. To this must be added the loss due to condensation resulting from the loss of heat from the exposed surfaces of the drying machine and its connections, which will be from one-third to one-half of a pound of water per hour for each square foot of exposed surface, according to circumstances.

The rotary bleacher will, if of the usual size, require about three thousand pounds of steam to bring it to the boiling point, and the radiation from it will result in the condensation of about 180 pounds of steam per hour.

The heating of the mill, the pipes in the drying lofts, and all exposed pipes will require about one-half pound of steam per square foot of surface per hour to make good the loss by condensation.

In bleacheries for cotton cloths and yarns, one pound of water evaporated in the generators will bring to a boiling point five pounds in the bleach, to which must be added the loss by radiation of heat. Dye-becks, scouring and washing machines, etc., will require steam in the same proportion. Cotton yarns, cotton in the bat, stockinet goods, etc., as they come from the hydro-extractors, carry about 38 per cent. of moisture, in fact, several weighings by the writer of goods from the extractor and from the drying-rooms showed a variation of less than 1 per cent. from the above.

Light ducks, drills, and jeans, were found to contain about 50 per cent. of moisture by weight as they passed to the drying cylinders, and by carefully collecting and weighing the water of condensation from the dryers, it was found to agree very closely with the amount which estimates showed would be required to evaporate the quantity of moisture carried by the goods, as stated above, after making due allowance for the loss by radiation of heat from the exposed surfaces of the drying machines. It should be mentioned, however, that the quantity collected has in every case exceeded, though but slightly, the estimated amount required.

A tentering machine operated in a closed room, with the temperature varying from 132 to 140 degrees, Fahr., condensed slightly more than one-half pound of steam to each square foot of coil per hour, the steam pressure varying from 35 to 40 pounds per square inch; had the pressure been higher, the condensation would have been greater, and more work could have been done.

Of woolen yarns the writer has not had so good an opportunity to ascertain the quantity of water remaining to be evaporated, but from limited trials made would expect it to range from 50 to 60 per cent.

We have touched, and but lightly, some of the processes requiring a large quantity of steam, and would add that this quantity is absolutely necessary under the most favorable conditions.

One fact should never be lost sight of by the manufacturer, viz.: whenever machinery is put in that requires steam in its operation, the sharp competition among the different makers of such machinery leads to their estimating and claiming, as features of such machines, the consumption of the minimum quantity of steam to do a certain amount of work, while similar causes tend in the opposite direction in the rating of the capacity of steam generators; that is, they are usually rated at their maximum capacity. This not infrequently leads to putting down insufficient boiler power, thus causing disappointment and dissatisfaction.

From the foregoing, it will be seen, the amount of steam necessary to do certain kinds of work is very considerable, and no arrangement can be devised that will in the least degree render the amount any smaller. In addition to the amount actually required to do the work, there will always be a certain amount lost by condensation in pipes, etc., and this quantity may easily become quite a large amount, as the following case will illustrate. A boiler to be used for heating purposes only was put in, and its capacity was sufficient to just supply the radiators and nothing more, under the most favorable conditions. The system as arranged had a very large quantity of piping, its only fault, as otherwise the arrangement was good. When started, the whole system seemed a failure, and gave great dissatisfaction. Investigation disclosed the fact that the supply and return pipes alone had radiating or cooling surface enough to condense all the steam the boilers could economically generate.

So, we find steam carried long distances and in many directions, in our large manufacturing establishments, and the heat lost in this manner sometimes bears no inconsiderable proportion to the whole amount used. It should also be borne in mind that the higher the pressure and temperature, the greater will be the proportion of loss from this source. It is our intention at some future time to discuss some of the cases of great loss or waste of heat from this cause that have come under our notice.

F. S. A.

"Contracted Perceptions."

Inasmuch as there is no accounting for the difference in individual tastes and views, it may be safely considered, that any steps in the direction of conforming to the multitude is a pitiable waste of energy. The differences of opinion that exist in the minds of some mechanics, men who have spent years in their various professions, and have a boasted experience of some longevity, and who, as they themselves express it, "ought to know how" must certainly astonish those that do not pretend to understand anything about it. When two doctors disagree in diagnosing a disorder, it is very evident that one of them, if not both, are not doctors. Doctors do not disagree, there is but one way of understanding natural phenomena; natural laws are immovable, and any difference of opinion or thought concerning them, is not the fault of the laws, but of the contracted or angular, and very often weak, perceptions of the thinker. The degree to which we understand is limited by the extent of our mind's digestion. Only those articles of diet that our stomachs can thoroughly digest, are of any value to the system, all others pass off in an undigested condition; our system is at war with itself — it is the victim of a misguided or paralyzed palate. So it may be said of our understanding, things that are thoroughly digested in the mind are beneficial and elevating, the countenance is illuminated, and disposition improved. The most objectionable and repulsive conversationalist is the individual whose mind's bowels are constipated with an undigested mass of ideas. It is to be regretted that this condition of affairs largely exists among mechanical men; subjects that ought to be universally understood are sometimes surrounded with an astonishing diversity of opinion, which may probably be accounted for, by the interests of the consulted being at stake. This, unfortunately, is not always the case; it would be easily understood if it was. It is more often the genuine earnest opinion of those who have had years of experience in some things, who can never be accused of being a subscriber to public libraries, lectures, and trades papers. The individual that has traveled in one long continued and undisturbed rut for years, who bases his opinions upon the phenomena without knowing the conditions existing, and who allows his years of uninterested service to stand in the way of a possible change of opinion, who never enlightens the apprentice boys in the shop, for fear that they will some day put him out of a job, and finally dies without having improved the practice of the profession one iota, the procession following them may sometimes be lengthy, but the wails and lamentations of the profession are feebly apologetic of original sentiment; the groceryman, tailor, and butcher, miss him, but the arts and sciences, NEVER.

John Erwood.

Grate Bars and Their Uses.

A PAPER READ BEFORE THE NEWARK N. A. S. E. BY F. B. ALLEN, SUPERVISING GENERAL AGENT OF THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

According to statistics, out of some sixty-nine million tons of coal mined in this country in 1880, probably over thirteen million tons were more or less perfectly burned under stationary steam boilers. As there is no detail of the furnace more important than the grate bar, perhaps we cannot spend the time at our disposal more profitably than by consideration of some of the principles involved in the design, construction, and use of this important adjunct.

It has been suggested that the oldest form of grate bars may have been a row of bars laid upon beams and stones, so as to admit air beneath the fuel in the intervals of the bars. While I have not ascertained who invented the grate bar, or when it was first used, something serving the purpose of grate bars are shown in the illustration of the

Marquis of Worcester's invention of 1663. The illustration is not sufficiently clear to determine much concerning the shape of these bars, nor other interesting details that would be valuable did we know them, and would assist materially in tracing the history of this useful article.

The grate bars of Savery's steam boiler in 1698 are more clearly shown, and in outline they are not unlike those of our day; there is also a dead plate, end bearing bar, and ash-pit, although history, if my recollection is not at fault, records that many of these improvements were made at a more recent date. We will not attempt to settle this question as the settlement is not important to our branch of the subject.

Though wrought iron grate bars have been used to some extent, and very highly commended for their economy and durability, the use of cast-iron bars in stationary boilers is so general as to be almost universal, and what is said herein regarding grate bars refers to cast-iron ones, unless otherwise stated.

The weight of fuel alone on grate bars cannot much exceed sixty pounds per square foot in any possible case. The weight of the load is not then an important factor. Practically, having provided the necessary air space, we dispose the metal and fashion the grate bars and bearers more to meet the possible strains of distortion due to a resistance to expansion when the intervening end and side spaces of the bars are choked with ashes, clinkers, or other refuse, and to withstand the careless, sometimes reckless use of the fire tools when cleaning fires.

There are a variety of forms of grate bars in use; for our present purpose we will simply classify them as the common bar, the air bar, and the water bar, an excellent and durable form of the common bar being those with a narrow and deep section in moderate widths and short lengths, say not exceeding three feet long in ordinary furnaces, and having as near as possible fifty per cent. of opening for the admission of air. The shape of these openings should be wider at the bottom than at the top, to lessen the danger of the air spaces becoming clogged with refuse and also to facilitate the flow of air. A short bar will warp less than a long one, and is less expensive to renew when it gets out of shape. Hollow air bars have been repeatedly tried and highly recommended, but they have not as yet had an extended use.

The water-grate bars, invented in 1824 and since frequently applied to locomotives and marine boilers, do not seem to grow in popular favor, and are scarcely known in stationary boilers. The objections urged against them are the expense of maintenance, their fittings and attachments, and the possibility of serious consequences should they rupture or burn out.

The rocking or shaking bar is an excellent device for breaking up the formation of clinker, and freeing the bars of ashes and other non-combustible products which accumulate on the bars, or in the interstices between them, obstructing the air passages, and by lessening the flow of air to the fire, lower the economy of the furnace. The possible saving in thus being able to keep the bars clean, over the too common way of opening the furnace doors at intervals, for the purpose of slicing or cleaning the fire — in which operation the temperature of the furnace is lowered to an extent, and for a time varying with the skill and celerity of the one who is doing the work — under ordinary circumstances is possibly ten per cent. of the efficiency of the furnace, some damage to the walls and adjacent parts, and any serious injury to those parts of the boiler exposed to the relatively cold currents of air which sweep over them at such times.

A consideration of the foregoing shows the theoretical advantages of the shaking or rocking bar; but practically — though realizing many of the advantages claimed for them — their use is attended with some trouble and expense, so that, while admitting the losses and disadvantages inseparable from the use of the common grate bar, a large number of engineers continue to use them.

The universal demand for cheaper power must hasten the introduction of improved forms of grate bars; and let us hope that the skill and ingenuity of our inventors may be further exercised, and produce a contrivance of the kind, so simple and inexpensive as to popularize it, and thus hasten its more general adoption.

Our best authorities agree that we need about twelve pounds of air to effect the complete combustion of one pound of coal, but that, owing to practical difficulties in the way, it is better to arrange our grate bars, registers, or other openings to the furnace, for a supply of double that amount, or twenty-four pounds of air, per pound of coal. While it is indispensable to an economical consumption of coal that we have the requisite quantity of air, it is also agreed that whatever air passes through the fuel in excess of that amount is wasteful, but that between too little and too much air, an excess is to be most desired.

There is a diversity of opinion as to what part of a furnace should be supplied with air to be the most effective. I do not think it is so important where the air reaches the coal or the gases arising from it, as that the mixture be effected before the gases are reduced in temperature below the point of ignition, or about 800° Fahr.

Careful determination of the temperatures, at various points from the furnace to the smoke-box, were made by the late J. C. Hoadley, at the Pacific Mills, Lawrence, Mass., in 1881. They were very instructive, and were as follows, for one of the boilers having a common setting; external air being 32°.

In the heart of the fire,	2,493°	Fahr.
At the bridge wall,	1,340	"
At pier,	895	"
In smoke box,	378	"
Gases escaping to chimney,	373	"
No flame in tubes.		

The dimensions of the boiler used in these experiments were, diameter sixty inches, length, twenty-one feet, and it contained sixty-five 3½-inch tubes twenty feet long. The coal used was that known as "Lackawanna" anthracite, egg size, of good quality, and reasonably dry. The average consumption of coal was 7.76 pounds per square foot of grate per hour. Though not pertinent to our subject, it may interest you to learn that under the conditions described, the average evaporation from and at 212° per pound of coal was 10.86 pounds (equal to 13.24 pounds per pound of combustible).

Those who believe that a tubular boiler should never, under any circumstances, exceed twelve to fourteen feet in length, will not get much comfort from this experiment.

Assuming proper chimney proportions and a natural draft, the grate-bar surface should be of such size as is required to burn the kind of fuel, and whatever quantity is needed to furnish the amount of steam required.

It is apparent to meet the foregoing conditions, the proportions of grate bars to heating surface will take a wide range; for instance, with coal of the ordinary size our most economical and efficient boilers have from thirty-five to forty-five square feet of heating surface for each square foot of grate, while in burning wet tan, green saw-dust, and some other refuse fuels, not more than half that amount of heating surface can be successfully served by one square foot of grate, the successful burning of such fuels requiring the air to be in close contact and plenty of it.

By means of a natural draft in some cases — in others it will require an artificial draft — screenings and other cheap fuels are burned successfully. It should not be forgotten that the coal fuels are chiefly valuable in proportion to the amount of carbon they contain, and that often the refuse that is sold as fuel, and thought to be cheap by the purchaser, is largely composed of dirt and other non-combustible ingredients, and is often very dear in the end. Culm, and other cheap fuels, may be successfully burned, but under some circumstances it does not pay to burn them.

We burn our fuel in the grate bars, and the products of combustion are conducted over certain surfaces which absorb their heat. These absorbing surfaces are known to us as heating surfaces, and that arrangement of heating surface is the most efficient which, with a high temperature in the furnace, abstracts the heat of the escaping products of combustion so effectively, that on their exit from the boiler to the chimney their temperatures shall not greatly exceed that of the temperature of steam within the boiler.

If in the case of the "Pacific Mills" boiler we assume that the losses in temperature at these different points, viz.: the bridge wall, the pier, and the smoke-box, are indicative of the value of those parts as heating surface in this particular boiler; the value of those several parts might be expressed as follows:

	2493	
The furnace,	1340	=54.5 per cent.
	1153	
Shell back of	1340	
bridge wall,	895	=21.1 per cent.
	445	
	895	
The tubes,	378	=24.4 per cent.
	517	100

Grate bars,	1153°	The value of the shell would be 75.6 per cent.
Bridge,	445	
Tubes,	517	The value of the tubes would be 24.4 per cent.
Escape,	378	
	2493°	

In this supposition the losses due to radiation from the brick-setting are disregarded.

In the Centennial tests, Philadelphia, 1876, with a steam pressure of seventy pounds and a sensible temperature of 316° in some of the most successful and best known boilers, the temperature of the waste gases did not exceed 411°. These temperatures were lower than ordinarily prevail in practice, where we not uncommonly find the temperature of the waste gases escaping to the chimney as high as 700°.

Experience has taught us not only that the heating surface shall be suitably arranged, but that it is equally important that it bears a proper ratio to that of the grate surface to give an economical and efficient boiler.

With a good draft properly regulated by dampers, and a furnace twenty-four to thirty inches deep, I believe fires six to eight inches thick will be found to give excellent results.

For externally fired boilers the designs of the Hartford Steam Boiler Inspection and Insurance Company generally provide a depth of twenty-four inches at the front of the furnace, and twenty-seven inches at the bridge. Some tubular boilers came under my notice a few years ago, in which the distance from the bottom of the shell to the grate bars was but eleven inches. It may be needless to say the performance of these boilers was never satisfactory until the grate bars were lowered to a more suitable depth. Modern boiler setting has considerably improved on this, as well as some other old time practices.

While there is a diversity of opinions among engineers regarding the management and regulation of fires in burning coal in stationary boilers — among your number are those whose experience and opinions are valuable, and I trust we shall have the benefit of them — permit me in closing to summarize ordinary experience on this subject about as follows:

That a moderately thick and hot fire with a rapid draft, uniformly gives the best results.

That grate bars will last longer, and it is believed that combustion will be promoted by having a body of water in the ash-pit.

That whenever practicable the damper should be closed before the furnace door is opened, and *vice versa.*

To remove one troublesome complaint that frequently causes grate bars to warp, have suitable space or clearance at each end of the bar; and grate-bar bearers will prove more serviceable if they are placed a short distance from the end of the grate-bar, leaving space so that whatever falls at the end may not lodge there. Some grate-bar bearers are placed close up to bridge wall at one end, and join the dead plate at the opposite end. As these places are most likely to accumulate ashes they speedily choke up, if openings are not provided for their escape.

That by skill in firing a saving of fifteen per cent. in fuel has been effected.

That under ordinary conditions with the usual sizes of coal it is better to fire a smaller quantity at shorter intervals, than a larger quantity at longer intervals, and that in large furnaces by firing alternately to the right or left there will be less fluctuations in the furnace temperature, consequently a steadier steam supply than if the whole furnace be covered at once.

It has been often asserted, and I think those most familiar with the work will be the least likely to contradict it, that the most successful smoke burner is a good fireman.

But in justice to the "other smoke burners," it should also be admitted that a good fireman is the exception, not the rule.

The advantage of a mechanical appliance for firing seems apparent, when we consider that to accomplish the best results in burning coal, the fuel should be supplied to the grate in definite quantities, periodically, and it is probable that the fireman who is doing the most effective service for any one of your membership is the one who is working systematically with machine-like regularity in discharging his duties.

While we recognize the skill and ability of a good fireman, we must not forget that the exercise of the same skill and ability produces widely different and more favorable results in a properly designed furnace than those obtained from one that is not. It will be found very interesting and instructive by those who are of an investigating mind to have sight-holes about the furnace, or connections through which the combustion of fuel and movement of the heated gases may be observed. Assisted by a few alloys or metals, the fusing points of which have been determined, much information may be obtained regarding temperatures at various points between the furnace and chimney.

The comparative value of a row or cluster of tubes may be approximately determined by a simple plan described in THE LOCOMOTIVE a few years ago, viz.: "A clean piece of soft white pine was placed at the front end of a boiler, nearly in contact with the ends of the center row of tubes. It was fastened so as to maintain its position, and left for several days. When examined it was found that the end of the stick in contact with the upper tube was burned to a coal and barely held together. At the tube next below it was a little less charred, and the effects of the heat decreased towards the bottom."

EDUCATION IN EUROPE. — The percentage of persons aged fifteen years and upward who can read is, in Germany 94 in 100, in Great Britain 91, in Austria 88, in France 88, in Italy 72, in Spain 69, and in Russia 53.

The percentage of those who can read, write, and work out simple arithmetical problems is, in Germany 89 in 100, in Great Britain 81, in France 77, in Austria 74, in Italy 63, in Spain 49, and in Russia 39.

The percentage of those who possess a fair acquaintance with more than one modern language is, in Germany 69 in 100, in Austria 61, in Great Britain 34, in France 28, in Italy 28, in Russia 23, and in Spain 13.

The percentage of those who have some knowledge of the classics is, in Germany 32 in 100, in Great Britain 21, in France 20, in Italy 19, in Austria 13, in Spain 20, and in Russia 2.

Why Tug-boat Boilers Explode.

We clip the following from the *Mechanical Engineer:*

"Only a short time since a most disastrous explosion took place on a small tug in New York harbor, killing all employed on board, blowing two men overboard from a schooner lying alongside the tug, killing one of the men instantly, and severely injuring the other. There was not a vestige of the tug left. Instantly the scientific crank bobs up and advances his theories of the function of unknown gases, and a thousand and one other ideas. Who ever heard one of them saying that an explosion took place from too little water or too much steam? These are causes that seem to be entirely ignored. Now, sir, I will let your readers into a secret that is unknown to the general public, but it is the property of about at least three thousand people right here in the vicinity of New York; as no one else seems willing to part with it, I will put up my share to the highest bidder.

"On the waters of the North River, East River, the Kills, and Upper Bay, tugs are constantly plying. If any one took the trouble to count them, it would be found that they numbered between four and five hundred, and if it were possible to bring all the steam gauges on them suddenly to view, what a revelation there would be, especially if alongside each gauge the certificate of inspection could be seen. I will wager a year's salary that more than one-half would be found with an over pressure of steam, of from five to forty pounds. I will go further and say that if the engineer does not do this, his place will soon be filled by another who will. After vainly seeking employment, perhaps for months, he too will be quite willing to take his chances of entering the next world on a cloud of his own manufacture. Says the reader: 'Why not report these facts to the inspectors? Surely it will be seen to.' I can answer this, and say most truthfully, of course it will, and so will the man who makes the report be seen to, and, by way of reward for his zeal, such an effective boycott will be placed on him in his efforts to secure employment, that he will wish he had taken his chances the other way, and risked the *old kettle* a little longer. Steamboat owners exact, captains and pilots exact, and engine builders demand this violation of law, and risk to life and limb, all for dollars and cents, and if the engineer complains, or points out the risks run, his services are very soon dispensed with. Let any of your readers ask an engineer of a tow-boat in New York if he carries more steam than the law allows, and if he is well enough acquainted, he will be astonished at the reply he will get. The constant pressure brought to bear on the engineers on this class of vessels to violate the law, is surely driving out the better class of men, and forcing them to seek employment elsewhere, leaving the reckless and ignorant to take their place. I am sorry to say that some of the larger passenger boats and ocean steamers are also given to the practice of carrying an over pressure of steam. That owners of vessel property will some day, in the near future, see the error of their ways, and give the engineer a fair chance, is the wish and hope of "An American Engineer."

New York, N. Y.

The Locomotive.

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The Flow of Gases through Flues.

As there seems to be some misapprehension about the flow of gases through flues, it being popularly supposed that "smoke will go as well through a crooked flue as it will through a straight one," and as it is generally assumed that the sole condition affecting the rate of flow is the sectional area of the flue, and the height of the chimney, perhaps a few words on the subject may not be out of place in the LOCOMOTIVE.

There are several elements which seriously affect the rate of flow of gases through flues, but in this article we shall discuss only those which are likely to materially affect the draught of steam-boiler chimneys. The principles which should govern the construction of chimneys and flues for boiler purposes are well known through experience, and attention should be given to the following points:

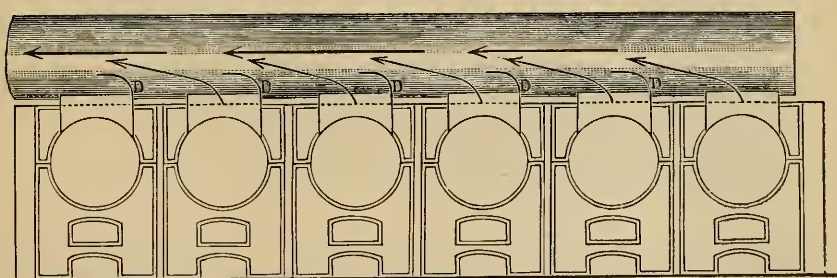

FIG. 1.

The sectional area of the chimney.

The height of the chimney.

The areas of the flues leading from boilers to chimney, and the form of their cross section.

The number and character of the bends in the flues.

The proportions of a chimney may be fixed by the following considerations: It is found by experience that for burning properly the coals ordinarily used in this section of the country for steam-making, the necessary draught-force is measured by a column of water from one-half to three-fourths of an inch in height. Also that to attain the maximum available power of tubular boilers, as ordinarily proportioned, with this intensity of draught, the sectional area of the chimney should about equal the collective area of the tubes of all the boilers connected with it.

We can attain this intensity of draught, without discharging the products of combustion into the chimney at an excessively high temperature, by using a chimney eighty-one feet high above the level of the grates, if the flues are properly constructed so that they cause no undue loss between the boilers and chimney.

The unit, then, for chimney construction may be regarded as a chimney eighty-one feet high, having an area equal to the collective area of the tubes of all the boilers leading to it, the boilers being of the ordinary horizontal return tubular type, having about one square foot of grate surface to forty-five square feet of heating surface.

The draught-power of chimneys being proportional to the square roots of their heights, if we build a chimney more than eighty-one feet high, we may reduce its area below the collective area of the boiler-tubes in the same proportion that the square root of its height exceeds the square root of eighty-one.

For example, suppose we have to design a chimney for ten boilers, 66 inches in diameter, each having 72 tubes, $3\frac{1}{2}$ inches in diameter, what would be its proportion?

The collective area of the 720 three and one-half inch tubes would be 6,017 square inches, and if the chimney is to be but eighty-one feet high, it should have this area, which would require a flue 6 ft. $5\frac{1}{2}$ ins. square, or if we made it circular, which would be preferable, its diameter would be 7 ft. $3\frac{1}{2}$ inches.

But suppose for some reason it is decided to have a chimney 150 feet in height, instead of 81 feet. The square root of 150 is $12\frac{1}{4}$; the square root of 81 is 9; and we

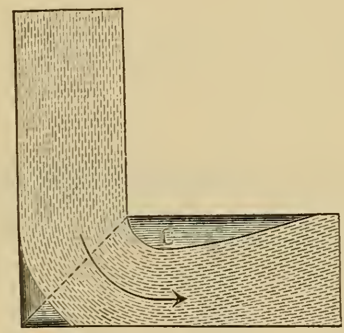

FIG. 2.

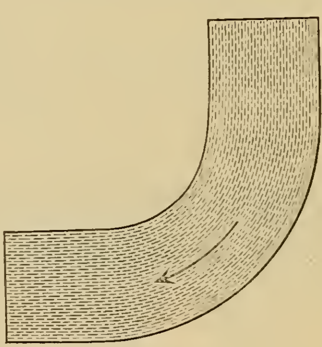

FIG. 3.

reduce the area of the chimney by the following proportion: 12.25 : 9 :: 6017 : 4420 square inches, which would be the proper area, and would call for a chimney five feet six inches square, or six feet three inches in diameter if round, and similarly if any other height were decided upon.

As to the cross section of the chimney it may be said; for any given area of flue less bricks will be required if it is made circular, but for small stacks curved bricks will be required to make a neat job. Therefore it is best to build chimneys square, both inside and out up to a diameter of from four to five feet, larger sizes than this are better built round. There seems to be no good reason, except for architectural effect, for building a chimney square outside, and putting a round flue into it.

There is considerable difference of opinion as to what constitutes the best form of chimney flue in longitudinal section. Some make a chimney smallest at the top, some make it largest at the top, while others make several contractions and enlargements between the base and the top, with the idea, we suppose, of utilizing in an increased ratio whatever advantages may be possessed by either of the two preceding forms, without being sure which of them is right. Others still make a contraction near the outlet, based on the principle of the *vena contracta*, or contracted vein, well known in hydraulics, but we confess our inability to see any theoretical advantage in this case, for the contracted vein in both hydraulics and pneumatics occurs only where a fluid or gas flows through an orifice in a *thin plate*, where they flow through a long pipe, of such proportions as a boiler-chimney, no contraction of the stream takes place at discharge, therefore, so far as the present writer can see, any contraction of the flue, no matter for what good purpose it may be intended, really diminishes the effective area of the flue. It has been found by many experiments, that any sudden variations in the size of a pipe conveying water or gases, whether they are contractions or enlargements, simply add to the resistance to flow; therefore we can confidently assert our belief that no form of chimney-flue possesses any advantages over a plain straight cylindrical flue; at least we have never seen any such advantages demonstrated.

The main flue between the chimney and the individual flues leading from each boiler, should always be designed according to this rule. Make it as nearly as possible equal to the area of the chimney, or of the collective area of the tubes in the battery of boilers connected with it, run it as straight as possible from boilers to chimney, and where bends are unavoidable, make easy turns instead of sharp right angles.

The number and form of the bends in a flue has great influence upon the draught. Bends are unavoidable: 1st. Where the gases turn to enter the tubes at the back end of the boiler; this end of the tubes should be turned over and smoothly beaded down to facilitate the entrance of the gases. 2d. Where the gases leave the front ends of the tubes and pass into the uptake; beading the tubes at this end is not of so much consequence as it is at the rear end, but it does no harm, and can be recommended. 3d. Where the gases leave the uptake and enter the main flue. The flow of the gases at this point may be facilitated by rounding the side of the uptake toward which the gases flow; but it is seldom done, and ordinarily it will not pay to do it. Also where the draught is strong and the main flue is small, division plates, as shown in Fig. 1, may be advantageously used to give direction to the outgoing current, and enable it to unite with the main current with less disturbance than would be the case without it. Where such a plate is used care should be taken that the plate does not project far enough into the main flue to interfere with the current flowing past. It should run clear across the flue, and its height should be just sufficient to make the lower segment of the flue cut off barely equal to the area of the uptake.

A sharp right-angle bend should never be allowed in the main flue between the point where it leaves the battery of boilers and the chimney. Where turns are unavoidable they should be made with as long a radius as is practicable. The effect of a sharp turn is shown in Fig. 2. The current of gas is carried forward by its momentum, and the stream suffers a contraction at C which causes a serious loss of energy. Figure 3 shows the action where a bend of longer radius is used The current is enabled to pass around with scarcely any contraction, and consequently very little loss of *vis viva*.

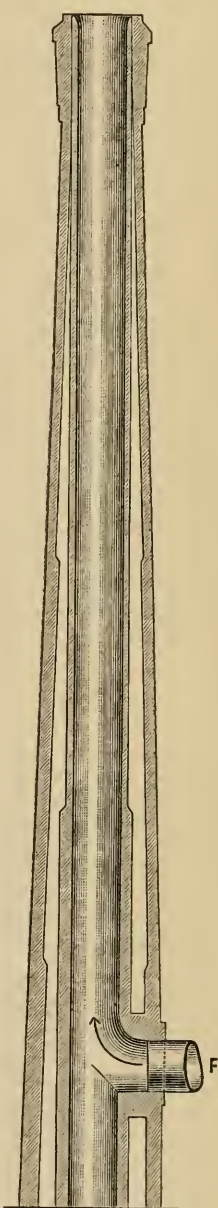

Fig. 4.

The fourth and last unavoidable bend occurs where the gases pass from the flue into the chimney. A sharp bend here is the almost universal rule, whereas it ought to be the universal exception. The chimney should always be rounded off above the flue, as shown in Fig. 4. Much less resistance will be offered to the flow of the gases if this is done, and it costs nothing to do it.

When two flues enter a larger one at right angles to it, and opposite to each other, as is frequently the case where there is a large number of boilers in a battery, and the chimney is placed near the center of the battery, the main flue should always have a division plate in its center between the two entering flues to give direction to the incoming currents of gases, and prevent their "butting" as it may be termed. This is a very important matter and should never be neglected. The same thing should always be done where two horizontal flues enter a chimney at the same height, at opposite sides.

The foregoing remarks relating to bends seem almost superfluous; they would not be offered were it not for the fact that the principles involved are persistently disregarded on every hand. Arrangements of flues and chimneys which are the best possible under the circumstances are the exception, not the rule. They are rare exceptions too. We have in mind now a case where a pair of boilers were put in and a new chimney built for them. There was no earthly reason why a flue could not have been carried directly from the top of the uptakes to the chimney, but it was not done. The flue was dropped from the top of the setting down about four feet below the surface of the ground, thence sideways, *away* from the chimney about six feet, then upward about two feet, then horizontally through a mill-foundation about four feet thick, then making a bend of about forty-five degrees, and run to the chimney cutting through the foundation of the same, and entering it from below. No chance whatever was left to clean out the flue, which was contracted in many places. As a matter of course, the draught is so poor that the steam made by both boilers is much less than one would easily furnish with proper flue connections.

Inspector's Reports.

DECEMBER, 1886.

During the closing month of the year past our inspectors made 3,296 inspection trips, examined a total of 6,415 boilers, made 2,343 internal inspections, tested 317 boilers by hydrostatic pressure, and reported 7,728 defects, of which 1,030 were considered dangerous, and led to the condemnation of 47 boilers.

Our usual tabular statement of defects is appended.

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	429	40
Cases of incrustation and scale,	575	49
Cases of internal grooving,	50	23
Cases of internal corrosion,	181	23
Cases of external corrosion,	406	36
Broken and loose braces and stays,	355	47
Settings defective,	198	32
Furnaces out of shape,	245	15
Fractured plates,	185	54
Burned plates,	136	21
Blistered plates,	183	15
Cases of defective riveting,	2,339	209
Defective heads,	37	11
Serious leakage around tube ends,	1,311	313
Serious leakage at seams,	647	22

Nature of Defects.	Whole Number.	Dangerous.
Defective water-gauges,	106	25
Defective blow-offs,	42	15
Cases of deficiency of water,	17	10
Safety-valves overloaded,	21	9
Safety-valves defective in construction,	40	7
Pressure-gauges defective,	189	51
Defective hangers,	28	0
Defective fusible plugs,	5	0
Defective man-hole plates,	1	1
Defective feed valve,	1	1
Flue collapsed under hydrostatic pressure,	1	1
Total,	7,728	1,030

SUMMARY OF INSPECTORS' REPORTS FOR THE YEAR 1886.

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

	1885.	1886.
Visits of inspection made,	37,018	39,777
Total number of boilers inspected,	71,334	77,275
" " " " " internally,	26,637	30,868
" " " " tested by hydraulic pressure,	4,809	5,252
" " " defects reported,	47,230	71,983
" " " dangerous defects reported,	7,325	9,960
" " " boilers condemned,	449	509

The following is the detailed analysis of defects reported during the year 1886:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	5,230	404
Cases of incrustation and scale,	7,668	546
Cases of internal grooving,	324	114
Cases of internal corrosion,	2,118	228
Cases of external corrosion,	3,780	388
Broken and loose braces and stays,	1,985	382
Settings defective,	1,854	219
Furnaces out of shape,	2,313	170
Fractured plates,	1,862	848
Burned plates,	1,213	329
Blistered plates,	2,659	221
Cases of defective riveting,	17,618	1,919
Defective heads,	506	183
Serious leakage around tube ends,	11,045	2,541
Serious leakage at seams,	6,308	355
Defective water-gauges,	1,193	227
Defective blow-offs,	498	117
Cases of deficiency of water,	121	63
Safety-valves overloaded,	311	135
Safety-valves defective in construction,	448	132
Pressure-gauges defective,	2,744	396
Boilers without pressure-gauges,	27	11
Miscellaneous defects,	158	32
Total,	71,983	9,960

Grand Total of the Inspector's Work since the Company began Business, to January 1, 1887.

Visits of inspection made,	352,018
Whole number of boilers inspected,	709,588
Complete internal inspection,	253,941
Boilers tested by hydrostatic pressure,	52,219
Total number of defects discovered,	422,931
" " " dangerous defects,	81,500
" " " boilers condemned,	4,674

Boiler Explosions.

December, 1886.

Locomotive (170). — An awful accident happened on the line of the Beech Creek Railroad at the Jersey Shore station, fourteen miles above Williamsport, Pa., December 9th, by which four men were instantly killed. The accident was caused by engine No. 4 of the Beech Creek Railroad blowing up. It was an old freight engine, and had been in the Beech Creek shops at Jersey for repairs. It was taken out for a trial trip, and was run up and down the road between the shops and the Pine Creek station at Jersey Shore, a distance of three-quarters of a mile. On the engine were four men — P. H. Knight, engineer; Allen Ramsey, fireman, who were running the engine, and James Wearne, a fireman, and J. C. Field, a shop hand. The engine stopped on the track midway between the junction and Jersey Shore station. Suddenly the boiler burst and the engine was blown to atoms. Ramsey, Wearne, and Field were blown one hundred feet into the air, and fragments of their bodies were found eight hundred feet away. Knight was blown fifteen hundred feet to the right of the track into a field, and part of his body was found against a tree, while the other part was found in a swamp near by. It is not known what caused the accident as there was not enough of the engine left to show. Knight, Wearne, and Ramsey have families, and all the men resided in Jersey Shore.

Flour Mill (171). — The boiler of the Union flour mill, near Canal, Fulton, Ohio, exploded December 9th, wrecking the building, killing the head miller, and severely injuring several other people.

Locomotive (172) — A collision between freight trains occurred near Annville, Pa., December 9th, on the Lebanon Valley railroad, by which a man, supposed to be a tramp, lost his life. The boiler of one of the locomotives exploded and set fire to cars loaded with petroleum and hay. The road was blocked for several hours.

Saw-mill (173).—A battery of three boilers in Charles Hofferberth's saw-mill, Evansville, Ind., exploded December 14th, totally wrecking the building, killing and injuring several. The explosion was felt all over the city. A volume of smoke and steam rose, settled, and several large objects were seen sailing off into space. Only the front of the building was left standing, while the boiler house and engine-room were scattered for 300 yards. Two sections of the boilers were carried 400 yards away, while another section, weighing perhaps 300 pounds, was imbedded on the point across the Ohio River, three-fourths of a mile distant. The steamer *John S. Hopkins* was passing up the river when the explosion occurred, and this section passed directly over the pilot-house, while a part of the roof from the mill went sailing across in front of the boat. Another fragment was blown into the engine-room of the Ingle coal-shaft, striking the engineer on the head, inflicting a dangerous wound. Everything indicated enormous pressure, while the collapsed flues indicated scarcity of water. The boilers were very old, having been in use nearly forty years. They were thirty feet long, with two flues each. The fireman had just fired up when sawyer John Duley ordered the engine shut down while a band-saw was changed. This was done and the next instant the explosion occurred. Frank Poplin, who was standing in front of the boilers, was struck full in the face and hurled thirty feet away with a heavy fire-door across his feet, where he lay gasping for a moment, only to be buried in a mass of timber that fell. When discovered he was dead, with his head almost entirely blown off. The list of killed and injured is as follows: Frank Poplin, fireman, killed; Charles Keating, off-bearer, killed; Albert Heine, superintendent, arm torn to pieces; William Elmendorf, rip-sawyer, wounds in his head and left side injured; Fred Lechner, engineer, shoulder and arms badly burned; A. A. Perriman, fracture of wrists and internal injuries, probably fatal; Henry Deller, log-setter, scalded, injury to spine, probably fatal; Ben Johnson, bull-wheelman, fractured jaw and internal injuries, dangerously wounded; Robert Dixon, hand mashed—slight injuries.

Saw-mill (174). — At Switz City, Ind., on the Indianapolis & Vincennes Railroad, a portable engine, which was being utilized to furnish power for a saw-mill, blew up December 15th. A. H. Shoptaw, owner of the mill, was instantly killed; also his son, James, and a nephew, William Shoptaw. The bodies were horribly mutilated. Mr. Shoptaw was an old and respected citizen. The explosion is said to have been caused by the water in the boiler getting too low.

Packing-House (175). — The boiler in Turner's packing-house, Chicago, Ill., exploded December 20th, killing two persons, and slightly injuring several others. Loss about $45,000.

Saw-mill (176). — A boiler explosion at Cleveland, Ohio, December 21st, killed Frank Girrard, a laborer, whose mangled body was hurled about seventy feet. James Kintz, the engineer, and Patrick Hanlon, a railway brakeman, who happened to be near, were badly injured. The boiler was a dilapidated affair, which had been rented by some contractors to use in sawing timber for the new central viaduct, and it burst under a pressure of eighty pounds. Its valves had been tested only a few seconds before. Girrard was an Italian, who had a wife and four children in Italy.

Steam Tug (177). — The boiler of the tug *Escort*, No. 1, exploded in Coos Bay, December 22d, while the craft was towing a lumber vessel out to sea. One of the firemen was badly scalded, but no serious injury was done to others on board the tug. The *Escort*, No. 1, is owned by E. B. Dean of San Francisco, and has been in the Coos Bay towage service for a number of years. As a new boiler will have to be supplied in order to fit her for service again, the loss is about $10,000.

Saw-mill (178). — The boiler of John A. Smith's saw-mill, five miles northeast of Vandalia, Ill., exploded, December 23d, instantly killing the owner and fatally injuring William Sumption, the engineer. A piece of the boiler weighing several hundred pounds was carried a distance of nearly a quarter of a mile and lodged in the branches of a tree, which it splintered badly. A threshing machine was struck by another flying fragment and badly wrecked.

Electric Light Station (179).— The boiler at the electric light works in Fostoria, Ohio, exploded December 25th. The building was wrecked and Albert Baily, the engineer, fatally injured.

Planing Mill (180). — The boiler in W. Denny & Co.'s planing mill, Moss Point, Miss., blew up December 27th, demolishing the brick work and shed, and badly scalding the negro fireman, Isaac Myers. The boiler can be patched. The damage will only be small.

COAL MINE (181). — A terrible explosion occurred at the Armstrong coal shaft, at Perry, Iowa, December 28th, resulting in loss of life, and destruction of considerable property. One of the large boilers used by the company exploded, killing three men injuring one fatally, and another seriously. Sol Piper, the fireman, was scalded and mangled. John Blythe the pitt-boss, had his head blown off, and Charles Carson was blown all to pieces, parts of his body being found pasted to a box, and other parts found 100 yards away. A. B. Armstrong, the engineer, is only slightly injured. When the explosion occurred he had hold of the reverse lever, which was found 100 yards away. Ted Richards is fatally injured and cannot live. All the injured and killed have families. No cause is assigned for the explosion, as the boiler was nearly new. The head of the boiler was blown through a coal car on the track a short distance away and landed nearly a quarter of a mile beyond. The engineer had just finished letting forty miners down the shaft, and had the explosion occurred ten minutes sooner, the loss of life would have been terrible. The loss to property runs into the thousands.

LOCOMOTIVE (182). — A shocking and fatal accident occurred on an up-freight special on the eastern division of the C. P. R., two miles east of Nepigon, December 28th. A carpenter, named Gordon, from Port Arthur, was riding on engine 269, together with brakeman Frederick, fireman Harry Brunell, and engineer Ramsay, when the crown-sheet fell and the boiler burst. The frightful rush of steam blew the three first-named men out of the engine on to the track, where they had to lie in the cold, with the temperature forty below zero. All were terribly scalded and frozen. Gordon died two hours after with a broken back. The fireman had one leg broken, and was badly frozen on the face, hands, and feet. The brakeman was badly scalded and smashed about the face, but was able to walk. The engineer escaped injury.

CARPET CLEANING WORKS (183). — The boiler in the engine room of Kendell & Stewart's carpet cleaning and mattress manufacturing establishment, Denver, Col., exploded December 31st, completely demolishing the engine-room and two brick walls of the main building. A number of sewing girls on the upper floor narrowly escaped being injured. James Hall, William Eiser, and F. H. Hicks, employees, were caught in the ruins and seriously injured. Fire broke out in the debris, but it was promptly extinguished. The loss to the building and machinery is estimated at $10,000.

MACHINE SHOP (184). — Two large boilers in J. F. Seiberling & Co.'s Empire Mower and Reaper works, Akron, Ohio, burst December 31st, wrecking a large portion of the extensive factory, killing three men and terribly wounding four others, besides injuring many more. This is the shop that has been under boycott for a year past, and dreadful stories are out as to the cause of the explosion. There is a rumor that it was the result of a plot to blow up the shop, but this is so heartless that it is not generally credited. The boilers were located in a two-story brick structure, situated in a square of the buildings forming the works proper, so that the explosion fairly shattered the entire structure, in which three hundred men were employed. Three men — William and Rudolph Zander, and William Brown — were directly over the boilers and were horribly mutilated, Rudolph only escaping with life. Joseph Weaver was crushed by the falling wall. J. E. Varner, E. H. Cowen, Oliver Buss, and C. Dutt were disfigured, their arms and legs broken, and they will probably die. Fully fifty men were knocked down by the force of the shock, and badly cut with flying glass and debris.

IRON WORKS (185). — A boiler in Catoctin Iron furnaces, near Mechanicstown, Md., exploded December 31st, demolishing and shattering the surrounding buildings, and seriously injuring William Wilden and William Temple. Joseph Carty, and Charles Sweeny were also injured. Pieces from the exploded boiler were thrown 300 feet in the air. The accident will cause the place to shut down and throw 200 men out of work.

Summary of Boiler Explosions for the Year 1886.

Our usual summary and classified list of Boiler Explosions is given below. The total number of explosions, so far as we have been enabled to learn, was 185, in many cases more than one boiler exploded, but it is reported as one explosion.

The number of persons instantly killed, or so badly injured that they died within a very short time after the accident, was 254; the number injured, many of whom were stated by the report to be fatally injured, was 314, or a grand total of 568 persons killed and badly hurt. This is a showing of which the people of the country at large are not, in all probability, at all proud. The figures in detail are given in the accompanying table.

Classified List of Boiler Explosions in the Year 1886.

	CLASS OF BOILER.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Tot. pr. class.
1	Saw-mills and other Wood-working Establishments, - - - - - -	4	2	5	1	3	5	4	3	3	4	6	5	45
2	Locomotives, - - - - - - - - - - - - - - - - - -	2	2	1		3	1	1	4	3	..	2	3	22
3	Steam-ships, Tugs, and other Steam Vessels, - - - - - - - -	2	2	5	.	..	..	..	..	..	1	3	1	14
4	Portable Boilers, Hoisters, and Agricultural Engines, - - - - -	1	2	1	1	1	..	4	3	2	1	..	..	16
5	Mines, Oil Wells, Collieries, - - - - - - - - - - - - -	1	1	3	..	1	..	5	2	1	1	1	1	17
6	Paper Mills, Bleacheries, Digesters, etc., - - - - - - - - -	..	1	..	.	..	..	..	..	..	..		..	1
7	Rolling Mills and Iron Works, - - - - - - - - - - - -	2	1	1	..	1	2	..	3	1	2		2	15
8	Distilleries, Breweries, Dye-Works, Sugar Houses, and Rendering Works,	3	..	..	4	..	..	2	1	2	..	3	1	16
9	Flour Mills and Grain Elevators, - - - - - - - - - - -	1	3	..	..	..	1	1	..	..	..	..	1	7
10	Textile Manufactories, - - - - - - - - - - - - - -	..	..	..	..	.	.	1	..	1	..	1	..	3
11	Miscellaneous, - - - - - - - - - - - - - - - - -	3	4	2	1	..	4	8	1	2	1	1	2	29
	Total per month, - - - - - -	19	18	18	7	9	13	26	17	15	10	17	16	185
	Persons killed, total, - - 254, - " " " - - - - - -	17	6	28	3	18	14	40	30	10	37	26	25	
	Persons injured, " - - 314, - " " " - - - - - -	64	25	21	12	19	24	33	24	20	17	27	28	

As has invariably been the case, the greatest number of explosions has been furnished by saw-mill boilers, 24.3 per cent. of the whole number being in this class.

The next in frequency is the locomotive, 22, or nearly 12 per cent. of the whole being furnished the past year by this class. And yet many writers on the theory of boiler explosions make the assertion, to back up some pet idea, that locomotive boilers rarely explode. Facts do not bear out this assertion. The next largest number occurred among the class of boilers used about mines, collieries, etc., 17 being the total. Some of these explosions were very destructive.

Distilleries and portable boilers come next with 16 each. Some of the explosions in the latter were especially disastrous; their violence would seem to indicate almost to a certainty, strong boilers, plenty of water, and very high pressures, probably overpressure due to neglected safety-valves.

Rolling-mills and iron works come next with 15 explosions of the usual destructive character common to this class of boilers.

Steam vessels, which are generally near the head of the list, rank sixth, the total number reported being 14.

The Locomotive.

HARTFORD, FEBRUARY, 1887.

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

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies*
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Bound volumes one dollar each.

ONE would naturally suppose the boiler-room to be the last place that fashion would invade, and such may indeed be the case, but if it is, every other place on earth has been invaded, for it is certain that the boiler-room has at last been invaded by the aforesaid goddess.

It is the style now to consolidate everything. Following the example set by the steam-heating companies in the large cities, everybody wants to build one boiler-room and carry steam to the limits of his domain. This is all right if the limits are not too far removed, and other circumstances are favorable. Sometimes they are, and sometimes they are not. It seems to be a beautiful thing to have all the boilers in one place, as the steam-heating companies do, and furnish steam to everybody within several miles, but the fact remains that so far as the writer's knowledge extends, none of these companies pay dividends, which would seem to indicate that there is something wrong somewhere.

Now the facts seem to be just about as follows. It pays to carry steam a long distance, if you have a large quantity to carry, and the demand is constant, and the expenses of attendance can be reduced sufficiently to pay interest on the cost of putting down the pipes *properly*. If the pipes are *not* properly put down they are a source of constant annoyance and expense. Where steam has to be carried about a large manufacturing establishment, the pipes can generally be kept above the ground, in which case they are more easily protected, they are accessible for repairs, and generally the pipes can be so proportioned that they are no larger than is necessary to carry the requisite amount of steam, and the demand is reasonably uniform. In such a case as this it will generally be found advantageous to consolidate the steam generators if steam does not have to be carried more than from 1,000 to 1,500 feet, and this is generally the greatest distance found necessary for any single concern.

On the other hand we will suppose a group of buildings are to be heated. They are scattered about at various distances over a lot half a mile square with neatly kept lawns intervening. In this case the pipes *must* be carried below the surface of the ground. The steam being used for heating, low pressures must be carried. This necessitates large supply and return pipes. More than half the time when steam is kept on, the amount used for heating will be very small, but the mains are necessarily kept full, and the loss by condensation will be just as great as it would be if the pipes were carrying all the steam that would pass through them. In addition to this the expense of properly putting down the pipes in such a case is very great. Encasing them in the best non-conductor and burying them in the earth won't do. It is difficult if not impossible to make effective provision for expansion, and unless this *is* done there is always trouble, the pipes frequently break, which of course puts an end to warmth and comfort until they are dug up and repaired. This is no slight or inexpensive job in the winter season with the thermometer at zero.

The only way to put down pipes in such a case is to build a brick arched tunnel, large enough to carry supply and return pipes, and enable workmen to pass through and make all necessary repairs. Such a tunnel is expensive in first cost. Unless enough can be saved in attendance to pay interest on the cost of this tunnel, it is better in such a case to use separate boilers in each building, or if the buildings can be grouped conveniently, to avoid laying long underground mains, it may be possible to heat three or four from one boiler-room very economically.

It is within a comparatively short time only that the value of exhaust steam from an engine has been fully appreciated, and in many places even now it is allowed to go to waste when, if it were utilized as it might be, it would save the generation of an amount of steam nearly equal to the exhaust.

Exhaust steam is of practically the same value as an equal quantity of direct steam of high pressure for heating in the winter season, for use in dye-houses, and with proper arrangements for many of the numberless dyeing operations carried on in textile and other manufactories. For all these purposes the pipes must necessarily be somewhat larger than they need be where direct steam of high pressure is used. In many cases where failure has resulted from an attempt to use exhaust for the above purposes, the result has been due to the use of a too contracted system of piping, and in other cases, to a wrongly designed system.

Where a large establishment is heated by the exhaust, the system should be designed especially to promote a free circulation, otherwise dead failure is certain to result. It is by no means certain that because large pipes are used the circulation will be free; the details of the arrangement must be properly carried out. The writer knows of a case where large pipes were put in to warm a small building, and a pressure of seventy pounds per square inch failed to send steam through them. After some slight changes were made, steam could be sent through the entire system before the pointer of the pressure-gauge moved, and a pressure of from one to two pounds per square inch warmed the building perfectly in the coldest weather.

Where the demand for steam for which the exhaust may be used, or where the supply of exhaust is variable, automatic arrangements for making up the requisite quantity direct from the boilers can easily be constructed, so as to always insure the maximum degree of economy. When more heat than the exhaust can furnish is wanted the proper amount needed to supply the demand is drawn from the boilers; when the exhaust furnishes more than is needed it can be utilized to heat feed-water, or it can be used to warm a storage tank for hot water; where the establishment is large, and much power is required, the engine can be automatically arranged to run under such circumstances, from partially to wholly condensing, in which case the exhaust is discharged with a minimum amount of heat possible.

In all these cases the details must, of course, be worked out with special reference to the circumstances of each particular case, but as a general rule it may be stated that in nine cases out of ten no special apparatus would be required. In the general market for steam appliances, a selection of apparatus can be made which, properly combined, will yield the maximum of economy.

Facts Established by a Florida Artesian Well.—An artesian well is boring in St. Augustine, Florida. The well, which is twelve inches in diameter, is said to be the largest artesian well in the world, and by actual measurement flows at the rate of 7,000,-000 gallons a day. The hole is now 760 feet below the surface, and is deepening every day. The old-fashioned opinion that Florida was a coral reef has of late years been vigorously disputed. The boring of this well proves that an immense depth of coral underlies the State. Samples of the material have been saved at every stage of the boring. Another interesting fact is that, the deeper the well is drilled, the higher the temperature of the water becomes. It is now about eighty degrees Fahrenheit.

The Production of Open-Hearth Steel in the United States in 1886.

The *Bulletin* of the American Iron and Steel Association says: "Our production of open-hearth steel in 1886 was 245,606 net tons, or 219,291 gross tons, an increase of 96,-225 net tons, or 64 per cent., upon the production of 1885, which was 149,381 net tons. The production of 1886 was much the largest in our history. Our largest production of open-hearth steel prior to 1886 was in 1882, when we made 160,542 net tons. The following table shows the production of open-hearth steel ingots and castings in the United States in the first half and second half of 1886, arranged according to territorial divisions, and the total production compared with the total for 1885.

OPEN-HEARTH STEEL.	1st half of 1886. Net Tons.	2d half of 1886. Net Tons.	Total 1886. Net Tons.	Total 1885. Net Tons.
New England, New York, and New Jersey, . .	9,261	14,121	23,382	18,263
Pennsylvania, ...	61,590	110,910	172,500	94,898
Other States, ...	21,689	28,035	49,724	36,220
Total, ...	92,540	153,066	245,606	149,381

"The output of open-hearth steel in 1886 was produced by thirty-one old and eight new plants, located in eight States,—New Hampshire, Massachusetts, New York, New Jersey, Pennsylvania, Ohio, Illinois, and California. Of the new plants, one is in Massachusetts, six in Pennsylvania, and one in Ohio. Three open-hearth plants, built prior to 1886, were not in operation in that year. At the close of 1886 there were also nine new open-hearth plants, which had either been built in that year, but not put in operation, or were then building, or were projected by responsible parties. Of these, five were in Pennsylvania, two in Ohio, and two in Indiana. Pennsylvania's share of the total production of 1886 was over 70 per cent."

A Terrible Disaster Prevented.

"LOWELL, Mass, December 22.—John Cochrane, janitor of the new Weld Primary School building, was startled this morning to find that there was not a drop of water in the boilers connected with the steam heating apparatus. The situation was critical; for the furnace fires had been left burning over night, and the hundreds of school children were gathering in the building. He carefully let on the water and a terrific explosion was averted. Mr. Cochrane was completely unnerved after the danger was over. Investigation showed that some person had gained entrance into the building by smashing in a window and had opened the faucet in the exhaust pipe of the boiler, allowing all the water to run into the sewer. The perpetrator of the deed is unknown; and the only motive that can be assigned is that some unsuccessful candidate for the place of janitor of the school-house — and there were many — took this means to revenge himself upon Mr. Cochrane."

The above clipping from a daily paper contains a curious admixture of tragedy, comedy, and ignorance. The tragic part lies in the attempt to ruin the boiler, and perhaps kill or injure some of the occupants of the building, all for the sake of gratifying a petty spirit of revenge; and shows to what depths of meanness anything in the nature of political aspirations will bring a man. The comic part lies in the graphic description of Mr. Cochrane's "nerveless" condition after he had averted (?) the danger by turning water into the boiler when it was empty and the fires were burning. The ignorance belongs wholly to the aforesaid Cochrane. Any man who don't know better than to let water into an empty boiler, under such circumstances, ought never to have anything to do with them. Accidents are liable to happen at any time, by which a boiler may become empty, and if a person don't know enough to haul a fire instead of doing the very thing that, above all else, causes trouble if there was a possibility of it, his party services should be rewarded with the gift of some office where his ignorance will not endanger the lives of innocent children. The Council or Board of Aldermen is the proper place for such talent.

The Inventor of Saccharin.

Prof. Ira Remsen, in a letter to the New York *Times*, says: The substance which has come into prominence of late under the name saccharin was discovered in the laboratory of the Johns Hopkins University under the following circumstances: Fahlberg was working here about six or seven years ago as an advanced student. At his request I assigned a problem to him for original investigation. This investigation he afterward carried on under my guidance. When the work was completed, I wrote an article giving an account of the results obtained, and published it in the "Report of the German Chemical Society," placing Falhberg's name with mine at the head of the article. Afterward I published a fuller account of the investigation in the *American Chemical Journal*, again crediting Fahlberg with his share of the work by placing his name with mine at the head of the article. In other articles the now famous sweet substance known as benzoic sulphinide was fully described and its marked sweetness commented upon. Soon after this Fahlberg left the laboratory and, as it now appears, has occupied himself to some extent with the further investigation of the sulphinide. This he did without consulting me. He has also taken out patents covering the methods of preparation, which we first made use of here, and has not consulted with me in regard to this. In all his statements regarding the substance in question he strives to make the impression that the discovery is his, and in most references to it in print, he is given sole credit. I think it is time that I protest in the interest of truth and justice. Fahlberg carried out my directions and deserves credit for this, and for this alone. He did not make the discovery, and would never have made it if he had been left to his own resources. I have nothing to say regarding the probable success of this "new industry (?)" save this, that I do not believe that the substance can yet be made cheaply enough to make a successful rival of sugar. It is possible that the time may come when this can be done, but it is probably far distant. The headlines of your letter are highly misleading. Sugar has not been made from coal tar. The sulphinide belongs to an entirely new class of compounds which are now under investigation in this laboratory. Some of the other members of the class are sweet, while some are intensely bitter. One is sweet, and bitter-sweet when applied to the tip of the tongue, and bitter when applied to the base of the tongue. These substances have nothing in common with sugar except the sweet taste.

Finally, other sweet substances besides the sulphinides have been made from coal tar, and have long been known, but the world has not been excited over them, and there is, in my opinion, no occasion for getting excited over this latest example of the kind. Coal tar furnishes not only sweet substances, but substances of a great variety of odors and colors; or, it is more correct to say, that from coal tar substances are made which in the laboratory can be converted into a host of compounds, sweet, sour, odoriferous, and colored.

"Sharp as a Serpent's Tooth."

BY G. ARCHIE STOCKWELL, M. D., F. Z. S.

The serpent's mouth exhibits peculiarities found in no other form of life. Not only is the roof and palate studded with sharp, recurved teeth looking backward, and retractile, to prevent escape of prey once seized, but they are made up of bony plates and sections, that can scarce be said to be articulated, since they are merely attached by loose expansive ligaments; an arrangement that permits the mouth and throat to conform to the size and shape of the body swallowed. Only venomous reptiles are provided with canine teeth, which are always situate in the anterior portion of the jaw in advance of the general dentition, and likewise are the deadly fangs whereby is secured to some sixty forms the means of offense and defense, and of sustaining life.

The venom is practically the same in all species, exhibiting no differences that are not attributable to variations in size, age, habits, and residence. It dries in thin, small scales, is nearly or quite without odor, taste, or color, and defies the most exquisite of chemical tests, and the most powerful of microscopic lenses alike, to define it specifically; moreover is is pronounced harmless save when brought in direct contact with the circulation — the venom of half a dozen of the most virulent reptiles is powerless to affect one unfledged sparrow when poured in its op n beak!

The mechanism and application of the poison apparatus is most delicate. The fangs are hard, polished, recurved, slender, rivaling in pointing the finest cambric needles; and when the creature is passive lie folded back along the gums, hidden by reflections of the membrane of the inner lips. Each is penetrated by a delicate hair-like canal that, derived from a fissure at the base of the fang where it is enfolded by a duct communicating with the salivary gland, terminates near the point as a shallow groove; the tooth being falciform, and the canal direct, the relation is readily understood. At the base of the fang, extending from a point just beneath the nostril two-thirds the distance to the angle of the mouth, lies the salivary gland, that provides a pure mucous saliva, with which is found mingled in various proportions globules of a semi-oily fluid, the venom proper. The blood and nerve distributions to this gland are disproportionately large, the latter especially enormous, which leads to a surmise that the poison is but decomposed salivary products, and this is in some measure confirmed by the microscope, and by the fact that it is powerfully stimulated by fear, anger, and hunger. The venom as secreted slowly distils away, and finds lodgment in a bulb, the central portion of the duct communicating with the fang, this bulb being surrounded by fibres derived from the most powerful compressor muscle of the face, through whose act both it and the gland are made to give up their contents at will, the former being emptied and filled almost at the same instant.

The first blow exhausts the major portion of the fluid within the duct, and the second delivers venom diluted more or less with saliva. The third, fourth, and fifth consequently are less dangerous in order, and so on, until the poison is wholly exhausted, and pure saliva alone results. Commonly two blows utterly exhaust the venomous secretion, when the reptile becomes innocuous, to which fortunate circumstance, and the fact that venom is essential to securing food supply, may be attributed the low rate of mortality as compared with the numbers bitten.

When the offensive or defensive is assumed by the reptile, the posterior portion of the body is drawn into a coil or spiral, upon which the remainder and the head pivots, and whereby is secured the darting movement that enables the creature to reach out in any direction to three or four-fifths its own length. At the same time the fangs are drawn downward and forward, projecting between the lips, and the swollen salivary glands procure the peculiar bulging appearance of the face denominated "flattening of the head. When the head reaches the utmost limit permitted by the spiral, or the point where the blow is intended to be struck, a contemporaneous action of the compressor muscles of the face propels the venomous secretion through the apical outlets of the fangs, injecting into the bottom of the wound; or failing its mark, hurls it violently to considerable distance. This power to hurl venom is most surprising in some species. Sir Arthur Conynghame relates of the Natalombozi, or spitting cobra, that one in its death agony thus blinded an officer of her Majesty's XV Regiment of Foot at a distance of forty five feet, and the gentleman did not again recover his eyesight for a fortnight.

With the infliction of the stroke the fangs are reversed, dragged backward in the wound, lacerating the tissues as if with the view of ensuring fatality, a contrivance so malignant in ingenuity, it is little wonder the Semitic and other Oriental races accept the serpent as an emblem or type of supreme evil, the more so as the act is neither mechanical or obligatory; and some reptiles also, as the *fer-de-launce*, the *black mamba*, the *belted hamadryad* of Burmah, which often grows to fourteen feet in length, and the *water moccasin*, actuated by the most vindictive of motives, coil and cling about the part bitten, resisting all attempts at removal, as if desirous of instilling to the very last drop the supply of venom.

The removal of the serpent's fangs do not ensure its innocuousness save for a brief period, unless also the poison duct is destroyed. Immediately behind the canine teeth is a more or less numerous dentition, from which is pushed forward teeth as required to supply the place of the lost fangs, an act of development that requires but a few weeks at most. Serious results have occurred from handling reptiles supposed to have been rendered permanently harmless by removal of fangs, and the writer has twice suffered from carelessness in this particular. Now it is his custom, if desiring to experiment with a reptile of this class, to not only remove the chief fangs, but to destroy the duct by means of a heated needle or wire, cauterizing its outlet and the gums, when the gland may be artificially stimulated, and the poison secured by means of a fine needle-point syringe.—*New York Observer.*

The Longest Tunnel in the World.—An engineering work that has taken over a century to construct can hardly fail to offer some points of interest in its history, and illustrate the march of events during the years of its progress. An instance of this kind is to be found in a tunnel not long since completed, but which was begun over a hundred years ago. This tunnel, or adit as it should be more strictly termed, is at Schemnitz, in Hungary. Its construction was agreed upon in 1782, the object being to carry off the water from the Schemnitz mines to the lowest part of the Gran Valley. The work is now complete, and, according to the *Bauzeitung fur Ungarn*, it forms the longest tunnel in the world, being 10.27 miles long, or about one mile longer than St. Gothard, and 2½ miles longer than Mont Cenis. The height is nine feet ten inches, and the breadth five feet three inches. This tunnel, which has taken so long in making, has cost very nearly a million sterling, but the money appears to have been well spent; at least, the present generation has no reason to grumble; for the saving from being able to do away with water-raising appliances amounts to £15,000 a year. There is one further point, however, worth notice; for if we have the advantage of our great grandfathers in the matter of mechanical appliances, they certainly were better off in the price of labor. The original contract for the tunnel, made in 1782, was that it should be completed in thirty years, and should cost £7 per yard run. For eleven years, the work was done at this price; but the French revolution enhanced the cost of labor and materials to such an extent that for thirty years little progress was made. For ten years following, much progress was made, and then the work dropped for twenty years more until the water threatened to drown the mines out all together. Finally, the tunnel was completed in 1878, the remaining part costing £22 a yard, or more than three times as much as the original contract rate.

Incorporated 1866.

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The Locomotive.

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Explosion of a Saw-Mill Boiler.

Our illustration this month shows a boiler which exploded near St. Augustine, Fla., on the 18th of February last.

The boiler, which was used to drive a saw-mill, was of the hog-nosed type. It was

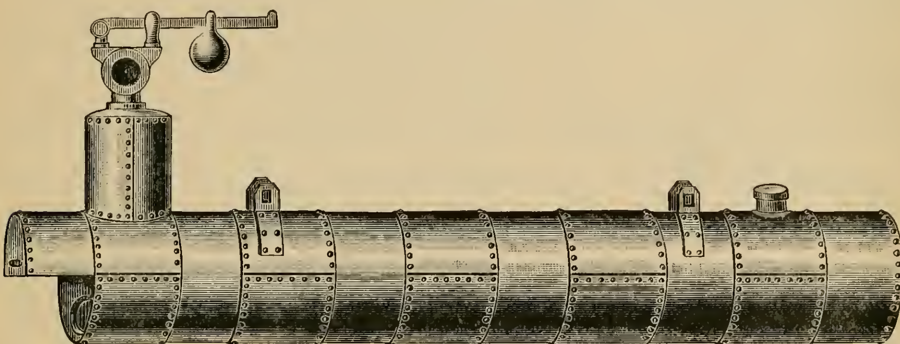


Fig. 1. Boiler Before the Explosion.

twenty-seven feet long over all, forty-eight inches in diameter, and had two flues sixteen inches in diameter and twenty-five feet long, heads cast-iron, man-hole in each head.

The following is the fireman's account of the accident: "We usually carried about

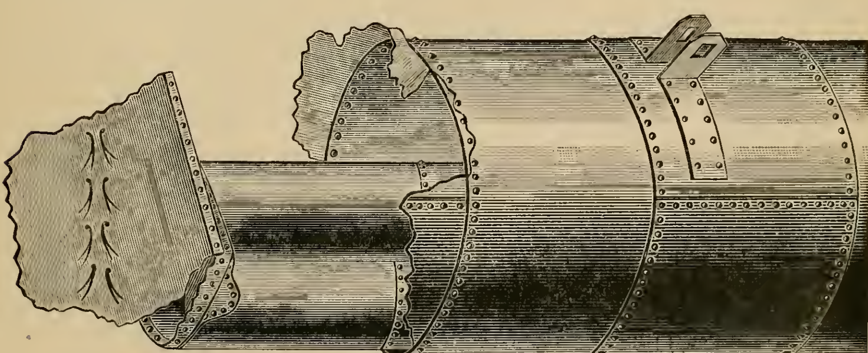


Fig. 2. Front End of Boiler After the Explosion.

seventy pounds of steam, and had sixty-five pounds when the engine stopped at noon. The water was fed to the boiler by an injector. It required hard firing to keep up steam. The boiler evaporated the water as fast as the injector could force it in, and as the water was low when the engine stopped, I kept the injector running until I had three gauges, and then shut it off. The pressure was then seventy pounds, and steam was beginning to blow off a little at the safety-valve.

I was on the north side of the boiler getting ready to eat my dinner, when I was lifted from my feet and thrown twenty feet away, unhurt; but my little girl, who had brought my dinner, and had started for home, was on the other side and was so severely scalded that she died two days later."

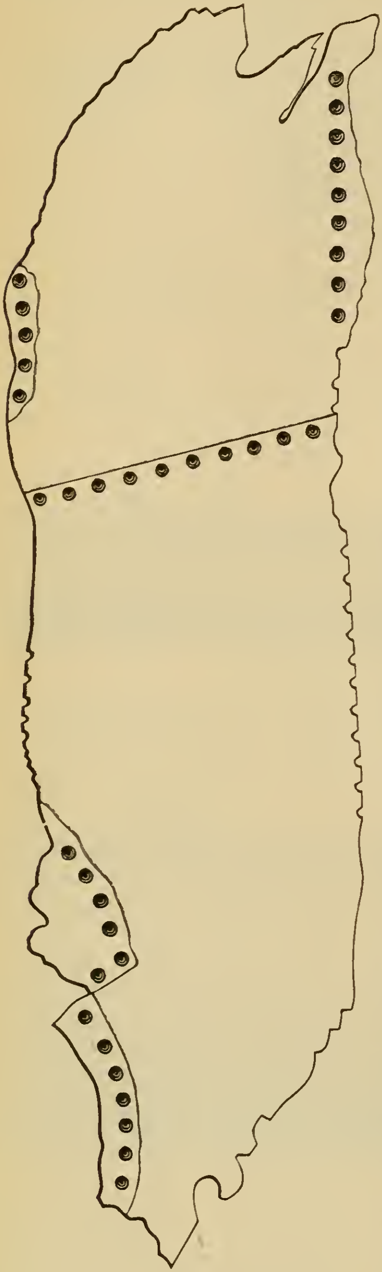


FIG. 3. DOME SHEET.

An examination showed the boiler to be very thickly coated with scale. The water had been taken, for about four months prior to the explosion, from an artesian well. The plates were found to be very badly corroded about the dome, some parts of the sheet on which the dome was situated being so thin it was difficult to determine the exact thickness.

By referring to the cuts it will be seen that this sheet was completely torn out and was thrown about fifty feet in a westerly direction, while the remaining portion of the shell was thrown two hundred feet in the same direction, forcing its way through a large pile of heavy lumber. The dome was thrown still further in the same direction, going about three hundred feet and passing through and tearing away the corner of a house on its way. The safety-valve, the front head of the nose, and the top sheet of the same part are missing, and are supposed to have been thrown about one hundred feet in a westerly direction and fallen into the river.

From the above description which was kindly furnished us by Mr. B. F. Robinson of St. Augustine, we think there is no doubt that the explosion was due entirely to the fact that the boiler shell was so badly corroded that it had not sufficient strength to carry the ordinary working pressure. From the direction taken by the fragments it would seem that the shell gave way near the bottom of the dome-sheet, probably in the second girth-seam. A rupture occurring at this point would extend upward, allowing that portion of the shell forward of the break to swing upward and backward, giving it the direction taken. The strain brought about by the steam pipe, which was connected to the top of the dome, and the reaction of the water and steam issuing from the dome and hog-nose would be sufficient to bring about the destruction of those parts as described. With the front portion of the boiler gone, the reaction of the issuing steam and of the large body of hot water contained in the remaining, and greater part of the shell would send it exactly as a sky-rocket is propelled, in the direction it took. The boiler set east and west, facing the east, and it was blown in a westerly direction.

Our correspondent writes us that there were various theories regarding the cause of this accident, but we do not see any grounds upon which to base any other than the one we have expressed. There are tens of thousands of boilers in this country to-day running under similar conditions, and the only mystery surrounding them is the fact that so few comparatively do explode, not that there are so many explosions.

Inspector's Reports.

JANUARY, 1887.

During the opening month of the year our inspectors made 3,705 inspection trips, examined a total of 7,465 boilers, made 2,428 internal inspections, tested 309 boilers by hydrostatic pressure, and reported 7,236 defects, of which 1,103 were considered dangerous, and led to the condemnation of 61 boilers.

Our usual tabular statement of defects is appended.

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	398	32
Cases of incrustation and scale,	632	43
Cases of internal grooving,	18	8
Cases of internal corrosion,	146	20
Cases of external corrosion,	272	35
Broken and loose braces and stays,	341	31
Settings defective,	145	23
Furnaces out of shape,	287	14
Fractured plates,	187	62
Burned plates,	96	29
Blistered plates,	228	17
Cases of defective riveting,	2,136	336
Defective heads,	43	13
Serious leakage around tube ends,	1,133	321
Serious leakage at seams,	640	23
Defective water-gauges,	133	18
Defective blow-offs,	42	10
Cases of deficiency of water,	19	7
Safety-valves overloaded,	57	22
Safety-valves defective in construction,	35	10
Pressure-gauges defective,	207	26
Boilers without pressure gauges,	11	2
Defective hangers,	24	0
Defective fusible plugs,	3	0
Defective man-hole rings,	2	0
Defective nozzles,	1	1
Total,	7,236	1,103

In an able article on the subject of boiler explosions, one of our contemporaries says: "Looking at the operation of locomotives ought to afford a lesson to the users of stationary boilers. The locomotive boiler is generally used with a factor of safety of not much more than half that employed in stationary practice; an enormous quantity of water is evaporated, yet with these drawbacks explosions of such boilers occur very seldom. But the locomotive engineer comes up to his position through a regular apprenticeship as fireman."

We will grant that the operation of locomotives ought to afford the users of stationary boilers a lesson, but we would respectfully submit that the lesson is this: Locomotives are regularly run into the railroad shops and thoroughly inspected by men who make such work a business, and all necessary repairs are made by them. The fact that the very operation of a road depends upon this work forces railroad companies to do it. The keeping of an engine in running order involves, incidentally, care of the boiler as well as the running gear. To this must be attributed the supposed immunity of locomotive boilers from explosion. But this work is not done by the engineers. This fact should be borne in mind.

Another fact that should be borne in mind is this: Locomotive boilers *do* frequently explode, in spite of all assertions to the contrary. There were twenty-two locomotive boiler explosions in this country in the year 1886, more than there were among any other class of boilers except saw-mills and wood-working establishments. We do not know how the total number of saw-mills in the country compares with the number of locomotives, but we have the impression that such boilers outnumber locomotives largely. If such is the case, the ratio of explosions to boilers in use does not show much to the credit of the locomotive, especially when we take into account the greater facilities available for repairing locomotive boilers.

But we do not wish to convey the impression in this article, that we believe locomotive engineers are, as a class, inferior to other sorts of engineers. On the contrary, we will distinctly state it as our belief that they understand their business as a rule, just as well as other classes of engineers understand theirs, and not one whit better. And we believe that this rule holds good throughout all professions. Take two young men of the same amount of intelligence, to use an illustration, educate one as an engineer, and the other as a physician, the chances are that the first will make as good an engineer as the other will a doctor, although the second one may succeed in making a fortune and perhaps a fair amount of fame, it will require no more intelligence, study, or application than will be brought to bear on his profession by the first one, who may always remain comparatively poor and never be heard of outside his immediate circle of acquaintances.

Boiler Explosions.

January, 1887.

Pattern Shop (1).— A small tubular steam-boiler in the pattern-shop of C. O. Warner, Beloit, Wis., exploded December 30th, while under a pressure of 110 pounds, and was torn into fragments. The concussion blew out the windows of the building and broke considerable machinery. Three men were in the room, and all escaped injury.

Saw-Mill (2).— The boiler in Moses Thompson's mill, Sheakleyville, Pa., exploded January 4th, wrecking the mill and killing John Scrivener, Isaac Mushrash, and a man named McAffee. Low water is supposed to be the cause.

Flour Mill (3).— The fine new mill at Elwood, Ind., owned by Mr. Newton House, was badly wrecked on the morning of January 4th, by the explosion of the boiler. The engineer, Del Lyst, the miller, Joseph Reid, were instantly killed, and his assistant, George Reid, badly injured. Many of the surrounding buildings were badly injured by flying debris.

Heating Boiler (4).— The boiler which heats the Center street school in Branford, Conn., blew a hole in its side January 4th, with a loud report. The whole building was shaken, and several articles in the room in the basement where the boiler is placed, were damaged. The accident happened in the morning before the school had opened for the day, and before any of the children had arrived.

Saw-Mill (5).— The boiler of a saw-mill, owned by J. R. Fiddler, two miles south of Hopkins, Mo., exploded January 5th, instantly killing R. M. Gray, J. S. Cox, and Martin Smith, breaking the arm and leg of the owner, J. R. Fiddler, and slightly scalding his son, Marion Fiddler. The force of the explosion was terrific. Half of the boiler was hurled at least 300 yards, cutting off trees nearly a foot through in its course. The other half of the boiler was thrown 200 yards in the opposite direction. The body of Cox was blown at least seventy-five yards, and was horribly mangled. The bodies of Smith and Gray lay close to where the boiler stood, and were so mangled as not to be recognizable. All of the killed were married men. Gray leaves a wife but no children. Cox leaves a wife and four children, and Smith a wife and two children. The boiler was an old one, with two flues. It was in bad repair, and had frequently been fixed. At the time of the explosion there was about ninety pounds of steam, the water was low, and Fiddler stopped the mill, and turned on the pump, and a moment afterward the explosion occurred.

Machine Shop (6).— On Saturday morning, January 8th, Mr. Lafayette Woodmansee, who has charge of the boiler for heating of the works of the Nichols & Langworthy Machine Company, Hope Valley, R. I., was attending to his duties, which for the moment had necessitated his presence on top the boiler where the valve is located to turn the steam into the works, and which is covered over with iron plates. At this critical moment a cap was blown off one of the tubes directly under his feet, the force of the cap and pressure of the steam striking the plate on which he stood, knocking him over and bruising him seriously from head to foot, the steam scalding his face and one of his hands painfully. His escape from more severe injury was very remarkable.

Heating Boiler (7).— January 9th, Enoch Murray, a painter, and John Griffin, a car inspector, went to the repair-shop of the Portland & Rochester railroad, Portland, Me., and found everything in the large building apparently all right. They left the shop, locking the door on leaving, and had got but a short distance away when there was a terrific explosion. The numerous glass windows were hurled outward, and the steam-heater made its way through the roof. An examination showed that the piping was a wreck, and that the roof and wall in several places had been shattered. The force of the explosion was great enough to send pieces of the heater a distance of 200 feet. Had the explosion occurred during working hours, an appalling loss of life would have resulted.

Mine (8).— One of the boilers used to supply the engines of Mount Hope Mining company's mine, at Mount Hope, N. J., exploded January 12th, with terrific force, partly demolishing the boiler-house and slightly injuring the engineer, Samuel Gilbert, and Richard Jaffrey, and Patrick Ryan.

Hoisting Boiler (9).— The boiler house of the Delaware & Hudson Canal Company, at the head of their gravity road at Fairview, in Lackawana County, Pennsylvania, was the scene of a destructive explosion January 14th. The boilers are, or were, six in number, and are arranged in one nest. About 10 o'clock the whole six exploded with a violence which shook the ground like an earthquake, and was heard and felt for a distance of two miles. The boiler-house and the engine-house, which stood close by, were totally wrecked and blown to pieces, the boilers were torn apart, and parts of them weighing several tons hurled a distance of from 100 to 200 yards. There were only two men around the building at the time, and both were fatally hurt. Perry Parsons, the fireman, was found under a pile of debris with several ribs broken, and his legs and feet badly scalded. Engineer Hawley Weed was thrown a great distance of forty yards and very badly hurt.

BLEACHERY (10).— The boiler in the Middlesex Bleachery at Somerville, Mass., exploded January 16th. The boiler was in the engine-room in a one story brick building 250 feet long by 150 feet wide, which contained also the stock, drying, starching, and finishing rooms. The explosion blew out the end of the building and allowed the roof to fall. A small amount of finished material was set on fire and somewhat damaged. The cause of the explosion was a defective safety-valve. The force of the explosion was very great, arousing everybody for a half mile or more around. A portion of the boiler went through an 18-inch brick wall into the chemical room, where considerable damage was done. Only two men were on duty at the time and they were in another part of the building and escaped unhurt. In the rough, the damage will be between $10,000 to $20,000, about half on building and half on contents.

SAW-MILL (11).— The boiler that supplies the dry house of Preston Rider's stave factory, at Crothersville, Ind., blew up January 17th, and two employees, Henry Millina and Archie Warner, were instantly killed. Millina's head was blown clear off his body, and Warner's head was torn literally to pieces. Their bodies were so horribly scalded that the skin peeled off from head to foot. Another employee had his foot broken. The boiler, weighing 5,000 pounds, was hurled 125 feet.

TUG-BOAT (12).— At Fall River, Mass., January 18th, the tug *Theodore Birely* was towing the schooner *Sylvester Hale* to Somerset and had reached a point between Slades Ferry Bridge and Forest Hill Garden, when the boiler of the tug exploded with terrific force, killing engineer Elmer Whitmarsh of Dighton, and wounding George Payne of Taunton. Engineer Whitmarsh was hurled over the main boom. His body was not recovered. A piece of Captain Coleman's ear was cut off, and he was also cut about the head. The *Theodore Birely* was owned by Stapels & Phillips of Taunton, and is a total loss.

ROLLING MILL (13).— A boiler in Swift's Iron and Steel works on the bank of the Licking River, in Newport, Ky., exploded January 19th, with terrific force. The engineer and two laborers were the only occupants at the time, and they escaped without injury. He said he had just inspected the fires and boilers before the explosion took place. The loss is estimated at $25,000. A similar accident happened about a year ago, causing nearly as great a loss.

SAW-MILL (14).— The boiler in Jackson Norris's mill, three miles from Washington, Davis County, Ky., exploded January 20th, killing the owner, his two sons, and William McAffee. The mill and machinery were totally wrecked, and the boiler hurled 400 feet from its bed.

GRAIN ELEVATOR (15).— The boiler connected with the grain elevator, at Newport News, Va., exploded January 20th, killing assistant fireman Samuel Robinson, and badly scalding and burning Martin McRae, fireman, and three colored men. The boiler-house was wrecked. Total damage amounted to $10,000.

SAW-MILL (16).— The boiler in a mill at Dexter, Iowa, belonging to a man named Mosher, exploded January 22d, with terrific violence, destroying the building, killing the proprietor, and tearing up the Rock Island main line for a distance of thirty feet. The mill, situated about thirty feet north of the Rock Island track, is a complete wreck. Not five minutes prior to the catastrophe the west bound passenger train, well loaded, had passed directly by the mill. Had the explosion occurred two minutes sooner the boiler, which, in its flight struck and tore up the railway track and twisted the rails out of shape for a considerable distance, would have been hurled through the coaches and caused a serious loss of life. As it was, passengers on the rear platform witnessed the disaster and congratulated themselves on their narrow escape. The owner, Mr. Mosher, was fearfully scalded and horribly mangled, and has since died. Knowledge of the cause of the accident probaby perished with Mr. Mosher and will never be known.

Locomotive (17).— The west bound passenger train on the Louisville & Nashville railroad was totally wrecked January 22d, by the explosion of the locomotive boiler. The train had just whistled for Hawthorne, a small station four miles east of Carmi, Ill., when the explosion occurred. Fragments of the engine were scattered many rods in every direction. The baggage and mail car and the two passenger coaches were ditched and badly smashed, but the sleeper, though derailed, was not overturned. Engineer William Hansacker, and fireman Robert Gray were both instantly killed. Their bodies are horribly mangled. Only two of the forty passengers were seriously injured. Lafe Bullett of Evansville, had one of his hands crushed, and is hurt internally. H. H. Ridgeway, a St. Louis drummer, received fearful contusions in the back and breast. Express messenger Wagner, mail messenger Clark, and a colored porter were more or less cut up and bruised.

Mine (18).— One of the boilers of the Kiefer mines at Egypt, Lehigh County, Pa., exploded January 23d, and greatly damaged the other. The exploded boiler divided itself, one-half going in an easterly and the other in a westerly direction. The former half fell about a hundred yards from the works, ploughed up and through a large quantity of earth against a frame dwelling. Part of the loosened earth crashed through a bedroom window and aroused a sleeping boarder. Joseph Saurwine, an employee of the mines, was asleep in the boiler-house, but was aroused by engineer Bachman a few minutes before the explosion. Bachman says the boiler contained three gauges of water. The boiler-house was completely wrecked, but nobody was hurt.

Rolling Mill (19).— An explosion of a boiler occurred at Spang & Co.'s Iron works at Etnaborough, near Pittsburg, Pa., January 24th. The mill was badly wrecked, and for some time after the explosion it was impossible to tell what damage had been done, the shower of dust, brick, and mortar completely shutting out everything from view. When the debris had settled it was found that the fireman, George Patterson, had been instantly killed. William Corville, an employee, was picked up from under the boilers in a dying condition. He was scalded by steam. Barkley Knocton, a puddler, was hit on the head with flying bricks and badly injured. M. Mullholland, a helper, had one leg broken, and was otherwise injured.

Paper Mill (20).— The boilers of the Harvey paper mill at Wellsburg, W. Va., exploded January 26th, with great violence, wrecking the mill and setting fire to the ruins. Two men were instantly killed, and two injured. John Nelson, the engineer, aged forty-five years, was blown one hundred feet and completely disemboweled. Thomas Nelson, his nephew, aged twenty-five years, not an employee of the mill, was blown fifty feet and covered by a falling wall. Smith Horner, who was outside the mill, was blown into the river. He escaped with a broken rib. James Parrish, who was sitting in the boiler-room when the explosion occurred, was blown out into the street, and was terribly scalded. Several others were knocked down, but escaped with slight bruises. Two of the three boilers were carried one hundred yards, one of them partially wrecking a dwelling-house.

Oil Well (21).— A terrific boiler explosion startled the men working in the vicinity of the Wolf & Kugler wells, in the Egypt oil district, about five miles from Oil City, Pa., January 26th. There are eight wells in this group, pumped by one engine, all having sucker-rod connections. The National Transit Gauger at ten minutes to four o'clock went to the boiler-house and saw that the steam gauge registered between eighty and ninety pounds and that there was plenty of water in the boiler. About five minutes later the explosion occurred, completely demolishing the boiler-house and instantly killing Samuel McCormick, aged fourteen, and William Maitland, aged nineteen, who were in charge of it. Both of the boys were unusually intelligent and fully capable of running the engine. The cause of the explosion is a mystery, but pieces of the boiler-plate found are very thin.

Electric Light Engine (22).— The boiler to the engine supplying electric light for South Chicago, exploded January 28th, instantly killing Myron Abbott. He was jammed in a corner and literally cooked.

Saw-Mill (23).— The boiler in the shingle-mill owned by Joseph Brothers, Lake View, Mich., exploded January 29th, demolishing the mill and instantly killing James O. Wilson, and seriously injuring James Joseph.

Sugar Refinery (24).— The steam boiler at the Alameda Sugar Refinery, Alameda, Cal., exploded January 29th, and completely demolished the building. The explosion occurred at the Standard Sugar Works. All of the boilers, seven in number, were blown out of place. Fireman Dennis had a leg broken and was otherwise badly injured. The loss will be from $7,000 to $8,000. The cause of the explosion is unknown.

Tug-Boat (25).— When the tug *Thomas J. Yorke, Jr.*, was off Marcus Hook, Thursday night, January 27th, the fore end of the boiler blew out, severely injuring the steward, William Loper, and the fireman, Alex. Dumoine. They were both removed to the Pennsylvania Hospital.

Threshing Engine (26).— An accident occurred near Unionville, Frederick County, Md., a few miles from the Carroll County line, Md., January 31st, which resulted in the killing of one man, and the wounding of two others. A number of men were threshing at Mr. W. E. Long's barn with a traction engine belonging to Wm. M. Gaither & Co., when the boiler exploded. The engine was blown to pieces, the barn set on fire, and the engineer, Mr. John Izer, was killed. Mr. Long and Mr. U. Stitely were both slightly hurt by being hit with fragments of the engine. The barn, with all its contents, consisting of grain and farming implements, and a large thresher, was burned.

Ancient Boston History.— Some opening chapters of the new *Memorial History of Boston:*

Chap. I. Boston!

Chap. II. When the gaseous elements of which the earth is composed first commenced to solidify, they solidified and stratified at Boston. Boston was the first solid bit of ground in the universe.

Chap. III. The more intelligent and highly-organized animals of the Miocene and Pliocene periods lived at Boston. There the Pterodactile mused over the past, and the Megatherium pondered the future.

Chap. IV. The first man was a Boston man. He was developed from spores out of Boston mud. He took out a patent for himself, so that he could not be imitated.

Chap. V. Boston was vaguely known to the Greeks. It is the real site of the fabled Atlantis. Plato died longing to visit the neighboring graves of Concord and hold sweet communion with the Concordians. Galileo involuntarily turned the first telescope in the direction of Boston. The Egyptians built the pyramids hoping to see Boston from their summits. Diogenes was rolling his tub toward Boston when death overtook him.— *N. Y. Graphic.*

The Locomotive.

HARTFORD, MARCH, 1887.

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

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

Eight Hours a Working Day, by Prof. R. H. Thurston of Sibley College, Cornell University, written for, and now appearing in, the columns of *Mechanics*, is a scientific discussion of the value of labor, and we can recommend its perusal to everyone interested in the subject.

The number of specifications for new boilers drawn at the Home Office alone, of the Hartford Steam Boiler Inspection and Insurance Co., foots up 293, the number of boilers called for in each ranging from one to twelve, and their sizes running from 30 inches in diameter to 72 inches in diameter. Drawn for our patrons only.

The number of railroad bridges that have fallen in the past few months, with their great attendant loss of life, would seem to indicate that something is wrong somewhere. Perhaps the railroads need protection from themselves in the matter of bridge building as well as in the matter of transportation, inter-State or otherwise.

Mechanical Anglo-maniacs would do well to read the article in the current number of the *Journal of the Franklin Institute*, entitled the "Sellers or Franklin Institute System of Screw-threads."

A great deal of adverse criticism of the "long and short haul clause" of the recently enacted inter-State commerce bill is appearing in the newspapers, the aim evidently being to render the bill as unpopular as possible, with the idea, probably, of securing its repeal, wholly or partially, as well as to affect the decisions of the commissioners. To our mind the thing is plain and simple, although it may not be a simple matter to re-adjust a state of affairs which has required years to bring about and establish. The idea of the railroads seems to be that certain places should have their freight carried for nothing while other places should pay the charges for all. This is not right, and while certain points would flourish and be greatly benefited thereby, a far greater number of persons and places would be impoverished. The greatest good to the greatest number will result from an enforcement of this clause, and the commissioners should see that it is enforced. If a railroad cannot get business enough to live on legitimate traffic and rates, that is the best possible evidence in the world that it is not needed, and there is no good reason why, like other business enterprises, it should not go to the wall.

Compulsory Prayers. — "What is this I hear," said Mrs. Spook, "about compulsory prayer being abolished in Harvard? Did they use to compel the students to pray?"

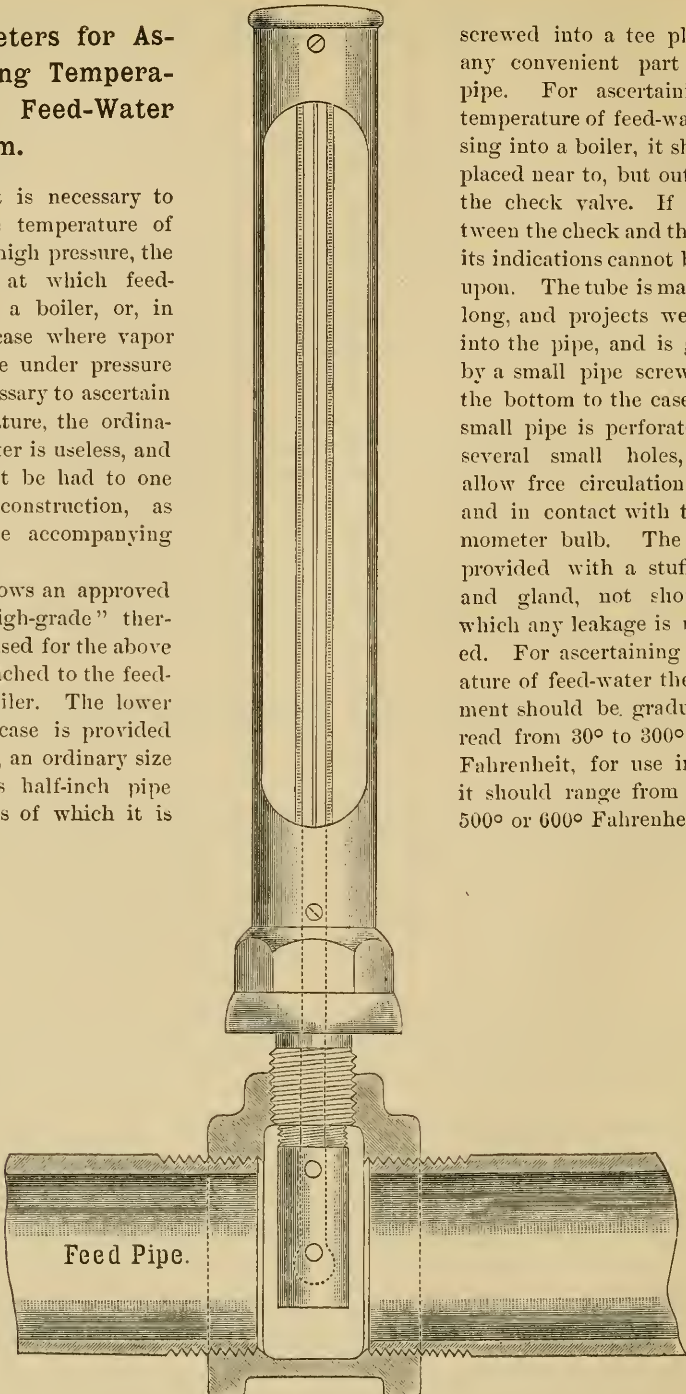
"Yes," said young Spook, who had just come home from college on a vacation; "yes, the janitor used to go round three times a day, and make every student get down on his knees and pray, and if the student resisted, swore at him like a pirate."

"That's just right," rejoined Mrs. Spook: "if a young fellow won't pray, he ought to be sworn at until he is ashamed of himself."—*Lynn Union.*

Thermometers for Ascertaining Temperature of Feed-Water or Steam.

When it is necessary to ascertain the temperature of steam under high pressure, the temperature at which feed-water enters a boiler, or, in fact, in any case where vapor or liquids are under pressure and it is necessary to ascertain their temperature, the ordinary thermometer is useless, and recourse must be had to one of special construction, as shown in the accompanying cut.

The cut shows an approved form of "high-grade" thermometer, as used for the above purposes, attached to the feed-pipe of a boiler. The lower end of the case is provided with a screw, an ordinary size for which is half-inch pipe size, by means of which it is screwed into a tee placed in any convenient part of the pipe. For ascertaining the temperature of feed-water passing into a boiler, it should be placed near to, but outside of, the check valve. If it is between the check and the boiler, its indications cannot be relied upon. The tube is made extra long, and projects well down into the pipe, and is guarded by a small pipe screwed into the bottom to the case. This small pipe is perforated with several small holes, which allow free circulation around and in contact with the thermometer bulb. The stem is provided with a stuffing-box and gland, not shown, by which any leakage is prevented. For ascertaining temperature of feed-water the instrument should be graduated to read from 30° to 300° or 400° Fahrenheit, for use in steam it should range from 212° to 500° or 600° Fahrenheit.



Notes and Correspondence.

Our article on the use of very high steam pressures in the issue of THE LOCOMOTIVE for October last has brought out several communications on the subject, some of which are of a more or less critical nature, while most of them endorse the stand taken by us. The following from a well-known engineer, being fully as critical as any of the letters received, we reproduce, and, what we have to say on the points raised therein, must apply to similar criticisms expressed by other writers.

To the Editor of THE LOCOMOTIVE:

In your article on the use of high steam pressures in the October, 1886, number of THE LOCOMOTIVE, you say "That time and money spent in devising boilers to carry very high pressures might possibly be spent to better advantage in improving the performance of the engine."

The functions of the boiler and engine are entirely different; that of the boiler being to take the heat of the coal, and this is done by the better class nearly perfect, the great loss being with flue gas.

The duty of the engine is to convert the heat so taken up into work. When Watt improved the engine, he had to devise a boiler that would sustain the necessary pressure, and from his time down engine designers have had the same thing to do. When it is found that certain types of engines are giving the highest results attainable with the pressures at hand, and there is reason to believe that another type will do better, but to be successful higher pressures must be obtained, there is nothing to be done but to build a boiler to carry that pressure, and until this is done the performance of the engine cannot be improved, and if the return tubular boiler won't fill the bill, like all things out of date, it must make way for something else.

We have locomotive boilers furnishing an almost incredible amount of steam, under a pressure as high as 160 pounds. A pair of 18 x 25 cylinders, with 6-foot drivers, making 40 miles an hour, means 880 feet piston speed, and with 140 pounds, which is about the average, and following ¼ stroke would make over 750 horse-power, or, with a triple expansion, some 1,500 horse-power.

Here is a place that a return tubular would be entirely out of the question. There are boilers built which will carry the 150 or 200 pounds required that will give as good or better results as the return tubular and expose thin metal to the fire.

If, in improving the engine the boiler stands in the way, necessity simply compels the devising of some other form. It is fate which all must finally yield.

W. E. CRANE, Waterbury, Conn.

"The functions of the boiler and engine are entirely different, that of the boiler being to take the heat of the coal, *and this is done by the better class of boilers nearly perfect.* . . . . The duty of the engine is to convert the heat so taken up into work."

The functions of the boiler and engine *are* entirely different, and we are not aware that we have at any time and place stated that they were not. If we have we shall be much obliged to any one if they will put their finger on the place where we did.

"And this is done by the better class of boilers nearly perfect." So it is, and so we stated in our article; an average efficiency of 75 per cent. of the calorific value of the coal being easily attainable. But it is a matter of daily record that the ordinary horizontal tubular boiler will not only give an efficiency equal to the best boilers of special form that have ever been made, but that a plant of any given capacity can be put down, of this type, for about one-half the money that the complex boilers cost. So we think it must be allowed that the ordinary form of horizontal tubular boiler is easily "one of the better class."

"The duty of the engine is to convert the heat so taken up into work." Just so. But it does not do it very perfectly, and increasing the steam pressure, in itself, does not help the matter, we are sorry to say, one bit. In the best engine ever made more than one-half of the steam that goes into the cylinder passes through it without doing any work whatever; it acts as a kind of tramp steam, as it were, and we would beg leave to call our critic's attention to the fact that *this* was the point at which our previous article was aimed. When he or any of our other correspondents will show how this loss in the engine is to be obviated by the use of very high pressures, or the substitution of any many-fangled sort of a boiler for the "old reliable," now in almost universal use in this country, we will discuss in detail the other points of his communication.

H. F. S

To the Editor of THE LOCOMOTIVE:

DEAR SIR,—Thinking that it would be interesting to you, I write to you in regard to a singular freak that the guage-cocks on a locomotive on the Richmond & Danville Railroad performed, said freak or phenomenon being well calculated to set an engineer on the beam ends of his wits. It was as follows:

The engine had four guage-cocks tapped directly into the boiler-head without any combination or stand-pipe; the boiler, with closed throttle, showed water at the third guage, the first and second being the same; upon opening the throttle it showed water at the first and third but the second, it is said, gave neither steam nor water; and upon again closing the throttle, the second gave water as before.

Now the explanation that I would offer would be this: that the second guage had become transiently stopped up, for I afterwards heard that the cock in screwing in had been screwed against a brace which partially closed the opening, and that this brace was in close proximity to one of the sheets exposed to the fire. The water in contact with this sheet might have undergone spheroidal suspension or repulsion and been driven from the sheet at this point when the throttle was opened, and again resumed its former position when closed, and as steam at very high temperature has very little or no color, the engineer might have thought that nothing was coming out of the cock. I have had nearly the same thing occur to me on a combination; it is always my practice to countersink the end of the cock and take a three-cornered file and make two slots across the opening at right angles to each other before screwing them in.

Yours respectfully, J. OSCAR GOODE.

RICHMOND, VA.

To the Editor of THE LOCOMOTIVE:

Will you kindly allow me to say a word or two in regard to "Accidents Resulting from Low Water"?

What I would like to remind you of is, the number of boiler attendants who are not able to discern a water-line glass chock full from one entirely empty. This same mistake I have seen occur twice with firemen who have been under my charge; one had no water at all and was waiting for it to come down and show itself, when I came in the fire-room to try his water; upon looking at this particular boiler I asked him how long it had been out of sight, when he said he supposed it to be full. The other case was directly the reverse from the foregoing; this man happened to get a full glass, and thinking his water was out of sight (which was a fact in one sense), continued pumping until the safety-valve was pushed up by the pump's exertion. I have found that where both glasses and cocks are used, the glasses are invariably relied on, while the cocks are left to take care of themselves, being seldom opened unless the engineer in charge is one of the TRUE PRACTICAL kind. Very truly, WM. M. LINNETT.

NEWARK, N. J.

The electric boiler explosion crank is still abroad in the land as the following communication, which we clip from a daily paper of a recent date, will attest:

"May I ask you to indulge me through the columns of your paper? It is my wish to ventilate my views upon this subject, as a great deal of importance may attach to the workings of the first named, in relation to its amalgamating with steam at high pressure in steam boilers. These direful and dreadful explosions must be something more than overpressure, when in such cases the boiler would only have to break out or burst in the weakest part. It seems as though we might with propriety classify these explosions under two heads, viz.: one, the kind spoken of, only a burst as a relief due to overpressure and nothing more; then there is a kind that would seemingly bring down the very walls, level everything within a mile or so. The detonation and destruction are perfectly awful to contemplate. This I will call No. 2, extra-hazardous. Why, may I ask, is this marked difference in the two kinds of explosions? If I venture an opinion, it is the result of low water, which is a cause of some parts of the boiler being overheated; *electricity* is generated; by its mingling in concert with steam, that if then superheated and surcharged with electricity at this critical juncture of things, the plates become hot enough to ignite the electricity and steam and the result is a most disastrous explosion, dealing death and destruction around.

"There is a subtlety, a silent working of this electricity in steam quite overlooked by engineers, they attributing all explosions to other causes than the real one.

"May I ask: Why do not explosions of boilers upon the splendid Atlantic ocean steamers occur? I answer, simply because the feed water pipe into their boilers is always copper; not that they look upon it as a safeguard against explosion, which, in my opinion, it is. It is used by them simply because it will not rust or corrode as an iron pipe will by the salt sea water used for the boilers. Still this copper feed water pipe is what has proved of inestimable value; other than a feed pipe. It has proved to be a most excellent conductor of electricity out of their great gang, or nest of boilers; and by such appliance, unknowingly I presume to them, has fully prevented any explosion of boiler on any steamer of all the ocean lines. So much for copper pipes leading into and out of boilers. I would suggest that all stationery boilers have a copper feed pipe attachment, directly applied as a safeguard, to conduct off the electricity from within them. Or attach a copper rod to enter through the top part of the boiler, bent to run horizontally along the steam space above the water line; the other end of rod to be inserted in the ground until moisture is reached, and all the electricity will be constantly carried out of boilers and a much greater degree of safety insured.

Very respectfully submitted, ETC., ETC."

This upsets all our notions upon the subject of boiler explosions. If electricity amalgamates with steam at high pressure no person is safe for an instant.

Then again, the peculiar classification of explosions is something new if not amusing. Explosions due to over-pressure produce simple bursts, relieving the pressure. Well, that is about all they are, really, but these simple bursts are generally sufficient to lift buildings, boilers, and anything else that happens to be conveniently located in the vicinity. Again, the idea that the plates of a boiler became hot enough to ignite electricity must by a novel idea to physicists. How this intensely high temperature is attained is not quite clear to our minds. We wish it could be further elucidated.

The writer's question, "Why do not explosions occur upon the Atlantic ocean steamers?" may be best answered by saying: they *do* occasionally occur. And his idea that copper pipes convey away electricity (in case it should be formed) is absurd and childish. Iron is supposed to be a tolerably good conductor of electricity, at any rate we have an idea that a three or four inch iron pipe will carry off *something*, if it is given a chance. But really, granting all that the writer supposes, where in the world is the copper pipe going to conduct the electricity to on shipboard anyhow ?

Making Silver Prints on Wood.

It is said that photographic prints directly upon wood, from which engravers may work, may be made by the following process:

Take Gelatine, ...	45 grains,
White Soap, ...	45 "
Water, ...	$5\frac{1}{4}$ fluid ounces.

Soak the gelatine in the water for five or six hours, then dissolve it with the aid of a water bath. Cut the soap into small pieces, and add to the gelatine solution, stirring the whole with a glass rod to insure a perfect mixture, then add powdered alum until the froth disappears, and strain through muslin. Cover the block with this mixture and a little zinc white, then wipe off so that a very thin film will be left, rubbing it gently, so that the film may be of as even a thickness as possible. After drying, apply with a wide badger's-hair brush a coating of the following:

Albumen, ...	$3\frac{1}{4}$ fluid ounces,
Water, ...	$2\frac{1}{2}$ " "
Sal Ammoniac, ...	$67\frac{1}{2}$ grains,
Citric Acid, ...	$18\frac{3}{4}$ "

Whip the albumen to a froth, and allow it to settle; to the limpid portion add the water, then the sal ammoniac, and carefully stir with a glass rod, then add the citric acid. When the block is dry, sensitize with a solution of —

Water, ...	$3\frac{1}{4}$ fluid ounces,
Nitrate of Silver, ...	$187\frac{1}{2}$ grains.

Pour this upon the surface of the block, spread it evenly with a glass rod, and pour off the excess. When the block is dry, expose it under a negative in the usual manner, until it is printed the exact shade desired. When printed, immerse the printed surface in a very strong solution of salt for about three minutes. Then wash it under a stream of water for a short time, and fix it by placing it face downward in a saturated solution of hyposulphite of soda. After fixing, wash under a stream of water about ten minutes; when dry, it is finished and ready for the engraver.

Collapse of Flues.

It has been found in nearly every instance that, where flue boilers are extensively used, the collapse of the flues figures very prominently in the expense accounts of the owners. Inquiry as to the causes of accidents of this nature and the adoption of precautionary measures have not been neglected, and yet it is questionable whether much good has been done and whether the conditions of collapse are always properly recognized. The low-water theory, which has hitherto been applied so uniformly and conveniently to all cases of boiler accidents, has naturally been pressed into service in this matter also, though with more reason than ordinarily, since low water is undoubtedly a factor of great importance. Still it should not be credited with as much weight as it receives.

Boiler flues, it should be remembered, are rarely, if ever, perfectly round, but have flat places which are often responsible for a good deal of mischief. An imperfect flue of this kind may give satisfaction for years if worked under favorable conditions and within the fixed limit of pressure. If, however, a heavier demand be made on the boiler, and this pressure be exceeded, the flat portion of the flue will readily increase in area and the strength of the flue will be correspondingly diminished. It is not difficult to see that low water would produce a similar result, the flue sheets without the protective covering of water becoming overheated and yielding to the pressure. Again, a deposit of scale would work in precisely the same manner, showing that all these agencies should be duly taken into account in case of a collapse.

Where the decreased resistance of a flue is the result of over-pressure, the remedy is at once apparent. The use, in the flues, of strengthening rings, Galloway tubes, and other devices designed to increase resistance to collapse, is ample proof that the weakness of the flues is generally recognized. With good care, however, they are not liable to give serious trouble, and it will certainly pay steam users to be guided more than hitherto by the requirements of safety, convenience, and durability.—*Lumber Trade Journal.*

Why Johnnie Brown Escaped a Thrashing for Playing Poker.

"My son," said Brown senior, as he emerged from the house and caught his son counting out a roll of bills, "where'd you git all that money?"

"Oh, I've been sittin' in at a little game of poker all the morning."

"John!" and the old gentleman's tone was stern; "do you mean to say that you have been tempted by that insidious device of the Devil? I am astonished at you — after all my teachings, too. John, follow me to the woodshed."

"Oh, father, I didn't mean any harm," blubbered the boy. "I just ran across a couple of tenderfoots from the East who couldn't play poker even a little bit, and we had a quiet little game."

"You did, eh?" and the old man delved in the wood-pile for a suitable shingle.

"Yes, and one of those fellows was the biggest fool I ever saw. Why, father, he held two pair once, and bucked agin my four of a kind for near half an hour. It was a jack-pot, you know, an' I stood 'pat' an' he — "

"Eh? What's that?" queried the old man, as he poised his shingle in the air. "The blamed fool backed two pair agin a 'pat' hand on a jack-pot, did he?"

"Yes, an' another time he ran ace high agin my straight flush."

"Say, Johnnie, you don't mean it, do you?"

"Yes, I do, father."

"Didn't know no more about poker than that, eh?"

"Nary a bit, father."

"Say, Johnnie, hev them fellers left town?"

"No. They're down to the road-house, now!"

"Well, you just run your poor old father up agin 'em. There ain't no use bein' a hog when you strike a gold mine. Be quick, now!"

And five minutes later Johnnie was tearing madly down the road trying to keep ahead of the old man as they steered for the road-house.—*The Rambler.*

The Locomotive.

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Destructive Explosion of a Horizontal Tubular Boiler.

The explosion illustrated below occurred some months since in a neighboring State, destroying a large amount of property, but fortunately no one was killed or injured.

The boiler was one of a battery of similar boilers, set and connected in the usual manner. It was sixty inches in diameter, and sixteen feet long, the shell and heads were of steel, and of good quality; it was well made and had been in use about two years.

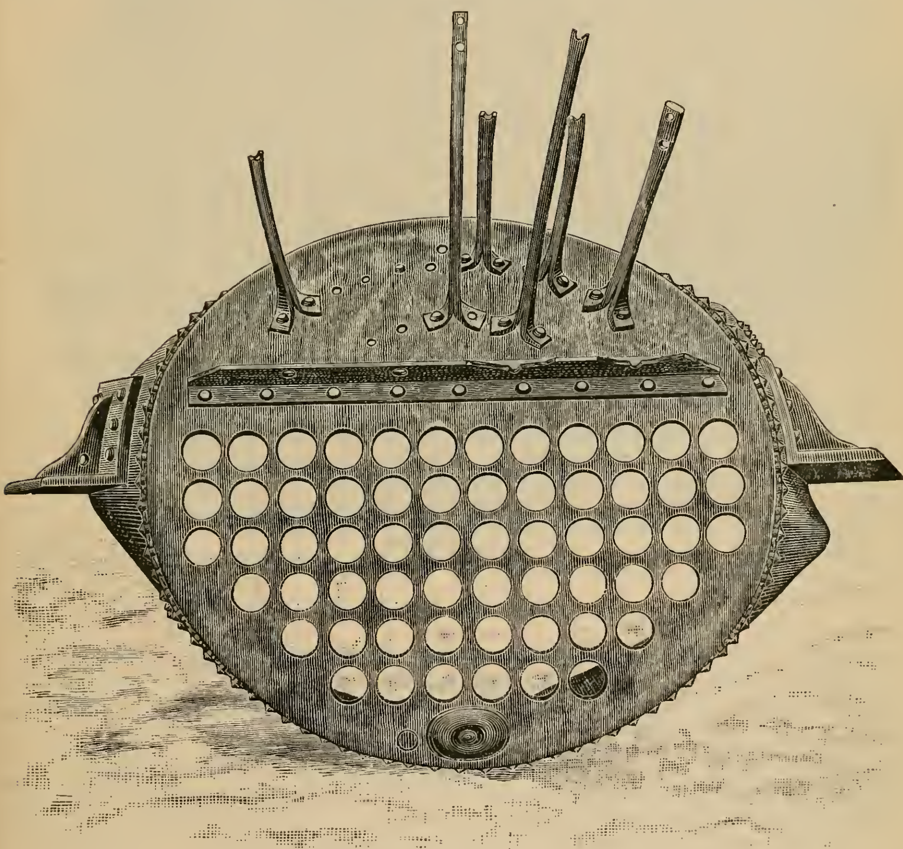

Fig. 1.

From what information we could gather, it appeared that this boiler had been blown off the day previous to the explosion for the purpose of cleaning. It was started up during the evening so that it would be ready for use the following day. Whether the stop valve was closed on this boiler, or whether steam was being drawn for some purpose for which but a small portion of that generated by the boiler was required, we were unable to ascertain, but the probability is that the valve was closed while the cleaning operation was going on, and was not opened afterward. However this may be, it was plain that the escape of steam by the usual outlet was in some manner prevented. During the night the boiler exploded. Our illustrations show two views of the shell, and a view of the front head. Fig. 1 shows the front head, Fig. 2 a view of the front end of the shell, and Fig. 3 a view of the back end of shell. The destruction of the boiler was very complete. An examination of the fragments seemed to indicate that the initial break occurred at the back end. Probably the tubes let go first, the sudden reaction in

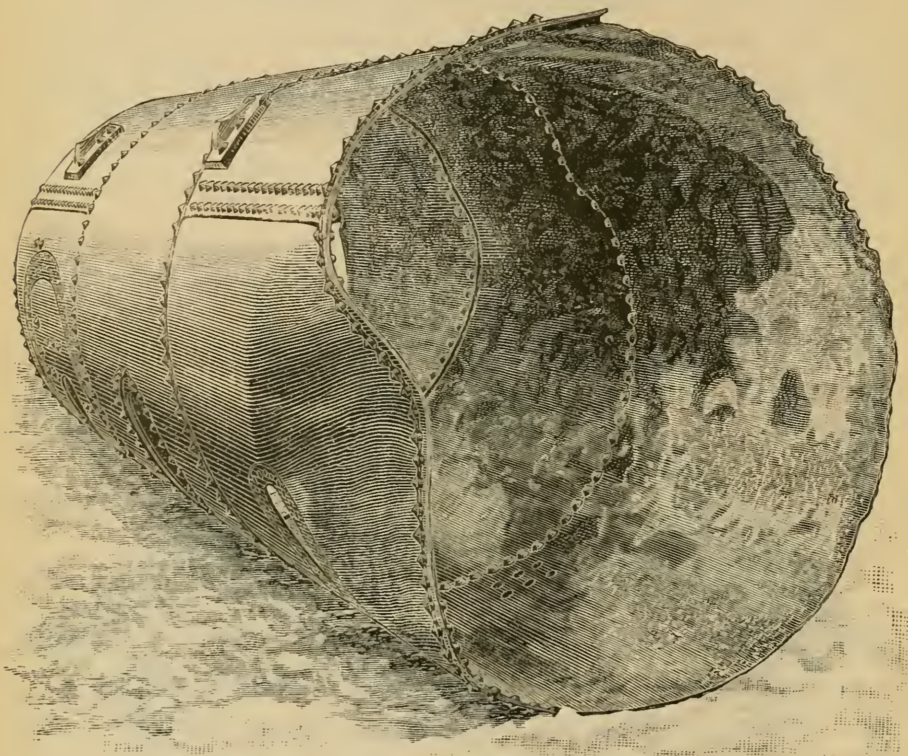

Fig. 2.

a longitudinal direction being sufficient to start a circumferential fracture in the shell near the front head, when the whole boiler went to pieces, as shown in the cuts, demolishing the boiler-house, and destroying property of the value of several thousand dollars.

An examination of the boiler after the explosion showed the plates to be in good condition, and amply strong to sustain any ordinary working pressure. Why then should it give way in the manner indicated?

As before stated the stop-valve was probably closed. If it was not then all outlets to pipes beyond into which the steam could gain admittance were closed, for the explosion was due entirely to overpressure, which was rendered possible by the simple fact that the safety-valve was inoperative.

An examination of this important fixture after the explosion showed an accumulation of scale and rust around the spindle and seat which fastened it so firmly, that several blows from a sledge hammer were entirely insufficient to start it in the least degree from its seat. This, simply, was the primary cause of the accident; ordinary attention would have prevented it, and it was simply a piece of sheer good-luck that the explosion occur-

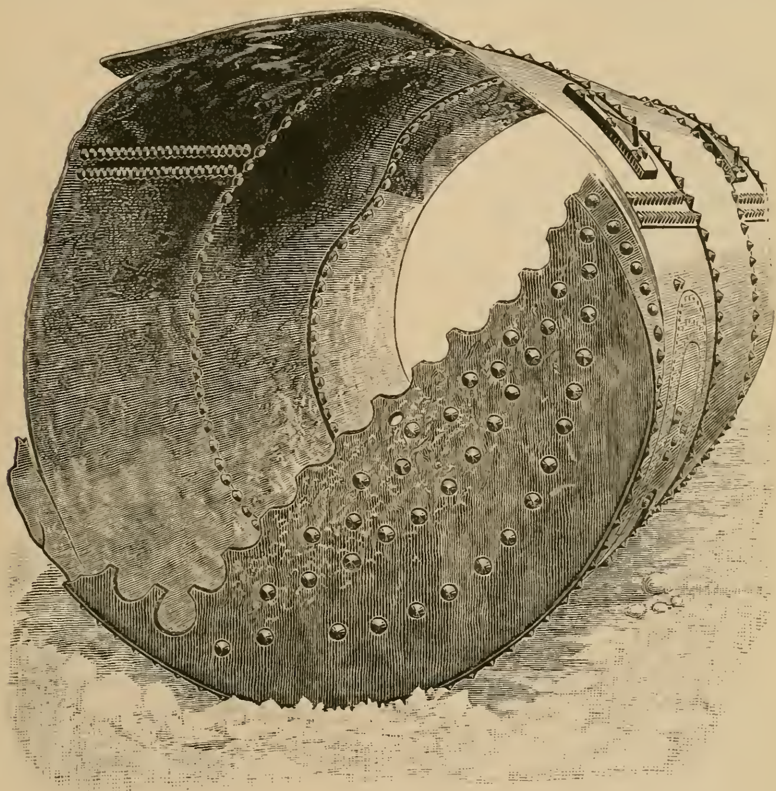

Fig. 3.

red in the night. Had it happened during working hours, the loss of life would have been very great. The only comment necessary is: Be sure your safety-valves are in perfect working order.

Inspector's Reports.

February, 1887.

During the month of February our inspectors made a total of 3,433 inspection trips, examined 6,406 boilers, 2,241 both externally and internally, and tested 381 by hydrostatic pressure; 6,555 defects were reported, of which number 699 were considered dangerous, and led to the condemnation of 40 boilers. Our usual summary of defects is given below.

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	326	33
Cases of incrustation and scale,	528	32
Cases of internal grooving,	24	9

Nature of Defects.	Whole Number.	Dangerous.
Cases of internal corrosion,	120	21
Cases of external corrosion,	298	35
Broken and loose and defective braces and stays,	241	33
Settings defective,	114	16
Furnaces out of shape,	178	6
Fractured plates,	131	67
Burned plates,	83	17
Blistered plates,	165	14
Cases of Defective riveting,	2,269	70
Defective heads,	45	22
Serious leakage around tube ends,	1,026	229
Serious leakage at seams,	683	21
Defective water-gauges,	102	20
Defective blow-offs,	43	5
Cases of deficiency of water,	10	3
Safety-valves overloaded,	27	11
Safety-valves defective in construction,	27	8
Pressure-gauges defective,	176	17
Boilers without pressure-gauges,	12	2
Defective man-hole rings,	4	3
Defective man-hole plates,	1	1
Defective hand-hole plates,	1	1
Defective hangers,	14	0
Defective fusible plugs,	6	2
Defective tubes,	1	1
Total,	6,555	669

Low water, while probably not responsible for one-half of the explosions that are attributed to it, is still of very frequent occurrence, and when it does occur generally results in more or less injury to boilers.

The more common effects of shortness of water in the ordinary tubular boilers are: Leakage at seams and tube ends, melted fusible plugs, and, when the water is very low, burned and blistered plates, and if the boiler is old, made of poor material, or corroded badly, great danger of explosion. It is the fashion to charge the majority of explosions to low water, and while it undoubtedly is the indirect cause of many, and should always be carefully guarded against, still it is a matter of record that the tubular boiler, if made of good material, and if it is in good condition, will bear quite a scorching and sustain no great harm.

Boilers having large flues, on the contrary, are very apt to be destroyed by explosion if the water gets low enough to uncover the tops of the flues. When this happens they get hot on top, and in this condition are very much weakened, and being in unstable equilibrium invariably collapse, and the shock produced by the sudden collapse is generally sufficient to cause rupture of the shell and explosion. A three or four inch tube, on the contrary, owing to its small size and more perfect form, has sufficient strength to withstand ordinary pressures, even when quite highly heated, and the danger of collapse and explosion is very much reduced.

A multitude of devices have been invented and applied for the prevention and detection of low water, and many of them are very useful safeguards, if they are not relied upon too implicitly. When they are so relied upon they generally are the direct cause of the catastrophe they are designed to prevent. For if they are not watched, and kept clean and in good order, they become inoperative if any but the very purest waters are used, and the attendant is deceived by them and disaster results.

There is no royal road to security against the occurrence of low water; the best safeguards are a set of good gauge cocks on the boiler, and a competent man in charge.

An amusing incident which occurred not long since may be related here. A battery of boilers were fitted with a very good kind of a low water detector, one of the kind which sets off a ten-horse power whistle when the water approaches the lower limit. The fireman was instructed that "the whistle would blow when the water got too low in the boilers." All went well for some time, and the fireman had nearly forgotten about the alarm, when one day he let the water get a trifle too far down in the boilers. Off went the whistle, and so did the fireman. Thinking the alarm meant that the boilers were on the point of explosion, he took to his heels and made good time until he was at least half a mile from the boiler-house. Had not some one who understood the operation of the alarm, and heard its continuous whistling, made an investigation and started the feed pump, serious damage to the boilers would surely have resulted.

Boiler Explosions.

FEBRUARY, 1887.

COAL MINE (27). — The boiler at No. 5 coal mine, Corning, Ohio, exploded February 7th, tearing the boiler-house all to flinders and throwing the roof several feet in the air. The stone partition between the engine and boiler-house was blown to atoms. Fortunately no one was hurt.

COAL MINE (28). — The boiler at Jones's coal works, half a mile above the mouth of Pigeon Creek, Monongahela City, Pa., exploded February 11th, scattering everything in the vicinity, and throwing some of the boards on the side of the building and large portions of the boiler across Warne's meadow. Daniel Roush, the engineer, was very severely burned about the face. Samuel Ivil and James Smith, who were in the boiler-room at the time the explosion occurred, received slight injuries.

PAPER MILL (29). — A rotary rag boiler in Hubbard's paper mill at Norwich, Conn., exploded, February 11th, demolishing a small brick building adjacent to the mill, but doing no personal injury.

SAW-MILL (30). — A destructive explosion occurred February 14th at a shingle mill nine miles south of Cabool, Mo. The boiler exploded with terrific force, and pieces of it were hurled a distance of 100 yards. Thomas Smallwood, aged 70 years, was killed outright. His son George and two men named Crane were fatally injured.

SAW-MILL (31). — The boiler in Britt's saw-mill, eight miles from Okolona, Clark county, Ark., exploded, February 14th, killing J. Hendrix, the engineer. A light pressure of steam was kept up all night for the purpose of running the pumps in case of fire, and the engineer made up too much fire and then went to sleep. He was blown fifty feet and horribly mangled.

SAW-MILL (32). — A fatal and destructive boiler explosion occurred near Corydon, Ind., February 17th. The boiler in a saw-mill let go with fearful violence, instantly killing one man, wounding three others, and wrecking the machinery. The name of the unfortunate who was killed is John Schwartz. He leaves a wife and six children. His side was mangled and his head cut open by the flying mass of iron.

CAR HEATER (33). — The heater in a car on the Wabash road exploded, at Danville, Ill., February 22d. The windows were blown out, both ends of the car shattered, and the entire structure was injured. The next car received some of the shock, several windows being broken. At the time the car was filled with sleeping passengers, who were thrown in confusion about the floor. Some were seriously injured by the broken glass and pieces of iron and wood. Almost before the train could be stopped and the passengers rescued from their predicament, the car caught fire from the lamps which had been shattered, and from the fire under the heater, and was almost entirely destroyed. Enough time was afforded, however, for the passengers to secure a safer place.

COAL MINE (34). — A new steel boiler at the shaft of the Coal Bluff Mining Company, at Carbon, twelve miles northeast of Terre Haute, Ind., exploded, February 26th. A boy named Phillips was killed, and William B. Alton, the engineer, seriously injured; also his helper. The boiler, 30 feet by 40 inches, was thrown 800 feet over tree tops, and when it struck the ground bounded a hundred feet further. The mine buildings were demolished. Fortunately the mine had shut down for the day, and no outside employees were about except those injured.

LOCOMOTIVE (35). — As the large new passenger engine William H. Sayre, on the Lehigh Valley road, was backing down from Black Ridge Station, Hazleton, Pa., February 26th, it jumped the track and was overturned, and immediately afterward the boiler exploded, completely demolishing the engine. William and John Pickering, brothers, the engineer and fireman of the locomotive, were badly injured, and the life of the latter is despaired of. The engine was completed at the shops only three days before.

BOILER SHOP (36). — A steam boiler exploded with tremendous force at Andrew J. Sheppard's machine shops on lower Court street, Buffalo, N. Y., February 22d. Mr. Sheppard had arranged to sell the boiler, and was making a test. The boiler had been supplied with water, and the gauge registered 105 pounds. Mr. Sheppard stepped away for the moment, intending to get the steam five pounds higher. He was not over thirty feet away, and was standing with his back turned, when the explosion occurred. The boiler shot up like a rocket. It went upward nearly one hundred feet and then came down and crashed into Valter & Feltenhousen's factory, across the street, 300 feet away. The boiler broke a hole in the building forty feet long by ten feet wide. Some seventy workmen are employed by Valker & Feltenhousen, but most of them were at dinner. Those who were inside were terribly frightened. At Sheppard's shops there was a scene of demolition. The private office was knocked into kindling wood. Large holes were knocked through the walls of the shops and those of Hodge, Howell & Co. adjoining. The roofs of both buildings were lifted off, but fell back in nearly the same tracks. The yard where the boiler stood was filled with flying bricks and scraps from the boiler. The men were nearly all of them in the yard, and all heard the whizzing close to their ears. Huge pieces of iron cut through the walls as if they had been paper. No one received so much as a scratch, which is regarded as simply a miracle. The damage amounts to several thousand dollars. The boiler cleared the clouds of telegraph wires on both sides of the street, and a passenger train which was at the moment running through it.

LOCOMOTIVE (37). — The boiler of the locomotive of an accommodation train on the Chicago & Eastern Illinois Railroad exploded at Chicago, Saturday afternoon, February 26th, killing Engineer Meinzer and Fireman Law, and seriously injuring Conductor Woodward. Several people on the street were badly injured.

SAW-MILL (38). — The boiler in McConaughrey & Miller's saw-mill, near Winchester, Ohio, exploded, February 28th. Joseph Emery, a workman, was fatally injured by a large piece of iron. Two other men received serious injuries. The loss to the mill will exceed $1,000.

A boiler on the estate "Toledo," near Havana, Cuba, exploded, February 14th, killing two persons and wounding ten others.

By the explosion of a boiler on the Mosquera estate, at Matanzas, Cuba, five persons were killed and several others were injured.

The Locomotive.

HARTFORD, APRIL, 1887.

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

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

WE would specially caution our inspectors, and urge upon them the necessity of impressing upon the minds of all the employers about a boiler-room, when they are inspecting boilers in a battery some of which are under steam, that on no account shall they meddle with steam or blow-off valves, while the inspector is in a boiler. It is very easy for a man only occasionally employed about a battery of boilers, and not familiar with the arrangement of the piping, to make a mistake under such circumstances, which may cause the death of the inspector, by inadvertently turning steam into the boiler when he may be at work. The writer himself had a very narrow escape from death a few weeks since through a mistake of this sort, and he would again urge the necessity for the greatest care in this respect.

AT last the manufacturers of non-conducting coverings for pipes and boilers have become sensible of the fact that a really good and efficient covering which is light and may be easily applied and removed repeatedly without injury, "fills a long-felt want," and such are beginning to appear in the market.

THIS from *Engineering* is very good. It refers to bids on the Hawkesbury River Bridge, which were "tendered on a plan almost universal in the United States, but of rare occurrence" in England, viz.: provided the material, loads to be supported, depth of foundations, and general conditions, stipulated by the engineer-in-chief of the railway were complied with, all other matters were left to the discretion of the firm tendering. *Engineering* says: "This freedom of action, bringing into play previous constructive experience, with its accompanying advantage of practical details of construction at known cost, permits a firm to make a reasonable tender, with confidence of a successful pecuniary result, and if more frequently adopted in this country, we should not so often see in our bridge-yards, iron and steel undergoing unnecessary, expensive, and difficult manipulation, resulting in complicated forms destructive to the material itself."

Evidently *Engineering* has not a high opinion of the abilities of the average British bridge engineer.

THE following communication from Professor R. C. Carpenter of Michigan Agricultural College is interesting as bearing upon the construction of long lines of steam-pipe, but it does not affect our statement in the article referred to, that it *pays* to carry steam long distances if you have enough to carry, otherwise not. Expansion joints are a good thing, when they cannot be avoided, but in manufacturing establishments, where high pressures are carried, they are best avoided if they possibly can be. We have yet to find a case of this sort where the man in charge did not wish "there was some way to get rid of that expansion joint." We have also to hear of any large steam-heating company, who do not have a great amount of trouble with their pipes. We must repeat here what we have previously said, that we cannot recommend burying long lines of pipes in the earth.

Michigan Agricultural College,
Lansing, Mich.

Editor of The Locomotive:

Dear Sir,— In the issue of The Locomotive for February, 1887, there was an editorial regarding expansion joints used in conveying steam a long distance for power or heating that is not in accord with my experience. In 1881 I put in for this Institution, about 1,500 feet of underground piping to carry heat to various buildings for steam-heating. This piping was all in double line, one line for steam and the other to return the water of condensation from the buildings. Altogether we put in twenty-four expansion joints; these joints were securely braced, and were put in, at an average distance of 125 feet. We, however, put two together and left a man-hole at each set of expansion joints. These have now been used six winters, and there has been no trouble of any kind with any single one of these joints. They have simply worked perfect. The only attention they receive is inspection and careful oiling once each year. I think if an expansion joint is properly put in and packed, that it will cause no trouble whatever. I believe the prejudice against them to be due to imperfect setting in some cases, but in most cases I think the objections are merely imaginary ones.

Respectfully yours,

R. C. Carpenter, *Prof. Engineering.*

To the Editor of The Locomotive:

Sir,— I saw in The Locomotive recently a communication regarding chimneys, and chimney draft. The boiler under my charge is three feet in diameter and seventeen feet long, with forty-eight three-inch tubes. The chimney is not over forty-five feet high. it is fourteen inches by thirty inches inside. I have hard work sometimes to make sufficient steam to run with, and I think it costs more to run than it would if I had a higher chimney. Please give me the height and size of chimney for a boiler of the given dimensions. and oblige, Yours respectfully, Stephen Snow.

Brockton, Mass., April 21, 1887.

A boiler chimney to give sufficient intensity of draught to burn coal as it should be burned should have a sectional area at least equal to the collective area of all the tubes, and it should not be much less than eighty feet high. For such a boiler as our correspondent describes we would recommend a chimney not less than twenty inches square, by from seventy-five to eighty feet in height, with straight and easy flue connections of full area between boiler and chimney.— (Ed. Locomotive.)

In the last volume of "Proceedings of the Engineers' Club of Philadelphia," Mr. J. E. Codman gives an interesting account of a case of low water in a steel boiler, which affords us another illustration of the peculiar fitness of this material, when it is properly made, for steam boiler construction.

The boiler in question was of the internally fired type, eleven feet six inches diameter, ten feet ten inches long, had two furnaces each three feet six inches diameter and eight feet long. Back of the furnace was a combustion chamber, twenty-six inches deep. the gases returning through one hundred and eighty-eight tubes, three inches diameter and seven feet long.

The bottom, sides, and crown-sheet of the combustion chamber were corrugated, the depth of the corrugations being five inches, no braces or stays were used, it being considered that the corrugations gave sufficient strength to enable this portion of the boiler to withstand the pressure to which it was subjected. The crown of the combustion chamber was arched, its highest part being about three and one-half inches above the top of the upper row of tubes. The water was usually carried at the middle gauge cock, the center of which was six inches above the top of the crown sheet, and nine and one-half inches above the top of upper row of tubes.

The boiler had been in use about two and one-half years, and for some time before the accident had been worked to its full capacity. Through carelessness the water was allowed to fall below the bottom of the second row of tubes from the top, leaving the entire crown-sheet bare, and exposing it to the full effect of the fire, with no protection whatever, and a pressure of sixty pounds per square inch steam pressure. The effect of this was to heat the crown to a high temperature, greatly weakening it, when the pressure forced it down, taking with it the upper side of the back tube-sheet to which the crown-sheet was riveted. The highest portion of the crown-sheet was depressed several inches, and the upper side of tube-sheet was doubled down over the upper row of tubes, causing leakage. Those in charge of the boiler, not being aware how low the water was, put on the feed pump and filled the boiler up, but the leakage was so great that it was thought best to shut down the boiler and draw the fires, when an inspection showed the above-described condition of the boiler. No signs of cracks were discovered in tube or crown-sheet, notwithstanding the fact that water had been pumped in while they must have been red hot. The tube and crown-sheets were taken out, bent back into their original positions, replaced, and the boiler is now running at its usual pressure, apparently as good as it was when new.

Statistics of the Iron Trade for 1886.

THE following statistics of the Iron Trade for the past year and the first three months of the present year are extracted from the Annual Statistical Report of the American Iron and Steel Association. They will be found very interesting:

"The aggregate production of iron and steel in the United States in 1886 is given in the following table in comparison with that of 1885, the percentage of increase in 1886 being also given.

PRODUCTS. Net tons. (Except nails.)	1885.	1886.	Increase per cent.
Pig iron,	4,529,869	6,365,328	40
Bessemer steel ingots,	1,701,762	2,541,493	49
Bessemer steel rails,	1,074,607	1,763,667	64
Open-hearth steel ingots,	149,381	245,250	64
Open-hearth steel rails,	4,793	5,255	9
Crucible steel ingots,	64,511	80,609	25
All kinds of rolled iron, except rails,	1,789,711	2,259,943	26
Iron rails,	14,815	23,679	60
Kegs of iron and steel cut nails,	6,696,815	8,160,973	22
Blooms from ore, pig iron, and scrap,	41,700	41,909	..

"In the following table we give the number of furnaces in blast at the close of each of the last three years, classified according to the fuel used.

Kind of Fuel.	Dec. 31, 1884.	Dec. 31, 1885.	Dec. 31, 1886.
Bituminous,	86	111	143
Anthracite and mixed anthracite and coke,	84	105	125
Charcoal,	66	60	63
Total,	236	276	331

"At the close of 1886 the total number of furnaces in the United States which were active or likely to be some day active was 577.

SUMMARY OF STATISTICS FOR 1886.

Production of pig iron in 1886, net tons, ...	6,365,328
Production of spiegeleisen in 1886, included in pig iron, net tons, . .	47,982
Production of bar, rod, bolt, hoop, skelp, and shaped iron in 1886, net tons, ...	1,580,337
Production of plate and sheet iron except nail plate in 1886, net tons, .	420,007
Production of iron and steel and combined iron and steel cut nails and spikes in 1886, kegs of 100 pounds, ...	8,160,973
Production of steel nails only in 1886, kegs of 100 pounds, . . .	2,968,989
Production of all rolled iron, including iron nails and excluding rails, in 1886, net tons, ...	2,259,943
Production of Bessemer steel rails in 1886, net tons, ...	1,763,667
Production of open-hearth steel rails in 1886, net tons, ...	5,255
Production of iron rails in 1886, net tons, ...	23,679
Total production of rails in 1886, net tons, ...	1,792,601
Production of iron and steel street rails in 1886, included above, net tons,	48,009
Production of Bessemer steel ingots in 1886, net tons, ...	2,541,493
Production of open-hearth steel ingots in 1886, net tons, ...	245,250
Production of crucible steel ingots in 1886, net tons, ...	80,609
Production of blister and patented steel in 1886, net tons, ...	2,651
Production of all kinds of steel in 1886, net tons, ...	2,870,003
Production of iron blooms in 1886, net tons, ...	41,909
Value of imports of iron and steel in 1886, ...	$41,630,779
Value of exports of iron and steel in 1886, ...	$14,865,087
Imports of iron ore in 1886, gross tons, ...	1,039,433
Domestic production of iron ore in 1886, gross tons, ...	10,000,000
Production of anthracite coal in 1886, gross tons, ...	32,136,362
Total domestic production of coal in 1886, gross tons, ...	106,780,033
Miles of railroad completed in 1886, ...	8,648
Total number of miles of railroad December 31, 1886, ...	137,158
Iron and steel ships built in the fiscal year 1886, ...	26
Immigrants in the calendar year 1886, ...	492,887

FOREIGN COMMERCE OF THE UNITED STATES SINCE 1861 — THE BALANCE OF TRADE FOR TWENTY-SIX YEARS.

Official Figures from the Bureau of Statistics of the Treasury Department.

The following table, compiled from the reports of the Bureau of Statistics, shows the imports and exports of the United States in each fiscal year, ending June 30th, from 1861 to 1886, and during seven months of the fiscal year ending Jan. 31, 1887. The phrases "net imports" and "domestic exports" indicate that all merchandise and specie imported and re-exported are excluded from the table. The column headed "Balance of Trade" shows the difference between the net imports and domestic exports of merchandise without reference to the movement of specie. A + mark before the amount indicates that the balance of trade was in favor of the United States; when no mark occurs the balance of trade is against this country.

Fiscal Years.	Merchandise. *Gold Value.*		Balance of Trade.	Specie.		Specie Balance.
	Net Imports.	Domestic Exports.		Net Imports.	Domestic Exports.	
1861,..	$274,656,325	$204,899,616	$69,756,709	$40,348,401	$23,799,870	+$16,548,531
1862,..	178,330,200	179,644,024	+ 1,313,824	10,572,063	31,044,651	20,472,588
1863,..	225,375,280	186,003,912	39,371,368	1,421,056	55,993,562	54,572,506
1864,..	301,113,322	143,504,027	157,609,295	8,192,633	100,473,562	92,280,929
1865,..	209.656,525	136,940,248	72,716,277	6,784,970	64,618,124	57,833,154
1866,..	423,470,646	337,518,102	85,952,544	7,299,395	82,643,374	75,343,979
1867,..	381.041,764	279,786,809	101,254,955	16,178,299	54,976,196	38,797,897
1868,..	344,873,441	269,389,900	75,483,541	4,150,241	83,745,975	79,595,734
1869,..	406,555,379	275,166,697	131,388,682	5,585,462	42,915,966	37,330,504
1870,..	419,803,113	376,616,473	43,186,640	12,147,315	43,883,802	31,736,487
1871,..	505.802,414	428,398,908	77.403,506	7,231,395	84,403,359	77,171,964
1872,..	610,904,622	428,487,131	182,417,491	6,664,395	72,798,240	66,133,845
1873,..	624,689,727	505,033,439	119,656,288	10,777,909	73,905,546	63,127,637
1874,..	550,556,723	569,433,421	+ 18,876,698	21,524,187	59,699,686	38,175,499
1875,..	518,846,825	499,284,100	19,562,725	12,625,704	83,857,129	71,231,425
1876,..	445,938,766	525,582,247	+ 79,643,481	4,469,070	50,038,691	40,569,621
1877,..	438,518,130	589,670,224	+151,152,094	27,746,915	43,134,738	15,387,823
1878,..	422,895,034	680,709,268	+257,814,234	23,143,074	27,061,885	3,918,811
1879,.	433,679,124	698,340,790	+264,661,666	12,853,594	17,555,035	4,701.441
1880,..	656,262,441	823,946,353	+167,683 912	85,239,284	9,347,893	+75,891,391
1881,..	624,213,229	883,925,947	+259,712,718	105,395,594	14,226,944	+91,168,650
1882,.	707,337,049	733,239,732	+ 25,902.683	36,535,182	43,480,271	6,945,089
1883,..	703.565,144	804,223,632	+100,658,488	18,292,239	21,623,181	3,330,942
1884,..	652,148,936	724,964,852	+ 72,815,916	20,518,514	50,225,635	29,707,121
1885..	562,020,520	726,682,946	+164,662,426	25,386,908	24,376,110	+ 1,010,798
1886..	621,875,835	665,964,529	+ 44,088,694	18,054,363	51,924,117	33,869,754
1887*,.	379,213,477	449,744,917	+ 70,531,440	43,994,133	11,759,283	+32,234,850

* Seven months ending January 31, 1887.

Note.— The Canadian reports of imports into the Dominion of Canada from the United States, indicate that in addition to the above "Domestic Exports" there was exported in the fiscal year 1886 merchandise of the value of $17,027,875.

On the Remarkable Effects of Adding Saccharine Matter to Mortars.

A letter from Mr. Thomson Hankey "On a New Use of Sugar,"— *Times*, October 15th,— has given rise to wide discussion and inquiry. At a time when the price of sugar is so low, and, as I shall show, when the use of a very small quantity of it, or of treacle, adds largely to the strength of mortar, and makes Portland cement itself set with great rapidity, it seems to me that I may do a service to the engineers by laying before them the scientific grounds on which I was led to experiment on the subject, and the remarkable results which have been obtained.

The practical importance of this addition of saccharine matter to mortar I will state briefly, to begin with, and will give a few illustrations:

I mixed in a small jar some Portland cement and brown sugar, adding water and stirring. I took out a little of the cement for an experiment, and when I tried an hour after to take out more, I found that the remainder had already set.

My neighbor, Mr. Rowland, weighed carefully Portland cement and sand into four small jars. To two he added different sugars, to the third treacle, but to the fourth no saccharine matter. On the following day the cement had set — we do not know how much earlier, for it was not examined — in all the jars with saccharine matter. Mr. Holden, Jr., the foreman of a builder, examined all of them on the Monday following the Friday on which they had been mixed. On pressing the cement to which the treacle had been added, he said: "I might press the bottom of the jar out before I can make an impression on this." He then put his finger into the jar in which there was no saccharine matter, and stirred up the cement which had not set at all, and which did not set till a day or two after. It may be objected that it might not be an advantage that it should set so quickly. This objection will be answered by-and-by as I proceed, by showing that it is highly probable that the strength of Portland cement will be greatly increased by this addition of saccharine matter.

Mr. Thomson Hankey had experiments made, first by his own brickmaker, and secondly by a housebuilder. Both reported that the addition of sugar made a common lime equal to Portland cement.

The bearing of these facts will be plain to every engineer, but I cannot forbear mentioning here a startling incident. The Ecclesiastical Commissioners built for the late Bishop Fraser of Manchester, on his coming into the diocese, a lodge like that at Lambeth, with a lofty archway set in Portland cement. A clerk of the works appointed by the architect of the commissioners superintended it. After a due time the scaffolding was removed. One day — perhaps that day — the bishop walked through and had just got beyond danger, when the whole of the archway fell. If he had been under it he would have been killed, and his grand career as a bishop would have been cut short at the outset. Your readers, as I proceed with my statement, will judge for themselves whether the addition of a few shillings'-worth of treacle would not have made all secure, and would have saved the expense of doing this work over again.

I have to explain how it is that sugar, or rather that saccharine matter of any kind, produces this remarkable effect on lime. Here I ought to mention that I am a retired physician, and that the idea of putting the matter to the proof arose in the following manner: In medicine we have two kinds of lime water, one the common lime water that can be got by mixing lime and water. It is to be particularly noted that, add as much lime as you like, it is impossible to get water to dissolve more than half a grain of lime in one ounce, or about two small tablespoonfuls of water. But by adding two parts of white sugar to one part of lime, we obtain a solution containing about 14½ times more lime in the same quantity of water. Here it is to be observed — and it is a most important point — that there are hot limes, such as Buxton lime, which, if the sugar be incautiously mixed with them, will *burn* the sugar, make it a deep brown color, and convert it into other chemical forms, and possibly, and I think probably, will destroy its value in mortar. The way to use sugar with such limes is to dissolve it first in the water. I dwell particularly upon this because a gentleman referred to me by Mr. Thomson Hankey, in writing to thank me for the information I had given him, casually observed that his cement had turned nearly black by the addition of the sugar. Probably many other experimenters with sugar and hot limes have had the same result, and are in the belief that all is right. Our strong medical saccharated lime water looks like water.

Ten or fifteen years ago I had been experimenting with lime and sugar, but not in reference to mortar, and I spoke about that time to my friend, the late E. W. Binney, F. R. S., about this property of sugar. He said it was very curious, and that it was new to him; and he told me this anecdote, that in his grandfather's time an Italian architect came down to Worksop to erect a building for a nobleman, and insisted on being supplied with malt to make his mortar with. The malt was supplied and used. Many years afterwards this building had to be taken down; but, said Binney, "they could not pull it down, do what they would, and they had to use gunpowder." I said it would be the saccharine matter in the malt that produced this result. He agreed with me.

A few months ago I was at Peterborough, and went to see the progress of the restoration of the cathedral, where I made the acquaintance of Mr. Irvine, Mr. Pearson's clerk of the works. Mr. Irvine was for more than a quarter of a century with Sir Gilbert Scott, and possesses a greater knowledge of architecture, and antiquity bearing on

English architecture, than any one I ever met with. One day I said to him that I had been to Fotheringay. He replied that he had seen every other church than that in the neighborhood of Peterborough. I asked him to go with me on his Saturday's half-holiday, as my visit to the church had been a hurried one, and I wished to make some further inquiries. Besides I was glad to have the companionship of one who was so thorough a master of the subject. The chancel of this fine church, built before the nave, and so late as 1410, has entirely perished; and it had been so badly built that even in the time of Queen Elizabeth it had fallen in and was then in ruins. The chancel and tower exist, but the tower is unsafe, and if the church be not soon restored this grand historical monument may suffer or be destroyed. As Mr. Irvine and I walked to the railway station, I asked him whether he was aware of the chemical fact that the addition of sugar to water makes it take up about sixteen times more lime than water by itself does— I might have said a little more than fourteen times. He replied that he did not know this fact, and that he had never heard of it, and that he did not believe that it had been so used in mortars. I then told him what Mr. Binney had told me regarding the building erected by the Italian architect near Worksop. He said that he had been clerk of the works in the restoration of several cathedrals, in the books of which he had met with old entries of payments "For beer for the masons," and that he had found one entry where it was written, "For beer to mix with the mortar." I said that that would be for the saccharine matter in it; and I added that a few years ago I had seen in a newspaper that the vintage in Spain had been so abundant that the people had not casks enough, and were using the wine to mix with their mortar. It flashed across my mind that this traditional use of saccharine matter was probably the explanation of the exceptional hardness of the old Roman mortar, and had been handed down from generation to generation, and had at length been forgotten, in England at any rate. A few days afterwards I was pondering as I walked along the streets of Peterborough on this matter, when suddenly I said to myself, "Why not try the experiment?" I went into a grocer's shop and bought a pound of exceedingly finely powdered loaf sugar and some beeswax —of the wax I will speak some other time. I took the sugar to the hut in the cathedral yard, where I found the foreman of the contractor and Mr. Irvine. Laughing, I said, "I have come to teach you to suck eggs." After explaining to the intelligent foreman my views, he and Mr. Irvine kindly agreed to try the experiment. Some powdered lias lime and some of the sugar were being mixed together in an iron basin. Water was added, and Mr. Irvine began to stir them with a trowel. No sooner had he done so than he exclaimed, "Look, look! It is beginning to set already." I said, "is not that usual?" He replied, "No; something very uncommon." The mortar was poured out on the end of a beam, where it set. Some more was then made, much thinner, and a little sand added to it. With this, which was about the consistency of cream, two large fragments of the broken stone tracery of an old window was joined, and so were two bricks, two pieces of glass, and two slates. It would be about five o'clock in the evening. As I was going to leave Peterborough about noon on the following day, I called at the cathedral about ten in the morning to see the results. Mr. Irvine said it was too early to judge. He felt at the stone tracery very tenderly. Holding the upper fragment, he then tilted the tracery sideways, and as the stones held together, he then took hold of the upper fragment with both hands and lifted the whole stone without the lower fragment falling off. In like manner, in lifting both bricks the lower brick did not fall off. The slate and the glass seemed also set. So that the experiments seemed to confirm remarkably the view I had formed, on theoretical and chemical grounds chiefly, that saccharine matter added to mortar would be of great value, and that an important discovery had been made. I wrote to my brother-in-law, Mr. Guilford Molesworth, engineer-in-chief to the state railways in India, and author of "The Engineer's

Pocket Book," telling him what we had done. From him I received a letter dated Simla, August 28th, 1886, giving me the following interesting particulars: "With regard to your addition of sugar to mortar, it is a practice that has been in use in the Madras presidency from time immemorial." The following is an extract from the Roorha (?) "Treatise on Civil Engineering," Vol. I., page 150, third edition: "It is common in this country to mix a small quantity of the coarsest sugar — 'goor,' or 'jaghery,' as it is termed in India — with the water used for working up mortar. Where fat limes alone can be procured their bad qualities may in some degree be corrected by it, as its influence is very great in the first solidification of mortar. Captain Smith attributes the fact that mortars made of shell-lime have stood the action of the weather for centuries, to this mixture of jaghery in their composition. He made experiments on bricks joined together by mortar consisting of one part of common shell lime to 1½ of sand. One pound of jaghery was mixed with each gallon of water with which the mortar was mixed. The bricks were left for thirteen hours, and after that time the average breaking weight of the joints in twenty trials was 6½ lbs. per square inch. In twenty-one specimens joined with the same mortar, but without jaghery, the breaking weight was 4½ lbs. per square inch."

Mr. Molesworth then adds: "The use of sugar or jaghery was known to me when I was in Ceylon, twenty years ago. The masons who came over from Madras used to make most beautiful plaster work, almost like enameled tiles, of shell-lime mixed with jaghery. The surface took a fine polish, and was as hard as marble; but it required a good deal of patient manipulation, well suited to the national character."

This intelligence from India supplies proof of the most positive kind of the enormous strengthening power of sugar when mixed with mortar. It may be argued that some of our limes and cements are of themselves good enough without it. It is for engineers to judge whether they might not be made much better by it, or whether the facts I have brought forward do not show plainly that there should be an inquiry instituted by scientific men to investigate the actual *numerical* value of sugar, and the various conditions under which it acts, whether for better or worse. For the worse it cannot act, except such an insane use of it be made by adding too much, as to expect sugar to be itself mortar. The jaghery sugar used in India is sold in the London market at, I think, less than a penny a pound, and is used for feeding cattle. Treacle seems to me to be a most promising form of saccharine matter. I would shirk beet-root sugar. There is a rough unrefined treacle which is very cheap, and I should suppose would be excellent. A half-penny-worth of treacle and water added to a hod of mortar would, I conjecture, increase its strength by one-third, if not by one-half. But I must leave the matter in the hands of scientific engineers. I think it is very probable that this use of sugar with lime is of extreme antiquity, and that a knowledge of it passed from India to Egypt, and Rome; and that these nations used malt for its saccharine matter as a substitute for sugar. I have shown that the mediæval builders used beer in building our cathedrals, and beer is still used with plaster-of-paris. These I take to be the remnants of ancient tradition. It is said that in the cold winter when Bess of Hardwicke died, her masons had to "melt the beer which they mixed with their mortar." They would have acted more wisely if they had used infusion of malt only, for most of the sugar must have been converted into alcohol, and lost for the purposes of mortar making. Antiquarians may be able, from old documents, to throw light upon this subject; but I strongly suspect that the old Roman mortar had saccharine matter added to it; and I am of opinion that in all engineering works requiring great strength, it would be wrong not to take advantage of facts confirmed by the experience of ages. — Samuel Crompton *in The Engineer.*

The Best Stationery.

The most transparent kind of an "interview" is published by the erratic editor of one of our London exchanges. Whether the interview is a humorous article emanating solely from the brain of the writer, or whether he was imposed upon by the interviewed, is uncertain. The head of the London house of Aberdeen fine paper mills is made to say that they have a large trade in the United States and their trade is largely and steadily increasing. Every stationer and fine paper manufacturer in this country knows the absurdity of this statement.

The intelligent London *Paper Makers' Monthly Journal*, for February 15th, in mentioning the paper exports of all sorts from Great Britain to the United States for 12 years ending with 1886, says that the largest export for one year was in 1882, which was immediately after the reduction of the tariff, and then the amount was 1,316¾ tons. If this was all fine writing paper, two machines could produce it in the same time, and then one of them might be idle for a third of a year. In 1886 the export of all kinds of paper was 493.4 tons, which one machine would have no trouble at all in producing in 240 days. When the Aberdeen mills make allowances for the paper that Marcus Ward sends to this country, and the numerous choice specialties that constitute a large portion of the export, they will find but a very small quantity left for themselves, if indeed, there is anything left.

The price of the exported paper, too, indicates that it is in specialties. The average price for that exported to the United States in 1886, was a small fraction less than 25 cents a pound; add the duty of 25 per cent., and we have an average value almost as high as that of bank note paper. A large part of the paper that is brought to the United States from all countries is in specialties — paper that is not made here much or at all. There is still a prejudice here among the ignorant and shoddy that foreign stationery is the best. Marcus Ward's paper is the only foreign paper that the public in this country knows anything about — good paper, of course, but no better than the common linen paper made in a score of mills in New England, and it hardly requires a connoisseur to prefer the paper of Dalton, South Lee, Holyoke, Westfield, Unionville, and other places. Most of the other foreign stationery is of the very cheapest character and is palmed off on people who think they are "fashionable," and who would reject "Distaff," or "French" linen, or "Clover Leaf" linen as impositions. It is no brag at all to claim that the most elegant stationery in the world is make in New England, but it may not be made at a price that can compete with that of foreign goods.

The claim of the "interview," that provokes these words, is branded as bogus by the reference to the tariff of the United States. Of course an importer of fine writing paper to this country would know the rate of duty, which is 25 per cent., a reduction from 35 per cent., early in 1882; but the "head of the London house," who stuffed our credulous contemporary, said that it is 15 per cent., a reduction from 25. The American people who know what good paper is, got through buying British paper years ago, when Holyoke and Dalton crowded Aberdeen out of the country.— *The Paper World.*

Locomotive Coupling-Rods.— There have been several letters published in English engineering papers, recently, containing testimony with reference to the first use of solid eyes and bushes on locomotive coupling-rods. The latest writer says: "The first coupled locomotive with *solid eyes and bored and turned bushes* I had seen, was made by the firm of Slaughter, Grunning & Co. of Bristol, turned out early in 1861, to the order of the Waterford & Tramore Railway Company, and it was considered a new departure at the time. Can some of your other correspondents give an earlier date?"

It may interest some of these correspondents to know that solid eyes and bushes were used in this country on Winans' camel engines as early as 1852. They are also shown in an old lithograph of a "grasshopper" locomotive built by Gillingham & Winans in 1835. — *The Railroad and Engineering Journal.*

The Locomotive.

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NEW SERIES—VOL. VIII. HARTFORD, CONN., MAY, 1887. No. 5.

Boiler Setting.

It is a difficult matter even when the conditions are altogether favorable, to so construct a brick wall that it will not crack more or less when exposed to heat. This is especially so in the case of boiler settings, where the wall is of considerable height, has to sustain a heavy weight, and is subjected to intense heat at the furnace end and a (comparatively) much lower temperature at the other end. With boiler settings, more or less cracking when the settings are new is the rule, and large cracks allowing air to leak into the furnace, back connection, or flues, entail a great loss of efficiency, therefore it is always a matter of economy to construct the walls at the outset in the best possible

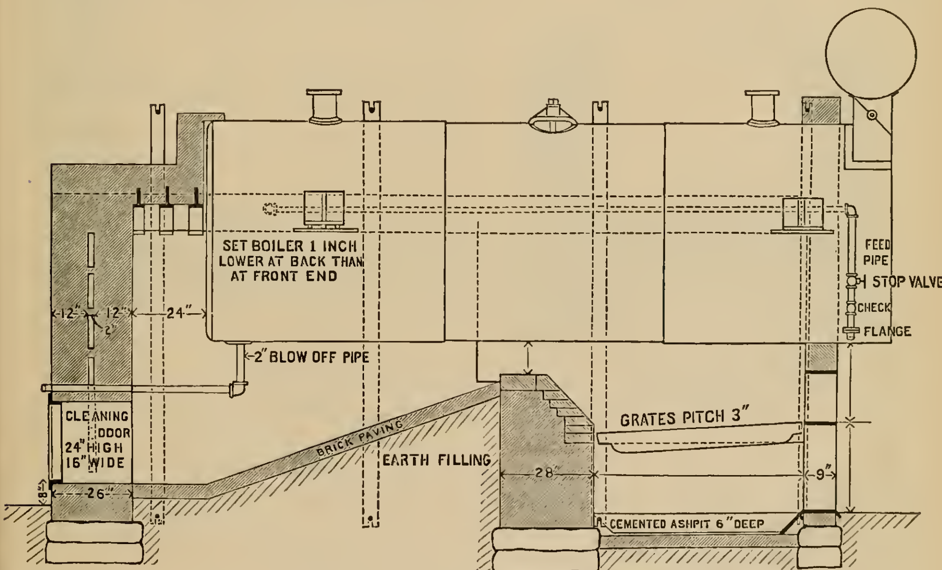

FIG. 1. LONGITUDINAL SECTION.

manner, so that the shaking from the effects of heat may be as little as possible. A prime requisite for a first-class job of this kind is a good foundation.

Boiler foundations are not, as a rule, exposed to the low temperature and freezing of the surrounding earth that building foundations are, still in favorable earth, that is, where it is not necessary to go to any great depth for a sufficiently firm foundation, the depth of the foundation should not be less than three feet, and four feet is better. In this case the footing courses of the foundation should be large flat stones, carefully bedded to prevent rocking, and laid in cement. The next course or two should also be of large stones, laid so as to break joints and distribute the weight as uniformly as possible. Above this brick may be used if they are enough cheaper than stone to make it an object to do so. Whichever is used, the trenches should be filled in as soon as practicable after the wall is laid, and the earth well rammed if the building is not roofed in, if it is, this latter operation may be done within any reasonable time.

From a distance of not less than four inches below the level of the boiler-room floor, or ashpit, as the case may be, the walls should be of good hard-burned brick, for above this they will be exposed to a greater or less degree of heat, and bricks will stand heat better than any other building material. (It would be quite unnecessary to make this statement, but we are led to do so by the fact that we have seen boiler furnaces *lined* with lime-stone! Perhaps the idea was to make mortar for the masonry *in situ.*)

If it is known that the ground is too soft to make a good foundation in the usual manner, it will be a good plan to make the excavation for the foundation over the entire area covered by the setting. This pit may then be filled with sand, gravel, or broken stone and concrete in which there is a good proportion of cement. The foundation may then be started upon this bed, and if good-sized stones are used for the first two or three courses, the chances are that no trouble will result. Where *quicksand* is encountered probably the best way to overcome the difficulty will be to put into the excavation a depth of not less than two feet of strong gravel well rammed in. Wooden platforms should never be used unless the location is so wet that they shall always be immersed in water, or they will soon decay.

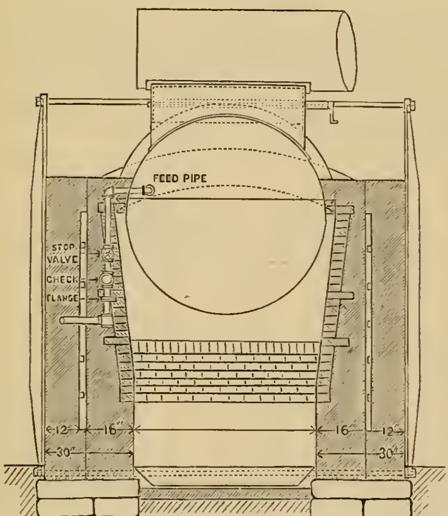

FIG. 2. TRANSVERSE SECTION THROUGH FURNACE.

The weight per square foot that may be put upon ordinary foundations, varies of course with the nature of the ground, two tons per square foot being about the greatest that is admissible when the soil is firm, if stability is required. In the case of boiler foundations it is somewhat different. The different portions of the wall are subjected to varying degrees of heat, which affects the setting walls proper so that varying degrees of strain are thrown upon the foundations, and the *least* settlement of the latter works mischief. The walls become cracked, the pipe connections are strained, causing leakage, all of which means, in the case of a large plant, great pecuniary loss. When an ordinary building settles slightly, the effect is not generally worse than a crack in the walls, which does not as a rule much affect the value of the building, and no continuous loss is entailed, but, as we have shown above, it is different with boilers, so that while the weight of boiler, settings, and attachments does not bring a heavy load per square foot upon the foundation, it will be found advisable to use a much heavier foundation, relatively to the weight borne, than is usually deemed necessary for a building, for by cracking of the setting walls, nearly the whole weight of the boiler might be concentrated upon a small portion of the foundation wall, which should be heavy enough to bear the weight without settling.

Our engravings this month show what we believe to be one of the best forms of setting for the ordinary boiler that can be adopted for general use where coal is used for fuel.

The setting is of the style known as the overhanging or projecting front. This has proved exceedingly popular wherever it has been tried, nearly all of the boiler-makers in this part of the country have adopted it as their standard, and the old style of flush front is rapidly becoming the exception where new boilers are put in. We always recommend the projecting front to our patrons, as it costs no more than the flush front, costs less to keep in repair, there is less danger of injury to the boilers, and it looks better than any other style of setting.

We recommend double side and rear end walls with a two-inch air space. The walls should not be tied together, but there should be projecting bricks from the outer wall extending in and just touching the inner wall. This leaves the inner wall free to expand under the influence of heat, without affecting the outer one, and still leaves the outer one in the position of a retaining wall.

The furnace walls should be battered about as shown in Fig. 2, being sixteen inches thick at the bottom, and leaving a clear space on each side of the boiler at the closing-in-

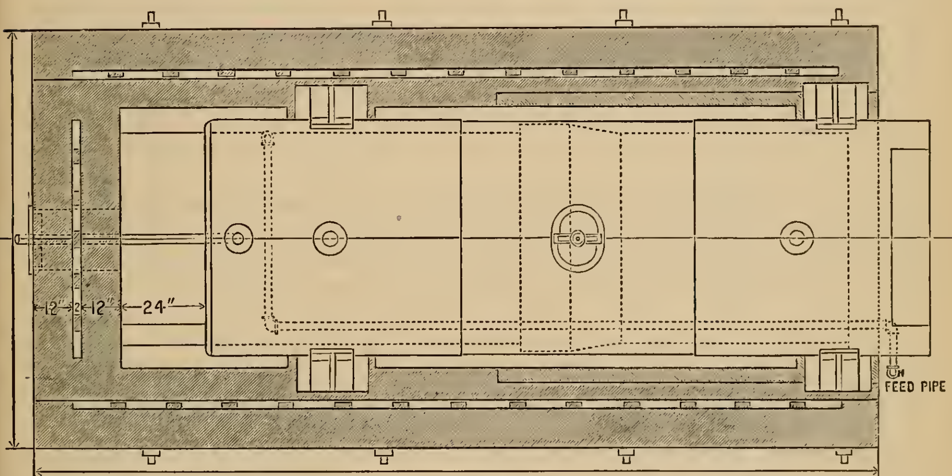

Fig. 2. Horizontal Section of Walls at Center of Boiler.

line of three inches. This gives ample room at the sides for the circulation of the heated gases, about the shell, a good chance to keep the shell clean, and also a chance to examine the shell when making inspections. More space than this at the sides we do not consider necessary, and much less is inconvenient for the purposes of cleaning and inspection.

The distance of the grate bars from the shell of the boiler is a question about which there has been much discussion, and there is a great difference in the practice of different engineers, some setting the grates up within eighteen inches of the lowest point of the shell, others making this distance as much as thirty-six inches, and we have heard of cases where forty-two inches has been tried, and declared to give better results with anthracite coal than any shorter distance. As is usually the case, the correct point is found between the two extremes. The fact is, the grates should be placed just as close to the boiler as they can be and obtain perfect combustion of the fuel, for the closer the layer of incandescent coal is to the boiler, the greater will be the effect of the radiant heat. We believe twenty-four inches below the shell to be far enough away for the grates when anthracite coal is burned, or for any fuel which does not contain a large proportion of volatile matter. Where very soft coal is burned, from twenty-seven to thirty inches will be found to give as good results as any greater distance.

The cutting-off of the front of the bridge wall at an angle of about forty-five degrees, enables the bridge wall to be easily kept free from clinkers, and will also facilitate the keeping of the fire clean at this point. Dropping the grates three inches at the back end gives a thicker layer of fuel near the back end of the furnace, and promotes uniformity of combustion over the whole grate, as with a uniform layer of fuel the air will naturally pass through it more freely at the back part of the furnace than at the front. This pitch also renders firing and slicing the fire somewhat easier.

The ashpit is best made about six inches deep, sides sloping at an angle of about forty-five degrees, with a good layer of cement over the bottom and up the sides to make it water tight. When running, this pit should be kept well filled with water. The advantages of this are not always appreciated. The grates are to a great extent prevented from warping, as the pit is always kept cool by the quenching of coal and hot ashes falling through, and the vapor always rising seems to aid combustion by keeping the fire decidedly cleaner on the under side.

The paving back of the bridge wall, with the cleaning door located at the bottom of the incline, enables the ashes to be easily hoed out of the back connection at almost any time with very little trouble. It is not necessary to stop the boiler, and let the setting cool to perform this very necessary duty.

The back connection is covered in by a brick arch resting on cast-iron arch bars. These arch bars are shown in cross section on the longitudinal section. Their ends rest on the side walls of the setting, and the rise of the arch should be sufficient to render the tubes easily accessible at the back end. For a sixty-inch boiler, the rise will be about seven or eight inches, varying somewhat for other sizes of shells. The arch is better if made of fire bricks, but for ordinary use, when boiler and grate surface are well proportioned, and the boilers are not forced, ordinary hard burned bricks answer very well. The closing in at the back end is best done by carrying the brick-work up above the top of the arch even with the upper part of the shell, and curved to conform to the curve of the shell, and plastering over with any of the many excellent non-conducting coverings to be found in the market. It should be remarked that about three-fourths of an inch space should be left between the back end of the boiler and the side of the arch, so that when the boiler expands, its movement will not affect the brick-work.

The furnace, front and sides, for at least a foot back of the bridge wall (and further does no harm and does not add much to the cost of the setting) should be lined with fire-bricks. The fifth or sixth course above the top of the grates should be a course of headers, for then the bricks below, when they get badly burned, as they unavoidably will after a time, may be removed and new ones put in without disturbing those above.

The setting should be closed in about on a level with the center of the upper row of tubes. Under no circumstances should the fire-line be carried above the water-line of the boiler. Intense heat at this point not only is sure to ruin the shell sooner or later, but it retards the circulation of the water, and the evaporative result is not so good as it is when the fire is shut off lower down.

Where the lugs or supporting brackets rest upon the wall, a plate about one and one-half inches thick and two feet long should be laid, the bracket resting upon this plate. Beginning, say three courses, below this plate the bricks should set out about one inch for each course, so that it, as well as the bracket, will be well protected from the heat.

Good hard-burned bricks should be used for boiler settings, those in the inner face of the walls being selected from the lot. The mortar should be composed of one part of lime with from four to six parts clean sand, well screened. The joints should be as thin as they can be laid, not over one-eighth of an inch, particularly those in the courses exposed to the heat of the furnace. The fire bricks in the furnace should be laid in contact with each other, a thin paste of fire clay, just enough to fill up irregularities in their surfaces and give them a solid bearing, being all the mortar that is admissible.

Inspector's Reports.

MARCH, 1887.

In the month of March, 1887, our inspectors made 4,164 inspection trips, visited 7,445 boilers, inspected 2,384 both internally and externally, subjected 428 to hydrostatic pressure. The whole number of defects reported reached 8,461, of which 709 were considered dangerous, 41 boilers were regarded unsafe for further use. The defects in detail were as follows:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	344	14
Cases of incrustation and scale,	548	16
Cases of internal grooving,	25	4
Cases of internal corrosion,	164	15
Cases of external corrosion,	345	25
Broken and loose braces and stays,	287	26
Settings defective,	166	19
Furnaces out of shape,	223	19
Fractured plates,	114	50
Burned plates,	116	29
Blistered plates,	224	13
Cases of defective riveting,	3,423	160
Defective heads,	37	8
Serious leakage around tube ends,	1,122	178
Serious leakage at seams,	818	74
Defective water-gauges,	95	6
Defective blow-offs,	59	6
Cases of deficiency of water,	13	7
Safety valves overloaded,	38	8
Safety-valves defective in construction,	28	3
Pressure-gauges defective,	224	24
Boilers without pressure guages,	15	0
Defective hangers,	9	0
Defective tubes,	15	3
Defective fusible plugs,	5	2
Defective man-hole rings,	3	1
Total,	8,461	709

Any sort of a casting seems to be considered good enough for a man-hole plate, and some of the specimens we meet are pretty tough looking ones. It is but a short time since we were called to examine what was thought to be a crack in one of the ribs of a man-hole plate. The defect proved not to be a crack but a flaw in the iron. When new it was filled with sand and had quite a smooth appearance, but the heat and the action of the steam had cleaned out the sand and left quite an ugly-looking place in the casting.

Further investigation showed that the opposite or outer surface of the plate had a honey-combed appearance, over nearly its whole extent. A very little picking with the point of a penknife developed the fact that about all there was to the plate was a thin skin of iron on each side, it being an easy matter to dig holes with the knife-blade an inch in diameter and half way through the plate, almost anywhere on the outside surface. In addition to this the casting was so uneven that it was a difficult matter to pack it and make it tight. It required a great amount of screwing up on the bolts, which of course means great strain on the casting, liable to lead, sooner or later, to fracture.

Such castings should never be used for man-hole frames or plates. Their use is attended with much trouble, annoyance, and in many cases, great danger.

Boiler Explosions.

March, 1887.

Distillery (39). — A boiler at the distillery of James Metcalf, at Morgan's Station, near Owensboro, Ky., exploded March 3d, scalding seven men, four of whom will die.

Saw-mill (40). — The boiler at Carr Brothers' shingle mill, twelve miles north of Alpena, Mich., blew up, March 8th. Emory Carr was killed instantly and Waldo Carr fatally scalded. Eugene Carr was also badly scalded. The cause of the explosion is unknown. The mill was blown to pieces.

Coopering Shop (41). — The boiler in W. F. Thompson's tub factory, near Ithaca, Mich., exploded March 8th. Fireman Rollin Norton was killed instantly. Orrin Harvey, aged sixteen years, died shortly after the explosion. Head Sawyer Charles Wilson is so badly injured he cannot recover. Several others were severely injured.

Saw-mill (42). The boiler of Gibbs' shingle mill, near Edmore, Mich., exploded with terrific force, March 9th, completely wrecking the mill and causing terrible fatality. Two men were instantly killed. Their names are not known. Six or seven were seriously wounded, one of whom will probably die. The loss of the mill is estimated at from $3,000 to $4,000, covered by insurance. No cause has been assigned yet for the accident.

Saw-mill (43).—A terrible explosion took place in Frankfort, Ky., March 16th, at the old Hackett & Seigler saw-mill, now owned by Wakefield & West. The mill had not been running for over two years, and in the meantime had been beneath the waters of two or more freshets, and steam was raised to put the machinery in motion and good order preparatory to beginning operations the following week. For some cause or other, believed to be from old and defective rivets, the boiler gave way at both ends and tore everything to pieces in front and rear, knocking brick, timber, and bits of iron in every direction, and flying backward through the air a distance of more than thirty feet. The engineer, who was on top of the boiler at the time of the accident, was carried astraddle of it and alighted uninjured with the exception of sustaining a few blisters. John Hurt and Willie Graham, and Jim Standley, employees, were wounded about the head and breast, the two former badly, and the latter very seriously. William Brinkworth was also bruised by a brick, which struck him on the head. The loss will probably amount to $800, without insurance.

Saw-mill (44). — A large boiler in the saw-mill of Joseph Ramer, five miles from Altoona, Pa., exploded March 17th, while the mill hands were at dinner. Mr. Ramer, the only man in the mill, was hurled through the roof and picked up outside horribly injured. His arm and leg were broken, and his shoulder dislocated; he was also internally hurt. The mill is a complete wreck.

Locomotive (45). — The boiler of locomotive No. 269, on the Louisville & Nashville road, exploded March 18th. A sheet was torn off from the top and the entire outside covering was blown away. There were two men in the cab at the time, a brakeman and the fireman, but neither of them were hurt further than being stunned for awhile by the concussion. The damage is slight only, and the locomotive can be repaired at an outlay of about $200.

SAW-MILL (46).—The boiler in O. H. Paessler's saw-mill, Van Wert, Ohio, exploded March 18th, and killed two persons. The mill, now almost a total wreck, was the finest in the country, and it is admitted that there was at least one hundred pounds of steam in the boiler when it collapsed. The hands were loading a car, and escaped injury, but Sam Miller, a stave-bolt maker, and Frank Burtsfield, a school teacher, were in the building and were instantly killed. The top of Miller's head was blown off, and he was mutilated beyond recognition. He leaves a family. Burtsfield's skull was crushed, his arms and legs were broken, and he was otherwise mangled.

Water Rams in Steam Pipes.

Mr. Charles E. Emery, chief engineer of the New York Steam Company, in one of his recent lectures on "The Transmission of Steam," refers in an interesting manner to water-rams in steam-pipes. In the April number of the *Stevens Indicator* Mr. Emery is quoted as follows:

"The principal cause of accidents in the operation of large, long steam pipes arises from the presence of water. If steam be admitted at the top of a vessel partially filled with cold water, condensation will take place until the surface is somewhat heated, and this, in connection with a cloud which forms above the surface, will retard rapid condensation, so that in due time the full steam pressure can be maintained above water cold at the bottom. This phenomenon is not an infrequent occurrence in boilers in which the circulation is defective. It is, therefore, perfectly safe to heat up any vessel containing cold water, if the steam can be admitted from the top upon the surface of the water and so maintained. If, however, steam be blown in below the surface of the water, a bubble will be formed, which will increase in size until its surface becomes sufficiently extended to condense the steam more rapidly than it can enter, when a partial vacuum will be created, the bubble will collapse, and the water flowing in from all sides at high velocity will meet with a blow, forming what is called a water ram. In blowing into a large vessel, these explosions occur in the middle of the mass, and create simply a series of sharp noises. If, however, steam be blown into a large inclined pipe full of water, it will rise by difference of gravity to the top of the pipe, forming a bubble as previously stated; and when condensation takes place, the water below the bubble will rush up to fill the vacuum, giving a blow directly against the side of the pipe. As the water still further recedes, the bubbles will get larger, and move further and further up the pipe, the blow each time increasing in intensity, for the reason that the steam has passed a larger mass of water, which is forced forward by the incoming steam to fill the vacuum.—*Iron Age.*

SLEEPING CARS FOR STREET SERVICE.—The longest street car line in the world is in Argentine Republic, South America, and it will also be the only line in the world to run sleeping cars for the accommodation of its patrons. The road has 200 miles of track, connecting a number of towns in the vicinity of Buenos Ayres, and its equipment has been supplied by a Philadelphia car company. Horses are used as motive power instead of steam, because fuel is dear, horses cheap, and the people are slow. Two tons of coal will buy a horse and harness. The sleeping cars are a curiosity. They are 4 in number, 18 ft. in length, and are furnished with 4 berths each, which are made to roll up when not in use. The cars are furnished with lavatories, water-coolers, linen presses, and other conveniences, and are finished throughout with mahogany. The other cars are 4 double-decked open cars, 20 platform cars, 20 gondola cars, 6 refrigerator cars, 4 poultry cars, furnished with coops, 8 cattle cars, 2 derrick cars for lifting heavy material, and 200 box cars. They are ready for shipment and will be sent to their destination in a few days.

—*American Manufacturer.*

The Locomotive.

HARTFORD, MAY, 1887.

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

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

THE application of soda ash or any other scale resolvent to a dirty boiler should be followed by a thorough cleaning shortly afterward to remove any scale which may be detached or loosened or injury to the boiler may result. The idea obtains in some cases that it is only necessary to put the solvent into the boiler, and let it work, no further attention being necessary. This is a great mistake. If a solvent does any good its action is either to loosen scale so that it becomes detached in flakes, or it dissolves it so that it remains in the water, either in a finely divided state, or in solution. In the first case, the accumulation of a mass of scale on the bottom of the shell is more than likely to result in burning the plates. The only thing to do is to open the boiler and remove it mechanically.

In the second case the result will depend more or less upon the nature of the scale, and the amount and character of impurities that find their way into the boiler. If the scale is cut by the action of the solvent into a fine powder, and grease gets into the boiler, as it will in all cases where an engine exhausts into an open heater for the purpose of heating the feed, trouble is sure to result. Burned plates may always be expected under these circumstances. The only thing to do is to blow off all the water in the boiler, thoroughly clean it out, and begin again, omitting the grease.

THIS country sustained its reputation at the opening of the American Exhibition in London the other day by blowing up the boiler which furnished power to drive the machinery.

"A CARLOAD of cherries was recently sent from California to Chicago, and the senders had to pay $500 freight — thanks to the inter-State commerce law." — *Daily Paper.*

Well, what if they did? If Chicago people eat California cherries why shouldn't *they* pay freight from California, instead of the people who live half-way between those two points?

A twin screw torpedo boat built for the Italian government by Yarrow, of Poplar (England), has attained on a trial trip a speed of 24.964 knots, or nearly 29 miles per hour. This is stated to be the greatest speed ever recorded. The boat was fully equipped and the water was somewhat rough. The dimensions are as follows:

Length on water line,	140 ft.
Beam extreme,	14 ft.
Draft of water,	5 ft. 4 in.
Displacement,	100 tons.
Indicated horse-power,	1,400
Average boiler pressure,	130
Average revolutions per minute,	366

This is the first occasion on which twin screws have been applied to a torpedo boat, and the results are certainly very surprising. If this speed could be maintained across the Atlantic, the passage between Sandy Hook and Queenstown could be made in 4 days 19 hours 30 minutes, a saving of nearly 1½ days on the fastest trip hitherto made.

The feat of building engines of 1,400 indicated horse-power to weigh less than 200 tons would a few years ago have been deemed impossible, but in this boat, engines, coal, hull, fittings, torpedoes, guns, steam-steering gear and crew, all told, weigh only 100 tons.

Monotonous Repetition.— We have been informed that the Colwell-motor racket is being played at Cleveland, O., with some degree of success. The deluded mortals out there who are investing their money could doubtless buy plenty of stock in this city at a heavy discount. We hear of several people in moderate circumstances who have been financially crippled by going into this lottery.

Those Lowell papers which published glowing accounts of the great invention and misled the gullible into a quagmire, owe an apology to their readers, which might not restore the lost dollars, but would at least prove to the world that the editors were not bought-up for espousing an iniquitous humbug.— *Lowell Vox Populi.*

The Strength of Materials.

Extracts from a paper on the strength of materials, by James E. Howard, Engineer of Tests at the U. S. Arsenal, Watertown, Mass.

The inspection of a bridge or other complex structure presents many difficulties, and to be of full value and reveal the true status of affairs it is a more laborious task than generally supposed by persons outside of the engineering profession. It does not consist merely in loading the structure beyond the weight of the heaviest train, but a careful examination of all its details. To do this work conscientiously and well, the position of an inspector will be no sinecure, and it can only be successful with the aid of engineering and metallurgic skill of a high order. The steps necessary to be taken in order to examine the superstructure of a bridge consists in ascertaining the maximum and minimum stresses which may come upon each member, assuming the workmanship to be good. This data will be obtained by computation, and from a mathematical standpoint there is little ambiguity as to what the stresses will be in the different parts of well-designed trusses. Having made this computation, it may be said the trouble now begins. Knowing the stresses which each member should bear, it must be found out in some styles of trusses whether the disposition of material and quality of workmanship enables such a disposition of loads to be effected, and where imperfections exist, learn of their extent. Finally, the most difficult part of the task is reached when we undertake to learn of the quality of the material, and whether it is capable of sustaining the imposed loads, not only for the present, but whether there is liability to deterioration which will detract from its durability and ultimate safety. As to the mathematical parts of the problem engineers are in accord, generally speaking; hence this part of the subject will not be dwelt upon. Questions relating to the strength and durability of metals cannot be answered with the same degree of precision. The subject of the strength of materials is a complex one in its different bearings, and our knowledge is derived from the combined experience of practical men, who for years have been close observers of the behavior of metals under the actual conditions of practice; also from the results of numerous special experiments, which have been executed for the direct purpose of following up different lines of investigation. Information derived in this last manner is of the most trustworthy character; whereas, in actual railroad practice, facts may be observed which involve several unknown elements, to eliminate which, years may elapse before the opportunity arrives. In the case of special experiments, by investigating one unknown element at a time, the correct solution of the problem is soon reached. There are cases, however, in which the element of time itself is the unknown factor, and the experiment of necessity extends over a long period. Work of this character, both scientific and practical, as regards the immediate value of the tests, has now been going on with the United States testing machine of 800,000 pounds capacity at the Watertown Arsenal for over seven years, during which time there has been tested to destruction, constructive material to the extent of over 320,000 pounds weight, and of which, railway material has formed an important part. A perusal of the annual reports of these tests, a congressional document for public distribution, will show that extensive tests have been made with full-sized bridge columns, with tension members, riveted joints, and other details of construction. These numerous tests have established many important facts, and ruthlessly destroyed fallacious theories.

Inasmuch as it is usually quite an easy matter to criticise existing affairs in a general way without adding materially to the common stock of knowledge, it may be desirable to change the programme and direct our attention chiefly to facts, and those features which bear directly upon the intelligent use of constructive material. In the tensile test of iron and steel we have its modulus of elasticity, elastic limit, tensile strength, elongation, contraction of area at point of rupture, and character of broken surface. Each of these are useful features to know. Temporary magnetism is more or less strongly excited, and the polarity of the fractured specimens enable their relative positions in the testing machine to be identified. Efforts which have been made to judge of the physical properties of metals from magnetic observations have thus far been unsuccessful.

The modulus of elasticity is a measure of the elasticity of the material within its elastic limit, and indicates the amount of extension or compression under given loads, and which the material entirely recovers from when the loads are released. Thus a piece of mild steel will elongate about one-thousandth of its length, when loaded to its elastic limit, and recover that amount when the load is removed. The amount of this elasticity displayed is in direct proportion to the load applied. Double the load produces double the elastic stretch. It is found, however, that when a piece of iron or steel is stretched beyond the elastic limit, and a permanent set, so-called, given the metal, a disturbance is caused in the modulus of elasticity, temporary however, and from which the metal recovers within a few days. While this disturbance exists the elastic elongation increases more rapidly than the loads increase. This fact is suggestive of fatigue or of some loss of cohesion in the metal, but anything said about this peculiar behavior beyond noting the above facts is conjectural.

It is necessary to consider somewhat at length these rather abstruse parts of the problem in order to show what does or does not appear to influence the durability of our iron and steel structures.

In regard to the elastic limit, this may be found to range, say, from forty per cent. of the tensile strength of the metal up to nearly its tensile strength, according to the previous manipulation of the metal, or the influence of its chemical composition. Some steel makers call the "natural" elastic limit that which results from finishing the metal at a red heat and allowing it to cool in the open air. The "natural" elastic limit may be elevated by cold stretching, cold rolling, cold hammering, or wire drawing. Steel is hardened by sudden cooling from a high temperature, but as bridges are not subjected to this kind of treatment after they are erected, although some of the members may have been in the process of manufacture, the effects of heat will not be discussed.

In case a load of tension is applied exceeding the "natural" or primitive elastic limit a new elastic limit is formed equal to and sometimes exceeding that load. In this manner a new elastic limit may be formed anywhere up to nearly the tensile strength. It will be seen from this how little importance can be attached to the elastic limit unless it is known how it was formed, and when an engineer says the working stresses should never exceed the elastic limit, and does not define that limit, taken strictly, that only means that the tensile strength shall not be exceeded, which must be obvious to any one. This brings up for consideration an interesting point in regard to the hangers used in the Bussey bridge, to the eccentricity of which was attributed their failure, notwithstanding the fact that an actual test of the only remaining hanger showed a tensile strength several times the load estimated to have come upon it in the bridge and the refusal of a new eccentric hanger to break in the eccentric part. No doubt the primitive elastic limit on account of eccentricity of load is soon reached, but then a new elastic limit would be formed and continue to be elevated as the weight of trains was increased. The question is, which elastic limit, if any, had anything to do with the ultimate failure. The resemblance of the failure of the hangers to the grooving of steam boiler plates suggests another explanation. An illustration presenting a case of elevation of elastic limit is found in piano wire, which is strained probably beyond even the tensile strength of the annealed wire, remains in this state for years, and whose entire business is to vibrate.

Passing on to the tensile strength of a metal, this is the load which once applied, and gradually increased produces rupture. This property is influenced by previous mechanical treatment, and generally speaking, the same treatment which causes an elevation of elastic limit, also causes an elevation in tensile strength. In this way bars which were tested to rupture at the Watertown arsenal four years ago, and gave a tensile strength of 52,000 pounds per square inch, now a retest of the fractured ends show a tensile strength of about 62,000 to 64,000 pounds per square inch. This feature led the late Sir William Siemens to remark of the mild steel made by his process that any so-called maltreatment to which that metal was subjected only led to increasing its strength. It is an important piece of evidence now wanting that will show, if such is the case, when a change occurs in the cohesion of the metal and this force ceases to increase, turns about and diminishes. Until this is clearly demonstrated and while there are other reasonable explanations why metals fail, we may be excused from undue anxiety on the subject of deterioration of metals as commonly understood.

Concerning elongation, this property is displayed by the metal between the load at the elastic limit and tensile strength, its maximum amount ranging from less than one per cent. in hard steels and cast iron to above thirty per cent. in mild steel and soft grades of wrought iron. Treatment which elevates the elastic limit and tensile strength detracts from its power of elongation. No doubt in many instances the ability to elongate or compress under loads exceeding the primitive elastic limit comes into use to assist in correcting imperfect mechanical adjustments of parts of structures. Contraction of area occurs locally after the maximum load has been passed, and marks the place where rupture occurs, the character of the broken surface showing fibrous or silky in ductile iron and steel, and granular in brittle metal.

The quality of a metal is judged by the physical properties above described, and there is a wide range of properties over which an inspector has to pass judgment when the material is accessible for test. In a bridge but little can be done; the parts are generally so well painted that they are nearly or quite invisible, and, even if exposed to view, the quality of the metal could not be thereby ascertained. If the loads in the bridge exceed the primitive elastic limit, it may be ascertained by the surface scale (magnetic oxide) starting off, as this scale will start off at that time. There is no known method of determining whether a bar is ductile or brittle except by testing it and developing these qualities, and this of course unfits it for use. Out of a lot of metal made from one grade of stock in the wrought iron or out of the same heat in a lot of steel, we have reasonable assurance that there will be uniformity within certain limits; therefore it is possible in new work to provide suitable metal from a comparatively small number of tests. But in the case of old material uncertainty exists as to the quality of the metal. As to the earlier methods of manufacture, we are unpleasantly certain a great many welds were used, and some of them may be, and doubtless are, imperfect. It is a very good weld that will sustain eighty per cent. of the strength of the solid bar. Most blacksmiths entertain exaggerated notions of their ability to weld iron, the opportunity of witnessing their work tested would dispel the illusion. Experiments upon the effect of suddenly applied loads have shown that tough metal is not thereby rendered brittle. Col. Maitland of the English army, cites his experiments which were made for the purpose of developing brittleness by suddenness of fracture. The material which was employed gave an elongation in the testing machine of thirty-five per cent. When ruptured by a falling weight the elongation was increased. Thinking that was not rupturing the specimen quick enough, he employed gunpowder with the same result as before; he then used dynamite, and finally gun cotton, when the elongation of the specimen actually rose to about sixty-eight per cent. It is needless to remark what his conclusions were. Other experiments which have been made with falling weights striking upon flat plates showed that both strength and toughness were retained by the metal, as also did similar tests with cartridges of gunpowder and dynamite exploded against plates.

A source of danger when steel is employed for bridges and other uses is the presence of initial strains which may be in the metal to a serious extent. Annealing corrects this evil. The initial strains may result from inequality in cooling when the metal is in process of manufacture, or from shearing or punching of the metal, or from hammer blows on the cold metal. Punching and shearing is also injurious to iron, but perhaps not to the extent it is in steel. Steel exhibits this peculiarity, that when sheared or punched the scale in that vicinity starts off in lines, which extend out in the solid metal, which seems to indicate that lines of strains sharply defined may penetrate the steel and not distribute themselves over much surface. May not these lines of strain reach sufficient intensity to cause that brittleness of fracture which at times occurs so unaccountably. Sharp corners should be avoided, also nicks in the edges of the steel bars.

A tough and fibrous metal when nicked around the outside will break short and brittle. Now suppose a nick was inside the bar, if it were possible to get one there, doubtless brittleness would result. A near approach to an interior nick is found in the case of a blow-hole in the steel which has not in the process of manufacture been flattened out in the direction of the line of pull; this causes brittleness in fracture, and as most steel rails are reported to fracture, when they do at all, in the first few months of their service, it is very probable that interior defects of this nature and initial strains are the causes. Certainly, if it were deterioration in quality from use, fractures would be more frequent instead of less as time elapsed.

Concerning the substitution of stone arches for iron bridges of moderate span it should be remembered that iron is the stronger material of the two, and except for the prodigal use of stone the structure would not possess advantages in point of strength. Practically there is no elastic limit to stone. It is beautifully elastic in the sense we referred to when speaking of the modulus of elasticity of iron and steel, having in this respect three to four times the elasticity of steel, but under maximum loads crumbles or flies apart; hence joints should be well made to bring much of the bed surfaces in contact, and where strength is required employ only the strongest cements. — *Boston Herald, May* 4.

Interesting Facts About Steel.*

Every piece of steel is at its best in all physical properties when it has been annealed so that it is in the condition which steelmakers call refined, that is to say, when the grain is in the finest condition possible, or when its crystals are the most minute and most uniform in size. This statement is subject to a slight modification in considering a piece of hardened steel; when steel is hardened properly the grain is slightly finer than it would have been if it had been allowed to cool slowly; but the difference is very slight, and if the hardened piece be subsequently annealed this difference disappears. Each temper of steel refines at a different temperature. A piece of 0.10 carbon steel will refine probably at a lemon color. A piece of 0.30 carbon steel will refine at a dark lemon or bright orange color. A piece of 1.00 carbon steel will refine at a dark orange color, or the color that is reached just as the last shades of black disappear. As a rule, the best heat to harden at is the refining heat, and the same heat is a good guide for annealing, although the heat may be raised very slightly in annealing high steel, but it should be done with great care, and it should be lowered considerably in annealing mild steel to avoid over-annealing. It is remarkable, and probably the most important property of steel, that, no matter what the grain may be, no matter how coarse from overheating, or how irregular from uneven heating, if it be heated uniformly to the refining heat, and kept at that heat long enough, the crystals will change in size and will all become small and uniform, so that the fracture will be so even that it will be called fine-grained and amorphous. The magnifying glass will, however, reveal a crystalline structure in the most beautifully refined steel. If a piece of chilled cast-iron be kept at a bright red heat for an hour or two, the chill will not only become soft, but the long crystals will disappear altogether, and the whole piece will be ordinary looking gray cast-iron. If a scalded or polarized ingot be kept at a bright red heat for an hour or two, it also will lose every trace of its needle-like polarized crystals, and will become a uniform fine-grained piece of steel, and it will be as tough as if it had never been scalded and brittle. If any ingot be annealed properly it will lose every vestige of its distinctive carbon crystallization; it will become refined and tough. Unannealed ingots are brittle, easily broken with a sledge, and are distinctively marked; annealed ingots are fine-grained and tough, and must be cut with a set to be broken: and when broken an effort to grade them by the fractures is the wildest guess work, in which none but a great expert should indulge. If a well-annealed piece of steel is the best piece of steel in every respect, an over-annealed piece of steel is the very worst piece, and should always go right back into the melting furnace. Over-annealed steel is brittle, harsh, not ductile, will not harden, and will not temper, and there is no way but melting to make it good. The time required for annealing is longer for a large than a small piece; the correct time must be arrived at by experience.

If it be true that the largest crystals and the coarsest and weakest structure are formed when iron and steel are allowed to cool slowly and in a state of rest; and if the finest crystals and the best structure can only be formed by quick cooling and the violent agitation of the hammer or of the rolls; or by careful heating to just the right temperature to cause the formation of fine crystals, it would seem somewhat anomalous to assume that this is all reversed in the cold state, and that cold iron and steel can be shaken up into coarse crystals and a weak condition. It may be possible that such an anomaly could exist, but it seems more reasonable to suppose that when an axle or a crank pin breaks and develops in the interior large, fiery, and weak crystals, that those crystals were formed there by too much heat, too slow cooling, and too little work when the piece was formed. It is proper to remark here that the hammering of a round piece

*Abstract of a paper by William Metcalfe, a steelmaker, read before American Society Civil Engineers.

between flat dies is a dangerous operation; it is a common thing to find round-hammered bars of steel burst in the middle for long distances, of which there is no evidence at the ends or on the surface; therefore round pieces for structural purposes would be safer if they were hammered in swedges or rolled in grooves.

As to the physical properties of steel, mild steel, such as is used commonly for structural purposes, is more ductile, stronger, and tougher than iron; it is more easily and safely produced in large masses than iron, and when worked properly it can be put into the most difficult shapes, and be made to do good duty. High steel is hard and brittle, and generally of great tensile strength; its use is hazardous, because of its great change of volume for a slight change of temperature; yet it can be made very ductile by careful annealing. When steel is to be subjected to repeated deflections or alterations of strain, the mild steel is the more enduring; but when steel is to be subjected to rapid vibrations, as in a pitman or a hammer rod, a higher steel is much better than dead soft steel. In using higher steel, however, it is important to have it well annealed and perfectly smooth. Instances have been known where a break in a hammer rod could be traced to a slight tool mark. No sharp angles or corners should be allowed in structural steel. Mild steel does not afford good resistance to abrasion; it is too ductile and flows too readily; the flow causes heating and increased friction, and the low tensile strength yields to the friction. The effect of the chemical constitution of steel is very marked, and is well defined in high tool steel, but it is not so well defined in mild steel, nor in Bessemer and open-hearth steel; therefore engineers do well not to meddle with chemistry at present; but it is safe to assume, in all cases, that the nearer the steel comes to being pure iron and carbon the better it is. It may be gathered, from what has been said, that in general it is better and wiser for engineers to adhere as closely as possible to mild steel for large structures, where the material is used in comparatively large masses; first, because it is more ductile than high steel, and therefore not so liable to break under sudden stress; and, second, because it can be safely worked into shape by less skilled hands than are required in the manipulation of high steel; yet there are cases where it is wise to take advantage of the superior strength of high steel in the largest structures, of which we have notable examples in the staves of the arches of the St. Louis Bridge, and in the wire of the cables of the East River Bridge. On the other hand, there seems to be danger in the enthusiasm of some of the admirers of mild steel whose statements that it will stand any amount of "abuse and punishment," etc., may mislead them and others into the idea that it can be handled without even as much care as is ordinarily bestowed upon wrought-iron. In reference to steam boilers, so far as strains are concerned, it would seem that high steel would be the best; but when we consider the daily alterations of heat and cold to which boilers are exposed, fire on one side, water on the other, and the general ignorance of physics of the men who handle them, it is obvious that mild, tough steel is the only kind that is safe, and the milder and tougher the better. — *The Mechanical Engineer.*

Capital in Storm and Calm.

Recently published works by the United States Commissioner of Labor disclose some interesting facts about paper manufacture. An inquiry was made regarding the effect of machinery on over-production, and the summary for the paper industry is as follows: "It is very difficult to get at the exact displacement of labor in the manufacture of paper, but a machine now used for drying and cutting, run by four men and six girls, will do the work formerly done by 100 persons and do it very much better. This is the testimony of one of the leading houses, while another states that the apparent displacement by machinery is illustrated by the fact that six men can now produce as much per day on a given sample as 100 men could produce in 1800 of an approximate grade. A well-known firm in New Hampshire states that, by the aid of machinery it produces three times the quantity with the same number of employees, that it did twenty years ago. In the manufacture of wall paper the best evidence puts the displacement in the proportion of 100 to 1."

Sudden and great changes of this kind in an industry may lead to overproduction, as they have been on the verge of doing in the paper industry, but the resulting cheapness of the machine manufacture, in the course of time, and the diversifying uses of paper, lead to a stimulation of demand, and eventually consumption overtakes overproduction arising from this cause.

An attempt has been made, but a very crude one, to ascertain the quantity of the factors in the cost of producing various manufactures, paper among the rest. There seems to be much confusion in analyzing this cost, with every one who writes upon the subject. The United States census, particularly, shows the densest ignorance, and there are analyses in a government report that are no better. For instance, a Delaware newspaper mill represents the cost of labor as 11.14 per cent. of the total cost of a given quantity of paper, and the cost of materials as 88.86 per cent.; another Delaware mill apportions to labor 8.33 per cent. of the cost and to materials 91.67, in tinted pamphlet cover paper; a Massachusetts mill making glazed, plated, and enameled paper makes the apportionment 26.67 per cent. for labor, 66.67 per cent. for materials, and 6.66 per cent. for administration.

The absurdity of these statements ought to be manifest to a school boy, and a practical business man would brand them as absolutely useless. Each of these three mills has given items of cost that together make 100 per cent., or the whole cost; yet the first two mills are represented as taking no account of administration, and all of them ignore insurance, taxes, interest, commissions, various risks that capital must be compensated for (as, bad debts, fluctuations in many branches of the business, etc.), and other items that can be mentioned.

A Maine newspaper mill represents the percentages of cost as follows: Labor, 13.88; materials, 57.45; other items, 28.67. Super calendered book paper — labor, 17.66; materials, 66.27; and other items, 16.06 per cent. The best kinds of writing paper — labor, 23.81; materials, 47.62; other items, 28.57. The most striking thing about this is that materials, as an element in the cost of production, are from two to four times more important to the manufacturer than labor is. The manufacturer who is scared when he contemplates high wages as having a bearing on competition, would do three times better if he should be scared equally as much when he contemplates materials as having a bearing on cost of production. The paper industry, happily, is favored above most other industries in being able to get a large portion of its materials at the lowest cost, while other industries are paying imposts on their materials.

The fluctuations that occur in the profit or reward going to the paper mill owner are strikingly revealed by the twentieth volume of the United States census. An Illinois mill owner got these percentages of the selling price of his paper in 1876, 1878, and 1880: 6.6; a loss of 3.6; and a profit of 6.6. A Holyoke mill had these variable percentages of reward: 4.16⅔ in 1871; 2.6 in 1875; and nothing in 1880, so that the mill owners got only their salaries in that year. A Berkshire fine writing mill's financial stress is revealed in these percentages, supplied by itself: In 1870, 32.29 per cent.; in 1875, a loss of 30¾ per cent.; 1880, profit of 25 per cent. of the product. The loss in 1875 was enormous and, of course, could not have been borne long. A mill in Pennsylvania, manufacturing fancy cassimeres, shows a record that is probably duplicated by that of many another mill in other industries. The fluctuations in the share of the product going to labor is insignificant, just as is the case in the paper industry, even for longer periods. The fluctuations are compared as follows for the cassimere mill, the minus mark signifying loss:

	1874.	1875.	1876.	1877.	1878.	1879.	1880.
Per cent. going to capital,	8.08	—.0003	9.8	.007	—1.98	9.4	6.56
Per cent. going to labor,	16.23	15	15.3	16	17.34	17.22	14

Several paper mills all show an evenness of reward going to labor; the percentages of the product taken by labor is as follows: In an Illinois mill, 1876, 26.6 per cent.; 1878, 30; 1880, 26.6 per cent. A Holyoke mill shows these percentages: 1871, 12½; 1875, 13⅔; 1880, 15. Another Massachusetts mill these: 1860, 9.15; 1875, 9; 1880, 11.7. A Pennsylvania mill: 1871, 17½; 1875, 22; 1880, 15 per cent.

Capital, vastly more than labor, is sensitive to every fluctuation of the market. It thrives one year; the next, it descends into the dumps; but labor keeps on in a comparatively even tenor of its way. Capital is on the surface of the water, where every breeze and gale laps it into waves; while labor lies beneath, where only the furious storm can reach it. This is what manufacturers have found out, and this is what the census of 1880 discloses.— *The Paper World.*

The Locomotive.

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Surface Blow-off Apparatus.

The most common and at the same time the worst difficulty that steam users have to contend with is the formation of hard scale and the deposition of sediment in their boilers, which occurs to a greater or less extent with almost all waters which are available for use in steam boilers.

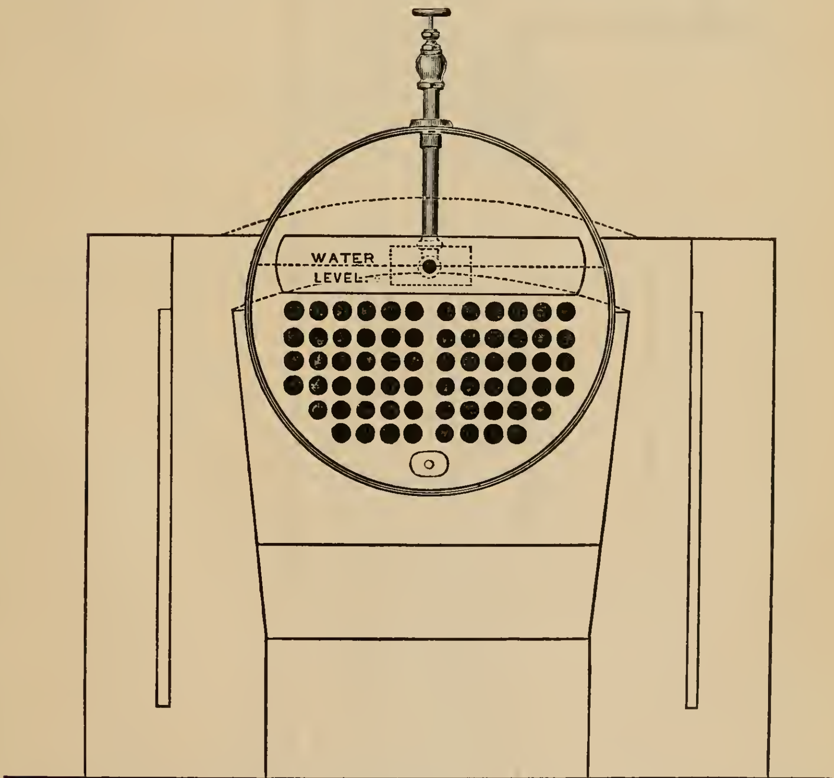

Fig. 1.

There has been a great deal of discussion as to how much the efficiency of boiler heating surface is impaired by the presence of scale of a given thickness, some claiming that a coating one-sixteenth of an inch thick increases the consumption of fuel fifteen per cent., and a coating one-fourth of an inch thick, sixty per cent., while others maintain that a coating one-half an inch thick makes very little difference in the evaporative efficiency of a boiler. We are not aware that any experiments have ever been made which are of value to determine the exact value of scale as a conductor (or non-conductor) of heat under the conditions of every day use, at the same time hardly any person of ordinary intelligence who has had a fair amount of experience will deny that the

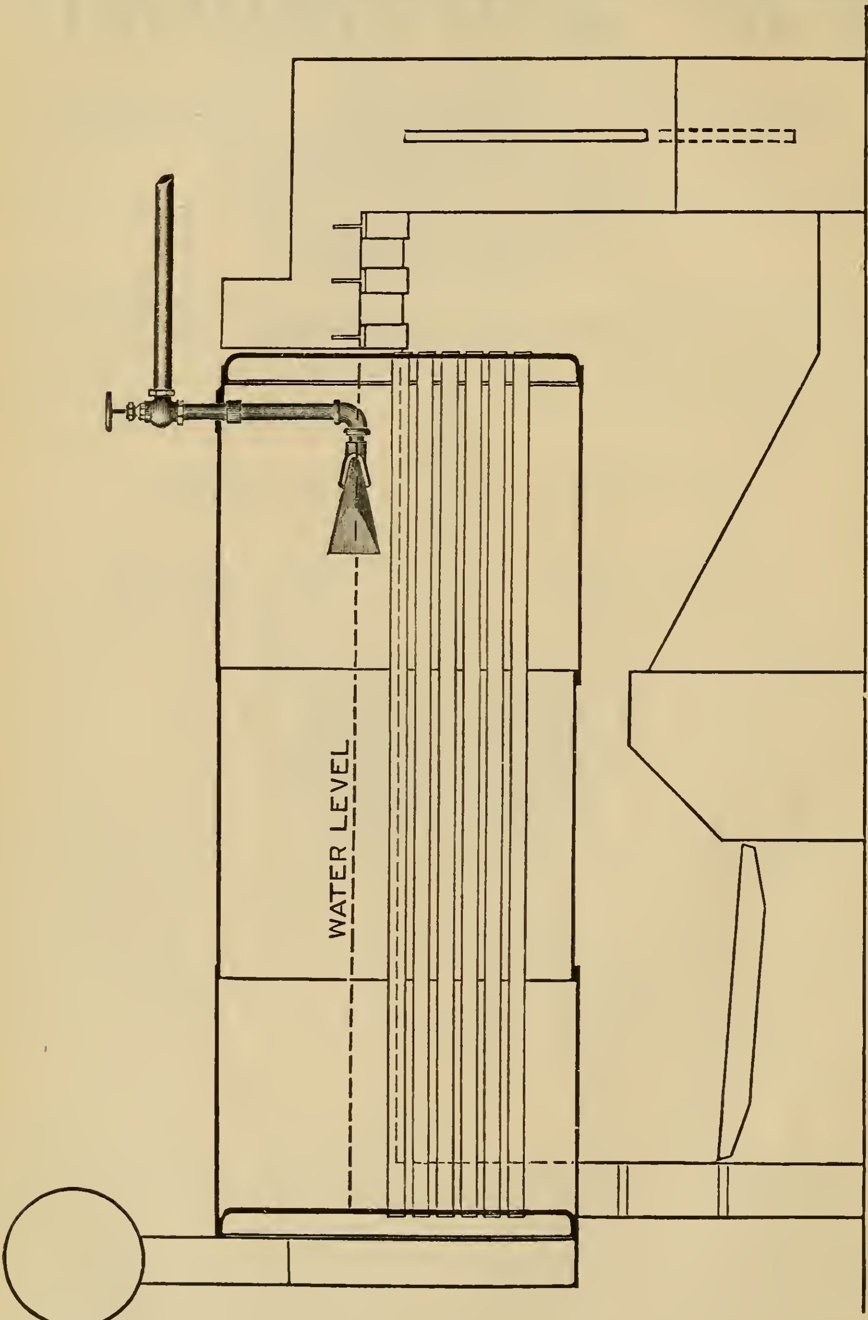

FIG. 2.

presence of a coating of scale, or a quantity of sediment, not only greatly lowers the efficiency of a boiler, but is more than likely to produce other and far more serious results, which renders it imperative that every means available be employed to prevent the formation or deposition of such matters.

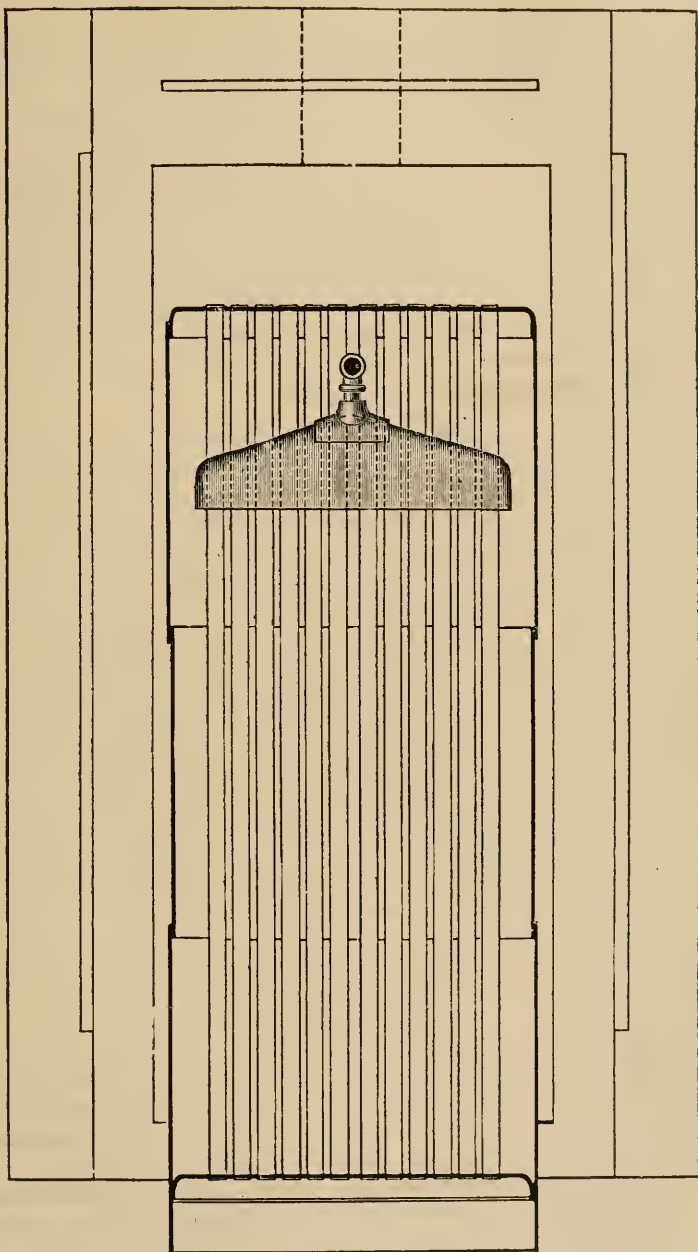

Fig. 3.

Carbonate of lime, sulphate of lime, and carbonate of magnesia are the principal scale-forming matters that are met with in fresh waters, and the quantity of these salts which water will hold in solution is about as follows:

Carbonate of lime, - - -	at 60° F., traces;	at 212° F., traces.
Sulphate " - - -	" 175 grains;	" "
Carbonate of magnesia, - -	" $3\frac{1}{4}$ ounces,	" "

The carbonate of lime is believed to be held in solution at ordinary temperatures, in the form of a bicarbonate. When introduced into the boiler the elevation of the temperature drives off the excess of carbonic acid, and leaves it in the form of a carbonate, which is at once precipitated. When precipitation occurs the carbonate does not at once settle down on the bottom of the boiler but floats on the surface, owing to its lightness, or remains in suspension. After a time it forms a sort of sludge, if grease or organic matter is present in the water, and when the boiler is stopped and active circulation ceases it settles upon the fire sheets and tubes and stays there, the circulation of the water not being sufficiently active to dislodge it after it once becomes attached to the plates. If grease is present it will now almost invariably cause overheating and bagging of the furnace plates; in conjunction with sulphate of lime, it goes to swell the bulk of the hard scale formed by that substance.

Carbonate of magnesia acts in much the same way as carbonate of lime, and gives rise to the same troubles.

It is while these substances are floating on, or are suspended in, the water that the use of the surface blow-off is attended with the best results. Our illustrations show a form of this apparatus which will be found as effective in its operation as anything yet devised, and we can recommend its use where water contains much carbonate of lime, carbonate of magnesia, or organic matter in suspension. Its use will be indicated in boilers where a soft muddy deposit is found covering the shell and heads along the water line. The cuts hardly need explanation. Fig. 1 is a section through the boiler showing a front view of the apparatus. Fig. 2 a longitudinal section of boiler showing a side view of the same, and its position in the boiler, while Fig. 3 is a plan. A wrought iron pan or scoop is made of the form shown, and having the dimensions indicated by comparison with the boiler, if the man-hole is large enough to admit it, if it is not, make it as large as will pass through the man-hole. It is connected as shown, being put well toward the back end of the boiler, and having its center about on a line with the water level in the boiler. The scoop should face the front end, for the general direction of the circulation is from the front end of the boiler backwards, and it is thus in a position to gather in the matter floating on the surface of the water.

By opening the stop valve shown on top of the boiler at proper intervals, about all of the scum or sludge floating on the surface may be taken out of the boiler without any difficulty.

A large amount of the sulphate of lime, the hard, scale-forming matter, may also be removed by a judicious use of this form of surface blow-off. When it is precipitated it does not at once deposit itself on the plates, but a portion of it is carried about by the circulation, and while in this condition it may, some of it at least, be removed.

The surface blow-off has fallen into disfavor in many cases, for the simple reason, that the form of apparatus tried has been worthless, or it has been improperly placed in the boiler. Two or three feet of one or one and a quarter inch pipe tapped through a boiler-head, generally at the front end, and perforated with small holes, is a favorite form, but it is almost useless for the purpose intended. What is needed is something large enough to give direction to the stream of water blown off, and always take it from the surface. This the apparatus illustrated above will do, and we have recommended its application in many cases, and good results have always followed.

Inspector's Reports.

April, 1887.

In the month of April, 1887, our inspectors made 3,917 inspection trips, visited 6,163 boilers, inspected 3,045 both internally and externally, subjected 490 to hydrostatic pressure. The whole number of defects reported reached 8,793, of which 1,119 were considered dangerous; 48 boilers were regarded unsafe for further use. The defects in detail were as follows:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	478	34
Cases of incrustation and scale,	678	41
Cases of internal grooving,	30	11
Cases of internal corrosion,	162	18
Cases of external corrosion,	375	44
Broken and loose braces and stays,	356	42
Settings defective,	186	19
Furnaces out of shape,	271	16
Fractured plates,	193	81
Burned plates,	141	29
Blistered plates,	251	18
Cases of defective riveting,	3,123	167
Defective heads,	56	20
Serious leakage around tube ends,	1,373	125
Serious leakage at seams,	592	56
Defective water-gauges,	97	14
Defective blow-offs,	36	9
Cases of deficiency of water,	8	3
Safety-valves overloaded,	32	12
Safety-valves defective in construction,	43	8
Pressure-gauges defective,	271	44
Boilers without pressure gauges,	2	1
Defective hangers,	27	0
Defective tubes,	4	4
Defective fusible plugs,	5	0
Defective hand-hole plates,	2	2
Defective dome construction,	1	1
Total,	8,793	1,119

Boiler Explosions.

April, 1887.

Cotton-Gin (47). The boiler in the gin and grist mill of George W. White, at Whitehall, Texas, eleven miles east of Navasota, exploded April 2d, dangerously injuring Henry Davis, an employee.

Saw-mill (48). A boiler in Crawford's planing-mill at the foot of Evans street, Cincinnati, Ohio, exploded April 4th, with terrific force, demolishing the engine-house and dangerously wounding four workmen. The boiler itself went spinning through the roof, going a distance of three hundred yards, where it fell on a shanty-boat at the edge of the river. It demolished the boat and instantly killed Mrs. Elizabeth McLean, who was at her work in one end of it. Her head was cut completely off, and one leg was found inside the boiler. Her husband, who was sleeping in the next room, was uninjured, but terribly frightened. The damage to the mill is several thousand dollars.

Mine (49). The hoisting works of the Nevada Queen mine, Tuscarora, Nev., were completely destroyed April 6th, by the explosion of the boiler. Five men were seriously injured, among them A. D. Russell, foreman of the mine, who is believed to be fatally hurt. The pumping machinery was also destroyed, and the mine is flooded. The North Belle Isle and other adjoining mines are also filling with water. It will be three months before new works can be constructed and work resumed.

Saw-mill (50). At Monero, N. M., April 7th, E. K. Caldwell, owner of a saw-mill, was filing the saw, when he felt himself struck by a piece of iron. Almost instinctively he dropped into the saw-dust pit just as the boiler of the engine burst, totally destroying the engine and mill and bringing the house down in ruins about its owner, who was safely ensconced in the pit. The neighbors, hearing the noise of the explosion, went to the rescue, expecting to find the body of Caldwell blown to atoms, but were pleased to find, on clearing away the debris, that he had received no injury beyond the blow on the side of his head from the first particle that warned him.

Saw-mill (51). Fleetwood Brothers' saw and planing mill, Hertford, N. C., was completely destroyed by a boiler explosion, April 7th. Two persons, William Gail, white, and Joe Turner, the colored engineer, were killed outright, and two others, J. R. Fleetwood, white, and Major Reed, colored, were fatally injured.

Saw-mill (52).—At Harrisville, Ritchie County, W.Va., April 7th, the boiler of William Morris' saw-mill situated on the edge of the town, exploded with terrific violence, killing four men and badly wounding and scalding three others. There were eight men employed at the mill, and when the noon whistle blew they all repaired to the boiler room, as had been their custom during the winter, to eat their dinner. They had not been in the room over fifteen minutes when the boiler burst, completely wrecking the building. All the men were blown into the air, two or three being carried over fifty yards. In a few moments the crowd, which was attracted to the scene, were engaged in aiding the injured or gathering up the killed. It was speedily found that John Scott, Andrew Lindsey, G. W. Williamson, and Charles Gray, were dead, and three of the other four were badly scalded and otherwise injured.

Shipyard (53). A boiler at Wolf & Davidson's shipyard, at the foot of Washington street, Milwaukee, Wis., exploded April 9th, wrecking the boiler-house and demolishing the surrounding machinery. The damage is estimated at $10,000.

Carpet-beating Works (54). A boiler exploded in a shed at the rear of the carpet-beating works of J. E. Mitchell, at 200 Fourteenth street, San Francisco, Cal., April 12th. The explosion wrecked the engine shed and two small sheds adjoining, and ignited the ruins. Engine No. 7 was quickly on the scene and subdued the flames. The damage done amounted to $3,000. At the time of the explosion the engineer was away at lunch. He states that when he left there was a steam pressure of only sixty pounds, and that the gauges indicated that there was plenty of water in the boiler. The only person injured by the explosion was a Chinaman, who was working in an adjoining yard. He was struck by a piece of flying timber and knocked senseless. His injuries, however, were not of a severe nature.

Pumping Engine (55). A large water tank on the East Tennessee Railroad, two and one-half miles south of Dalton, Ga., was burned April 10th. During the fire the boiler of the pumping engine furnishing water to the tank exploded, killing one man and injuring three others.

Saw-mill (56). There was a boiler explosion seven miles from Lancaster, Ohio, April 15th, instantly killing Stephen Stoltz, aged 45 years, married; Peter George, aged 25 years, and John Houston, aged 17 years, besides seriously wounding the owner of the mill, Samuel Houston. The cause was a dilapidated boiler and the turning in of cold water with a high pressure of steam.

Chemical Works (57). An explosion of a small boiler at the Georgia Chemical Works, Augusta, Ga., April 18th, caused the death of George Biggers, the machinist, and painfully injured Mr. John Waters, foreman.

Barge (58). The hoisting barge Lilliputa has been employed for some time in loading stone at Stony Creek for the New Haven breakwater. April 18th the boiler, which had recently passed a satisfactory inspection, blew up from some unknown cause, ripping up the decks and houses amidships, tearing away part of the bulwarks, and cutting down the single mast which went by the board. Happily there was no fatal result.

Steamer (59). The steamer Delta, a small craft plying between Wilmington, N. C., and the Upper Black River, exploded her boiler when near Sherman's Landing, April 20th. One man was instantly killed, and three others wounded. The boat was completely wrecked, and her freight destroyed. Lloyd Spearman, the colored fireman, was killed, and Captain John D. Kerr was scalded on the legs and body, but not seriously. F. J. Anders was injured in the shoulder seriously. One man, whose name was not ascertained, was badly scalded in the face. The force of the explosion was so great that the boiler was blown from one end of the boat to the other, a distance of forty feet.

Flouring Mills (60). The boiler of the Kingston Flouring Mills, at Kingston, Ohio, exploded April 21st. The engine room was badly wrecked. The engineer was blown through a window across an alley and against a fence, but was uninjured. William Urich, aged 19, was struck by the fire front and pinned against the wall with his leg broken. He was also probably fatally scalded. The cause of the explosion was that the boiler was old and not fit for use. It was formerly used by the State Agricultural Society, and was wasted by wear and rust so that it measured at the point where it broke only three-sixteenths of an inch in thickness. There was plenty of water in the boiler at the time of the explosion and only forty-five pounds of steam pressure.

Paper-mill (61). The rag-boiling boiler of the Ivanhoe paper-mill burst April 23d, and the fragments flew through a brick wall and crashed through the roof of Van Winkle's silk mill on the opposite side of the street. One man in the Ivanhoe mill was killed outright, three were fatally injured, and half a score of men and women were badly cut and bruised. The fatally hurt are: Michael Burke, 60, boiler-man; resided on Jersey street; leaves a wife and children; fatally injured. James Simpson, chest crushed in, lungs exposed. William Jenkins, head fearfully lacerated; suffering from shock. Maggie Van Sile, skull fractured and scalp and face horribly lacerated. The slightly injured are — Ellen Faulkner, David Todd, Maria Farrell, Bridget Cowan, Sarah McGraugh, Lizzie McGraugh, Mrs. Maggie Donnelly, Bridget McCormick, Rachel Levy, Owen Burns, and Mary Keisbury.

Iron Works (62). A battery of boilers at the Western nail mill, Belleville, Mo., collapsed April 27th, causing $2,000 damages and a suspension of work for ten days.

Saw-mill (63). A terrible explosion occurred April 30th, at the saw-mill of the Paducah Lumber Company, Paducah, Ky., by which four men were scalded, two of them fatally. Joe Berry, the engineer, was struck in the head with a missile and fatally injured. Jean Vassar, the filer, was terribly scalded and will die. Willy Joiner, foreman, sprang through the boiler-room window, carrying glass and all, and was severely cut by broken glass. His burns are slight. Robert Hicks, helper, was working the forge bellows and caught the full vent of the steam, inhaling considerable of it. He will die. Had the blowup occurred sooner, the list would have been larger, as most of the workmen had just left the boiler-room to go to work. But little damage was done to the machinery.

The Locomotive.

HARTFORD, JUNE, 1887.

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

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 *cents per year when mailed from this office.*
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Getting Boilers Ready for Inspection.

Sometimes boiler attendants do not fully realize the importance of getting their boilers in proper condition for inspection. This is especially apt to be the case with new risks, the first time they are inspected, and also in places where there may be a new fireman or engineer who, perhaps, has never before had charge where the plant was insured. If a boiler is in proper condition the work of the inspector is greatly facilitated, and the intrinsic value of the inspection may be much greater than it would be if the boiler is so hot and dirty that it is difficult to make a proper examination.

The Hartford Steam Boiler Inspection and Insurance Company has issued in suitable form for displaying in the engine and fire-room a set of rules for preparing boilers for inspection which we reproduce here. By observing them our patrons will find not only that the labors of the inspectors will be much facilitated, but that the resulting benefit to the boilers will amply repay for their observance.

RULES FOR PREPARING BOILERS FOR INSPECTION.

1. Haul fires and all ashes from furnaces and ash pits.

2. If time will permit, allow boiler and settings to cool gradually until there is no steam pressure, then allow water to run out of boilers. It is best that steam pressure should not exceed 10 pounds if used to blow water out.

3. Inside of boiler should be washed and dried through man-holes and hand-holes by hose service and wiping.

4. Keep safety valves and gauge-cocks open.

5. Take off man-hole and hand-hole plates as soon as possible after steam is out of boiler that boiler may cool inside sufficiently for examination; also *keep all doors shut* about boilers and settings, *except the furnace and ash-pit doors.* Keep *dampers* open in *pipes* and *chimneys.*

6. Have all ashes removed from under boilers and fire surfaces of shell and heads swept clean.

7. Have spare packing ready for use on man-hole and hand-hole plates if the old packing is made useless in taking off or is burned. The boiler attendant is to take off and replace these plates.

8. Keep all windows and doors to boiler-room open, after fires are hauled, so that boilers and settings may cool as quickly as possible.

9. Particular attention is called to Rule 5, respecting doors, — which should be open and which closed, — also arrangement of damper. The importance of cooling the inside of the boiler by removal of man-hole and hand-hole plates at the same time the outside is cooling, is in equalizing the process of contraction.

The utility of the first rule will be evident when we consider that if the grate is covered with a layer of several inches of coal, ashes, or clinker at a glowing heat, or if the pit back of bridge is in the same condition, so that the inspector has to look sharp or his clothes will get afire, his work cannot be done as well as it would be if things are comfortably clean. The removal of the ashes back of the bridge-wall may be a difficult matter, or it may be an easy matter, according to circumstances. If the pit is a deep one, and the only door into it is placed high up in the setting-wall, it is a very difficult and disagreeable job to remove the ashes until the setting has cooled down sufficiently to allow a man to get under the boiler and shovel them out. The process of cooling may be accelerated by playing water into the ash pit with a hose, but this is a practice we cannot recommend while the walls are hot, it is too destructive to them.

If the setting is of the form shown in our last issue the ashes can be easily raked out at any time, even when there is a fire on the grate, it not being necessary to go inside the setting to do the work. We can always recommend the sloping pavement back of the bridge-wall with a door at the bottom of the incline.

Regarding the second rule. If the feed-water contains scale-forming matters, and very few waters do not, and the boiler is blown off while the setting is hot, all the impurities will be baked on to the shell and tubes, and their removal may be attended with difficulty. Many boilers get fouled up from this cause, when if a different practice were followed they would be easily kept clean. The best way is to allow the boiler and setting to get comfortably cool, and then let the water run out. If this is done then all mud and sediment is easily washed out as directed in rule number three.

Immediately after the boilers are emptied the man-hole and hand-hole plates should be removed so that the boiler may be washed out if found necessary, and also that it may cool off quicker inside. Keep the chimney damper wide open; if it is the practice to run with it partially closed, open it wide, and also open the furnace and ash-pit doors. Close all other doors in the setting. The heat retained by the walls and the boiler will now cause a strong draft of air through the same passages that the gases of combustion pass through when the boiler is running, and also through man and hand-hole, and the boiler will be cooled off in the shortest possible time, and in the best possible manner, both inside and out. The importance of this proper cooling cannot be overestimated. It prolongs materially the life of the boiler.

Sixth, remove all ashes from under the boilers and sweep fire surfaces and heads clean. These surfaces should always be kept as clean as possible for economy's sake. It is essential to a proper examination of every part of the boiler-shell that it be clean. No man can tell what lies under a coating of ashes or soot half an inch thick.

Of the necessity of having packings of proper size and suitable materials always on hand it is quite unnecessary to speak. They are liable to be wanted any day and a full set should always be kept in stock so that if one blows out it can be replaced with the least possible delay.

If the windows and doors to boiler-room are kept open the free circulation of air around the boilers hastens the cooling and adds to the comfort of working in or under the boilers.

Copies of the foregoing rules for getting boilers ready for inspection, suitable for posting up in engine or boiler-rooms for reference may be had on application to this office.

We have so often pointed out the evils and even dangers arising from the use of open heaters that it seems almost superfluous to refer to them again, and we would not do so were it not for the fact that they are still put in and used, and even adopted in some cases against the advice of those who have tried them and experienced the usual kind and amount of trouble. Where an open heater is used in connection with an engine, or in any place where the steam becomes contaminated by grease, especially animal oils or fats, trouble with the boiler is a dead sure thing. We have never known of an exception to this rule. Various circumstances may delay the trouble for a greater or lesser time, but it is sure to come. The grease discharged into the boiler will settle down upon the fire sheets, the sheets will become overheated and bulge or blister. If they are not of good quality there will be great danger of explosion. The only way to avoid the difficulty is to discontinue the use of such a heater, clean out the boiler, and begin again.

It is a very simple matter to clean out a boiler which has become greased upon the inside if one knows how to go about it. *Grease* is insoluble in water. *Soap* is very soluble. Grease and soda combined form soap, which is easily blown out of the boiler. Therefore the easiest and simplest way to clean out a boiler which has become fouled up with grease is to dissolve a few pounds of soda ash or sal soda, from 10 to 25 pounds in water, put it into the boiler, fill up with water, and build just a little fire, little more than enough to boil the water, raise say 3 to 5 pounds of steam, and let it run this way for a day or two. If enough soda was used the boiler will be found, if blown off now, quite free from the adherent grease, it will only need to be washed out well to be in good condition. If there is any grease left it is evidence that not enough soda was used, or that the boiling process might be continued for a greater length of time, and the operation should be repeated.

If men who put up large business blocks would get their specifications for boilers, and amount of radiating surface made by disinterested parties, they would not so often be obliged to increase their boiler capacity, usually at great expense and trouble, as soon as cold weather sets in. It is all right to give a steam fitter *carte blanche* to go ahead and put in the heating apparatus in such cases, if the owners wish to do so, but it has been proved by experience that when several parties compete for such a job, each bidding on his own particular plan, and the lowest bidder gets it, that in about nine cases out of ten when the job is finished, something is wrong, and that something has to be made right, usually at great expense before the building can be comfortably heated.

Greater care than is usually bestowed upon that large and useful class of boilers known as portables might profitably be given to them. They are subject to hard usage under the most favorable conditions, many if not most of them are set up out of doors without any sort of covering or protection, they get rained and snowed upon, they are usually worked to their full limit, and the construction of those of the upright form renders them peculiarly liable to give out at the upper tube sheet. Usually about 18 inches of the upper ends of the tubes are not covered by water, and they are consequently overheated in this part. This sets them leaking around the ends, and this leakage in turn corrodes the tube sheet. Boilers of this sort which do not leak badly at the upper ends of the tubes, after they have run a short time, are the exception. They are also frequently run without any hood over the smoke pipe, and there is nothing to prevent rain from coming directly upon the head. This, of course, only aggravates the first mentioned trouble. Boilers of this class should always have some shelter over them if possible. If it is not possible, then they should be kept well painted and oiled. A cover should always be provided for the top of the smoke stack, and every means available employed to prevent corrosion, the great enemy of this class of boilers.

The Use of Very High Steam Pressures.

To the Editor of THE LOCOMOTIVE:

I see that in the March number "H. F. S." hardly gets the drift of my meaning, and with your permission I will put it in another form. I think we agree perfectly on the efficiency and economy of the boiler: but he says that "in the best engine ever made more than one-half of the steam passes through it without doing any work whatever." This is putting it too mild, as the heat represented by the evaporation of 2.57 lbs. water per hour is one horse-power.

In building the engine we arrange to get the lowest clearance possible, the valves to give free ingress and egress, and to cut off sharp so that the mean pressure shall be high with a low terminal pressure. Such an engine will be as perfect as it is possible to build. Then comes the experiments with high piston speed, high rotative speed, different pressures and rates of expansions, etc., all of which has been thoroughly gone over, and the best results with a condensing engine is about twenty pounds water per hour per horse-power, or only $\frac{1}{8}$ of the heat utilized. This result can be obtained with ordinary pressures, and is all that can be obtained with a single cylinder engine.

But there are engineers who have gone to work to improve on this by using more than one cylinder, and they are trying with a fair promise of success to reduce the consumption to fifteen pounds water per hour. With 1,000 horse-power, and a boiler evaporating ten pounds water, with coal $5 per ton, this means a saving of $3,750 per year, or six per cent. on an investment of $62,500. To get this with the new departure in the engine, they must have more than 100 pounds pressure.

Assuming that the same power of boilers to carry the higher pressures cost double, there will need to be but $\frac{3}{4}$ as much. These boilers also do not take as much room for the same power, and where real estate is valuable, the saving in room for boiler-house and smaller bins for coal, as well as the smaller house, etc., will make up the rest, so that it is possible that the boilers to carry the high pressure will not cost as much as the other type. There will also be less expense for firing and handling the coal. In view of the possibilities is it best to say to the men who are attempting to reduce the cost of American manufactures in this direction, "God speed, and give you success," or "Don't do anything that will supplant the tubular boiler?"

We are glad to see that our correspondent has adopted our own views on the above subject, at least so far as improving the engine is concerned. We hope he may be brought to agree with us on the other points in time. But there are two points on which he seems to have a wrong impression, and we would beg leave to call his attention to them.

1st. When we said (LOCOMOTIVE, page 44 current volume) "In the best engine ever made more than one-half of the steam that goes into the cylinder passes through it without doing any work," we meant to express, approximately, the actual performance of the engine. Now with a boiler pressure seventy pounds per square inch above the atmosphere, a perfect *engine* would develop one horse-power with a consumption of $8\frac{32}{100}$ pound of steam per hour. In the best performance at this pressure of which we have a reliable and complete record, $18\frac{4}{10}$ pounds per I. H. P. per hour were consumed. So it will be seen that we were not so very far out of the way. It will also be seen that there is chance for great improvement in engines using even this low pressure, which we would also call attention to. We confess our complete ignorance of any theory which is capable of demonstrating that not more than one-eighth of the *available* heat of steam is utilized in the engine.

2d. "They are trying, with a fair promise of success, to reduce this consumption to fifteen pounds of water per hour. . . . To get this . . . they must have more than 100 pounds pressure."

Why must they? We have shown that at seventy pounds the consumption has been as low as $18\frac{4}{10}$ pounds, and that this is more than twice as much as a *perfect engine* using steam of this pressure would require, then why not devote more attention to the improvement of the engine?

We would by all means say to the engineers who are trying to improve the *engine*, "God speed and give you success," and would also add, we believe, you will "get there" sooner if you accept and try to utilize what the boiler has already given you. When that is *fully utilized* we shall be ready to abandon the tubular boiler for anything that will give further improvement.

We would also add that we believe steam of 180 pounds pressure per square inch is now furnished by the despised tubular boiler for the only quadruple expansion engines in existence, and believe if higher pressures are wanted tubular boilers can be built to supply it. H. F. S.

Moulding Sand.

Sands.—There are several essential qualities possessed by moulding sand which render it the most suitable material for casting metal into. It is readily made to assume any desired form from the pattern, or sweep, or templet guide employed; it is porous, and, therefore, conveys away the gases generated by the evaporation of the moisture in the mould; it exercises no very perceptible influence on the metal itself, neither chilling it in mass, nor affecting its properties as a metal, since no chemical combination takes place between the two. It is cheap, costing a few shillings per ton only; and it is found plentifully in all parts of the world. By judicious selection and mixture, sand of any quality can be obtained, light, porous, free; or heavy, dense, strong; suitable either for the very lightest castings, or for those weighing several tons. Lastly, according to the presence or absence of moisture, it is coherent, retaining the form imparted to it, or loose and friable, being therefore in a condition for mixing readily with sand having other and opposite qualities. Good sand should be free from dirt and foreign matters generally, be of a uniform color in its natural condition, and when squeezed in the hand while damp, should cohere, and retain the shape imparted to it.

Moulding sands are obtained in the coal measures, the new red sandstone, and the green sand and chalk. Local foundries largely use local sands, so that a knowledge of the precise mixing of sands for any one locality has to be acquired there, and the experience thus gained is modified to be of service when the sands of another locality are employed. Nevertheless, there are certain general principles to be observed in the mixing and use of sands which apply to all alike.

The floor of a foundry is covered to a depth of from 2 ft. to 3 ft. with "floor sand," "moulding sand," or "black sand." This consists of the accumulations of sand used over and over again, as long as the foundry has been in existence, and has lost the special characteristic of "strength," retaining, however, that of moderate cohesion when damped. It is, therefore, "weak sand," and is used only for mere "box filling," or for making rough, open sand moulds.

The actual sand which is rammed around and in immediate contact, with the pattern, is termed "facing sand," because it forms the actual faces of the mould, against which the metal is poured. This is the true moulding material, on whose composition and character the quality of the casting itself depends in a very large measure, and which is varied by the skill and experience of the founder to suit different classes of work. Facing sands are made to vary in strength, porosity, and binding qualities, for different kinds of work, the reasons of which will be apparent as we discuss the different kinds of moulds. Belfast sand and Lanarkshire sands are used in Scotland, Erith sand about London, and in the northeast parts of England. In Derbyshire, Lancashire, Shropshire, Cheshire, at Falkirk, Devizes, Worcester, and other localities, sands suitable for foundry purposes are found. Some of these sands are more porous and sharp than others, and being "open," are suitable for light, thin castings, being more or less self-venting. Some of the more open sands are used alone, but most kinds require tempering by admixture with those of opposite qualities, in order to fit them for their specific uses. Thus, "strong sands," or those having a good body, or closeness of texture, are mixed in variable proportions with the open sharp sands, and by varying their proportions, sand, like iron, can be obtained in any required grade.

When molten iron is poured against sand the latter becomes "burnt," and the casting is roughened in consequence. Hence all facing sands are mixed with coal dust, the purpose of the latter being to prevent the burning of the metal into the sand, or, to speak more correctly, the fusing of the surface of the sand by the heat of the metal. The coal dust, being oxidized, interposes a protecting film of gas between the metal and the sand. Hence, the heavier the casting, and, therefore, the more prolonged the excessive temperature to which the sand is subject, the larger the proportion of coal dust employed. For the lightest castings it is scarcely required. The proportion of coal dust varies from one of dust in fifteen of sand for moderately light castings, to one in six or eight for the heaviest. In the use of facing sands the moulder has to exercise his judgment, and even in a single mould it is often advisable to employ sands of different textures, as, for instance, a more porous sand at those points where the metal beats longest, and closer sand, well vented, in parts subject to much pressure. When the metal has been poured, the coal dust becomes burnt out, and after the casting is withdrawn, the baked sand is then mixed with new sand and more coal dust, damped with water, dug over and used again; or the burnt sand is allowed to remain on the floor, and all new facing sand mixed.

Dry sand is a strong mixture, which is used for a better class of moulds than green sand. It is also specially adapted for heavy work. Less gas is generated by the use of dry than of green sand, and the mould is, therefore, safer. It is mixed damp and rammed like ordinary facing or moulding sand, but is dried in the core stove previous to casting. Being dried, it is hard, and will stand a greater degree of liquid pressure, approximating in these respects, and in being mixed with horse dung, to loam. But it differs from loam in containing coal dust, and in being rammed damp, like green sand, around a complete pattern.

Loam is a mixture of clayey and of open sands ground up together in proportions varying with the essential nature of those sands. It is a strong mixture, which is wrought wet, and "stuck up" while in a plastic condition, and being afterwards dried, forms a hard compact mould. The close texture of the loam is not vented, as is usual with green and dry sand moulds, with the vent wire; but certain combustible substances are mixed and ground up with the sand, and these, in the drying stove, become carbonized, leaving the hard mass of loam quite porous. The material usually employed is horse dung, containing, as it does, a large proportion of half-digested hay. Straw, cowhair, and tow are also employed, but the horse dung appears to be almost universally made use of. Loam is used in different grades, according as it is for the rough sweeping up of a mould, and for bedding in the bricks, or for facing and finishing the surface. Old loam, that is, the best unburnt portions stripped from moulds which have been cast in, is also ground up again with new sands, and used both in loam and dry sand mixtures. Loam, unlike the other mixtures, has no coal dust mixed with it.

Core sand is variously mixed. For light and thin casting it is open and porous, being chiefly and entirely moulding sand, and having just sufficient cohesiveness imparted to it by the addition of clay water, peasemeal, beer grounds, or other substances, to make it bind together. But for heavy work, and work which has to stand much pressure, strong dry sand mixtures, having horse dung, are used. It is always rammed damp, like moulding sand, and dried similarly to dry sand moulds. "Stuck up" cores are made with loam.

Parting sand is used for strewing between the joint faces of moulds, in order that they shall separate readily; that is, without tearing or damaging the mould faces at their line of separation. Its value consists in its non-absorption of moisture, so that it forms a dry, non-adhesive stratum between damp and otherwise coherent faces. New red sand which has been burnt or baked, or red brick-dust, or burnt sand scraped off the surface of castings, are all used. Parting sand is simply strewn lightly and evenly over with the hand.—*Industries.*

Too Much Enterprise.

Omniscience is the foible of the daily press. There is nothing dearer to it, except, perhaps, the appearance of omniscience. The possession of the real article might impose onerous responsibilities; but the *simulacrum* is very handy. And if there is anything which the parties concerned do not desire to make public, that is the very thing which a truly enterprising newspaper must profess to know.

People are frequently at a loss how to deal with the ubiquitous and inquisitive reporter, and sometimes (though it is both a wicked and a hazardous business) they "stuff" him. It is not often, however, that after being thoroughly stuffed he is put on exhibition. An illustrious instance of this rare occurrence was furnished a few days ago.

On Saturday, April 23d, the Philadelphia *Press* beat all its contemporaries with a report of what it called the meeting of the "National Bridge Builders' Association." That there is no association in existence under that title is an unimportant matter of detail. That the list of eminent gentlemen named as present could not by any possibility have come together as representing the bridge manufacturers of the country, is another trifle. But these introductory features were in perfect harmony with the report of the proceedings, which is as follows:

"Mr. —— presided, and Mr. —— was secretary. A report was made by these gentlemen on the Bussey bridge disaster, near Boston. They believed that the bridge had never been properly stiffened; had found that the original erection was faulty; that the parallel rods were put in the wrong positions, the effect being to reverse the design of the bridge, throwing the compression into the top chords and the tension into the bottom chords, when the reverse should have been the case. No provision had been made, either, to prevent longitudinal motion of the bridge when air-brakes should be put on in crossing.

"The matter of the Inter-State Commerce Bill was informally discussed, and the opinion was freely expressed that the railroad companies were taking advantage of it to demand exorbitant rates.

"Another question considered was the comparative merit of hot and cold blast in the manufacture of bar iron and steel.

"Probably the most important matter, however, that came up, was that of specifications. The car-builders of the country some time ago adopted specifications of their own independent of those of the railroad companies, and these were afterwards adopted by the latter. The bridge builders have already adopted these specifications, and reports showed that contracts based upon them are gradually being accepted by the railroad companies. It was the general opinion that the requirements were too high for the moment of inertia.

"Mr. —— strongly urged that the builders disregard the moment of inertia and substitute for it the formula for radius of gyration. The prevailing inclination was strongly in favor of this change, and it was practically decided to make it. ——— and ———, however, were appointed a committee to consider the point more fully. The understanding was that the committee should call another meeting when they were ready to report."

The intelligence and *vraisemblance* of this report staggers criticism and beggars admiration. We have suppressed, in reprinting it, the names of the distinguished experts mentioned. It might make them too proud to give them full credit for the views ascribed to them, and people who hold such views really ought to be modest, as becomes true originality. Besides, there remains the haunting thought that these persons were not present, did not boldly propose to substitute the radius of gyration for the moment of inertia, and might sue us for libel (so perverse are the minds of some men!) if we attributed such revolutionary sentiments to them. We must confess that the proposed use of the radius of gyration would be revolutionary; if it does not actually postpone our moment of inertia, it seriously shakes our center of gravity.

The adoption of the car-builders' specification is another bold proposition; and the explanation of the Bussey bridge disaster is too good for ordinary use. It ought to be saved for a jury, and illustrated with models, parallel bars and all. As to the comparative merit of hot and cold blast in the manufacture of bar iron and steel, it is a thousand pities that the mind which conceived this question did not also furnish the answer. What is the good of agitating the technical world with such thoughts, only to leave it, in its perplexity, to go on making bar iron and steel without any blast — thus paralyzing, as it were, a great industry ?

There is a rumor about that there *was* a meeting in Philadelphia, week before last, of the "American Bridge Manufacturers' Association" ; that the topics discussed were of private business only; that reporters were not admitted, and that the astonishing revelations made by the *Press* are the result of a practical joke played upon its too persistent representative. We do not vouch for this report, but we must confess that it has a certain air of probability. If it be true, it suggests to the conductors of daily papers the advisability of combining with extraordinary enterprise, ordinary intelligence. — *The Engineering and Mining Journal, May* 7th.

Simple Test for Wall Paper. — A simple and easily applied test for wall papers has been devised by Mr. F. F. Grenstted. No apparatus is needed beyond an ordinary gas jet, which is turned down to quite a pin point, until the flame is wholly blue. When this has been done, a strip of the paper suspected to contain arsenic is cut one-sixteenth of an inch wide and an inch or two long. Directly the edge of this paper is brought into contact with the outer edge of the gas flame a gray coloration, due to arsenic, will be seen in the flame (test No. 1). The paper is burned a little, and the fumes that are given off will be found to have a strong garlic-like odor, due to the vapor of arsenic acid (test No. 2).

Take the paper away from the flame and look at the charred end — the carbon will be colored a bronze red ; this is a copper reduced to carbon (test No. 3). Being now away from the flame in a fine state of division, the copper is slightly oxidized by the air, and on placing the charred end, a second time, not too far, into the flame, the flame will be colored green by copper (test No. 4). By this simple means it is possible to form an opinion, without apparatus and without leaving the room, as to whether any wall paper contains arsenic, for copper arseniate is commonly used in preparing wall papers. Tests one and two would be yielded by any paper containing arsenic in considerable quantities. — *British Medical Journal.*

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

New Series—Vol. VIII. HARTFORD, CONN., JULY, 1887. No. 7.

Limit of the Fire Surface of Boilers.

We have often pointed out the fact that if the fire-line of a boiler is above the water line, that is, if the setting is carried above the water-line before it is closed in to the shell, it is almost certain that the boiler will be injured, if not ruined sooner or later by the action of the fire upon that portion of the shell which is unprotected by the water. When boilers have been set in this manner trouble has almost invariably resulted, and many explosions have been caused directly by it.

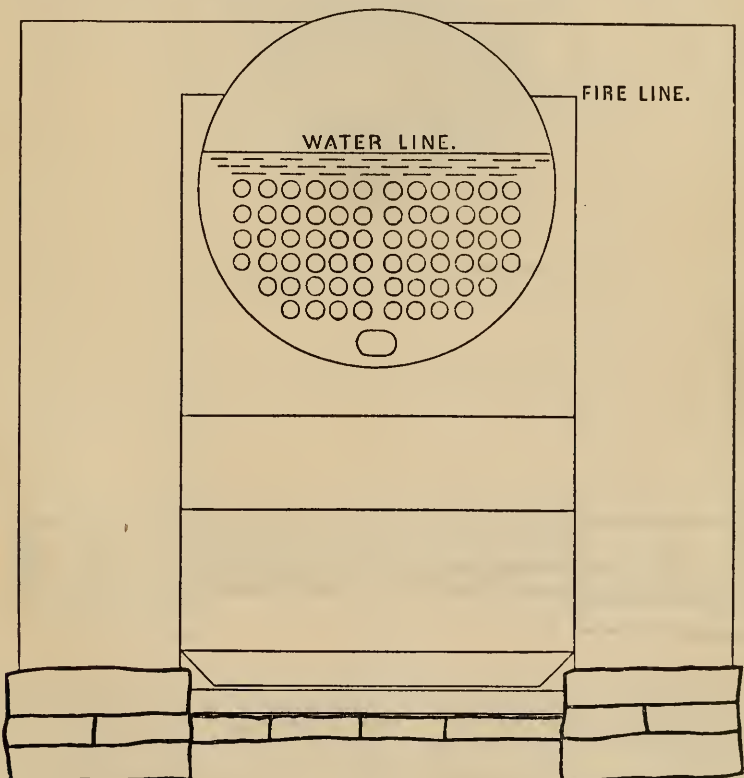

Fig. 1.

There are several methods of setting boilers so that portions of the shell unprotected by the water are exposed to the direct action of the fire. Varying amounts of the shell may be thus exposed in the various styles put forth, according to the construction. The inventors and advocates of some of them base their claim for advantage over common settings on the fact that they obtain in this manner a greater amount of heating surface; others claim for the same thing advantage resulting from superheated steam. In considering these claims it is evident that we need only bear in mind the two simple facts that heating surface, in order that it may act as such, must have fire in contact with one side and water in contact with the other, and that it is simply impossible to superheat steam when it is in contact with the large surface of water ordinarily presented by the disengaging surface of a horizontal tubular boiler. It is evident that whatever may be the claims made by advocates of such settings, the results will be the same in all cases, the difference being one of degree only, not of kind.

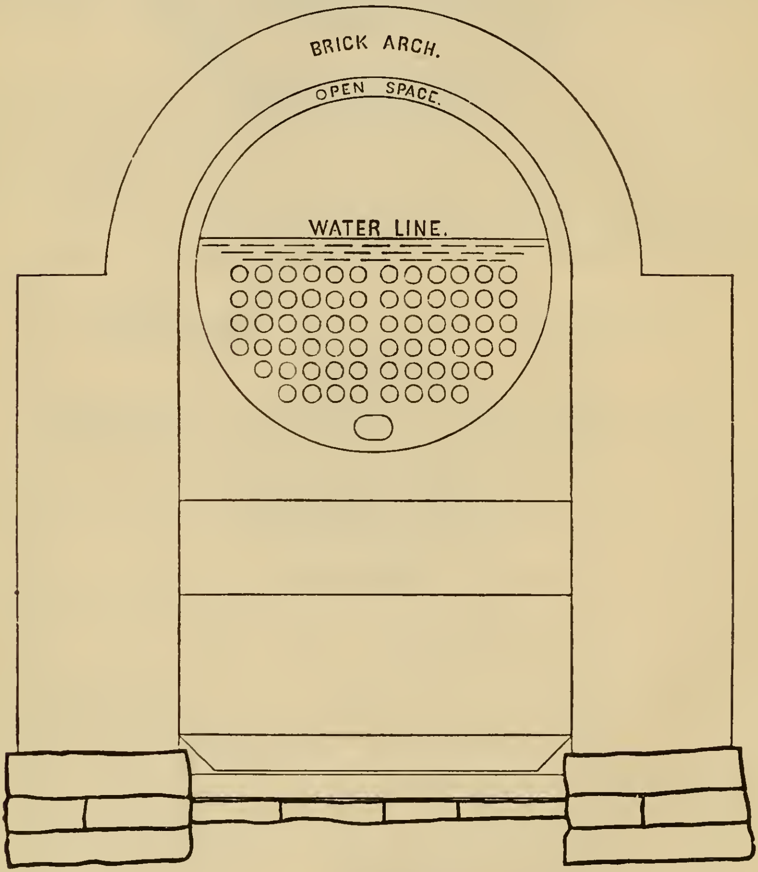

FIG. 2.

Our illustrations this month show the principles embodied in some of these settings which have been most extensively used. We publish them that our patrons may know what to avoid.

Figure 1 is a transverse section of a boiler and setting showing the most usual method of "stealing heating surface," as it is usually denominated. In this case the setting walls are simply carried up from six to twelve inches above the water-line before they are closed in to the shell. The strip thus obtained of the width stated above, evidently embraces two sides and the back head of the boiler, and is usually reckoned as heating surface, but as we stated above, it cannot be effective for there is no water on the inside of the shell at this point to absorb the heat in contact with the outside. The only effect resulting from the application of heat here is to burn the shell. If the operation is continued long enough there is danger that the shell may be so weakened that explosion may result at the ordinary working pressure.

Damage to boilers set in this manner is especially apt to occur where natural gas is used for fuel. The specific gravity of this gas seems to be less than that of the ordinary gases arising from the combustion of coal; at any rate, where it is used we have always observed a much greater volume of flame hugging the upper portions of the shell than is the case when coal is burned. Add to this the fact that where gas is used the actual

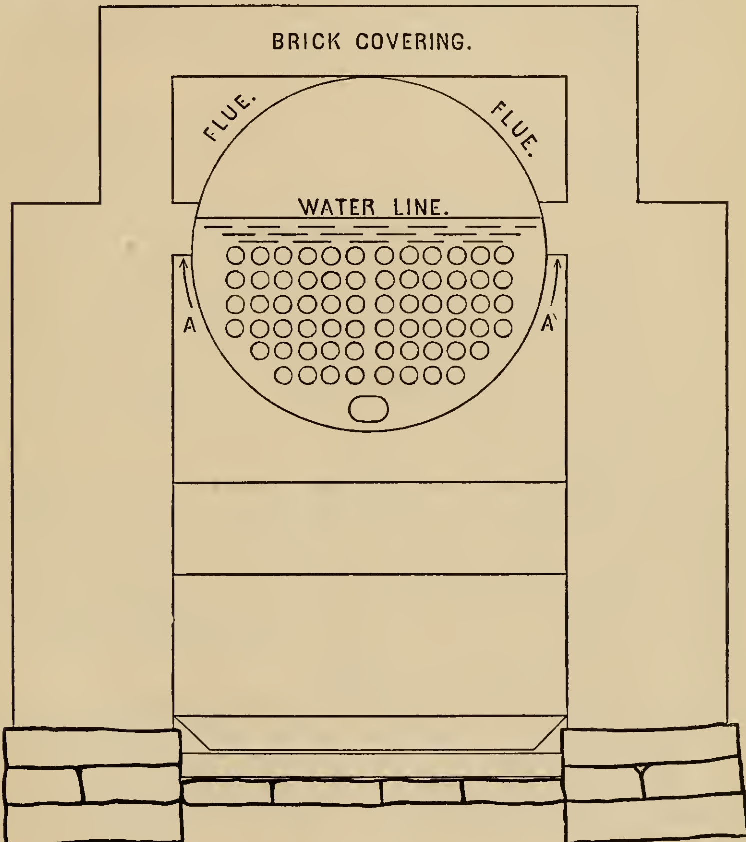

Fig. 3.

duty of the boilers, or the work they are forced to do, is usually much greater than it is where coal is burned, and we have some indication of the much fiercer heat obtained, and the correspondingly greater danger where any portion of the shell, unprotected by water, is exposed to the furnace heat. Much trouble from this cause has already resulted in the districts where natural gas is used, and we cannot too strongly urge upon boiler owners the absolute necessity that exists in such cases for keeping the fire line at least *as low* as the water line, it had *better* be a few inches lower, then any accidental lowering of the water-line of a few inches, liable to occur at any time and with the best obtainable care, will not be so likely to be attended with disastrous consequences.

Figure 2 is a section through a setting once in vogue throughout the country, where the whole shell was exposed to heat, an arch being turned over the top of the shell, a space of several inches extending entirely over the top of the shell, and in free communication with the furnace. This setting is not much used about this part of the country at the present time; it very soon demonstrated its dangerous tendency to corrugate the tops of boiler shells wherever it was applied. We would not have mentioned it were it not for the fact that a slight modification of it is being pushed in some sections of the country at the present time. We can only express sympathy for those who have been persuaded to have their boilers set this way, and would especially caution them not to burn natural gas with such a setting. In at least once instance a boiler set this way, and fired with natural gas, exploded the first time it was fixed up, killing the engineer, and demolishing the boiler and engine-room, the sole cause lying in the setting, which permitted the entire upper-half of the shell to become red hot, in which condition it, of course, had not sufficient strength to resist the pressure.

Figure 3 is a section through another form of setting, a favorite with many, and certainly not so objectionable as those shown in figures 1 and 2. The products of combustion, after passing underneath the boiler to the back end, return through the tubes in the usual manner, but instead of being led from front end to chimney, they are passed back over the shell to the rear end of the boiler, thence taken to chimney, the object sought being to dry or superheat the steam. So long as the setting remains in good order, with the side walls in close contact with the shell, and the water is good, no particular trouble need be apprehended from this form of setting. But if the setting becomes shaken so that the side walls become separated even but a slight distance from the shell, then trouble begins, for the fire will take a short cut up the sides of the shell at A, A′, into the overhead flue, it being the most direct route to the chimney, and in addition to destroying the efficiency of the boiler, the shell will always be burned unless it is very soon attended to. With some waters also, even when the setting is in perfect order, there will be just enough heat passed over the top of the shell to cause the most astonishing amount of corrosion in the steam space, the writer having seen boilers running less than a year, with the shells eaten fully half way through by actual measurement, due to this cause alone, while in the same room and running under exactly the same circumstances otherwise, with the exception that there was no flue over the top of the shell, were other boilers which had been running for fifteen or sixteen years, and were perfectly sound. Of this setting we can only say, we see no advantage to be gained by adopting it, while there is a chance that serious damage may be done.

Of course it should be borne in mind that with either of the foregoing settings, the damage is most likely to be done to shell when a boiler is fired up after being stopped for a time. At this time, before steam is up and the boiler is working at its ordinary rate, there can be no circulation or passage of steam over the overheated surfaces, so that whatever power or capacity steam may possess under such circumstances to prevent overheating of the shell by the absorption of the surplus heat, cannot be exercised at this time.

Inspector's Reports.

MAY, 1887.

In the month of May, 1887, our inspectors made 4,430 inspection trips, visited 8,227 boilers, inspected 3,694 both internally and externally, subjected 459 to hydrostatic pressure. The whole number of defects reported reached 9,414, of which 936 were considered dangerous; 54 boilers were regarded unsafe for further use. The defects in detail were as follows:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment, - - - -	603 - -	74
Cases of incrustation and scale, - - - -	922 - -	58

Nature of Defects.	Whole Number.	Dangerous.
Cases of internal grooving,	39	10
Cases of internal corrosion,	248	42
Cases of external corrosion,	382	39
Broken and loose braces and stays,	377	72
Settings defective,	226	28
Furnaces out of shape,	227	12
Fractured plates,	192	64
Burned plates,	137	41
Blistered plates,	298	15
Cases of defective riveting,	3,519	144
Defective heads,	52	14
Serious leakage around tube ends,	917	92
Serious leakage at seams,	634	75
Defective water-gauges,	112	59
Defective blow-offs,	59	15
Cases of deficiency of water,	14	3
Safety-valves overloaded,	32	8
Safety-valves defective in construction,	38	13
Pressure-gauges defective,	347	48
Boilers without pressure gauges,	6	2
Defective hangers,	26	3
Defective man-hole rings,	6	4
Defective dome construction,	1	1
Total,	9,414	936

A defective blow-off is always a serious defect. If it is in such a condition that it won't hold water, it is of course dangerous. All kinds of valves, whether straightway, globe, or any other form of construction yet devised for valves, are unsuitable things for closing blow-off pipes. They all have the grave defect that pieces of scale or other hard substances are liable to get under the valve and prevent its closing, and there is no way to tell whether this has happened in any particular case except by examining the end of the blow-off pipe after the valve is supposed to be closed, to see whether it leaks or not.

Plug-cocks as they are ordinarily made are always giving trouble by leakage; pieces of scale or other gritty substances cut the plug and body, they are liable to stick so that it is with great difficulty they can be opened, and various other things make them a source of much trouble, but for all this it is positively known at any time by a simple inspection of the plug itself whether it is shut or not, and the amount of leakage, if there is any, generally shows for itself around the plug, so we are inclined, in spite of its grave defects, to give preference to the common plug-cock over any form of valve, as a means of closing blow-off pipes.

But an improved form of plug-cock has within a few years been put upon the market (originally devised in England), which is without question superior to anything else for blow-offs. It is made of iron, is protected from corrosion, by Prof. Barff's process, and is packed with asbestos. Wherever it has been tried it has given most satisfactory results, and is undoubtedly the best blow-off valve made.

Rich Soil.—The only stockholder that ever got a dividend out of the old Farmington (Conn.) Canal has just died. The president told him that there was no dividend, and no prospect of any, and jestingly advised him to go home and mow the towpath for a dividend. Mr. Munson did so, taking a 20 per cent. dividend in hay from the eight miles of towpath, and went on doing this with perfect complacency thereafter.—*R. R. Gazette.*

Boiler Explosions.

MAY, 1887.

PORTABLE BOILER (64).—A boiler explosion occurred May 1st, near the corner of Avenue A and Delevan avenue, Buffalo, N. Y. It is at this point that the Belt Line Stone and Land company is engaged in quarrying stone. The boiler used in the pumping of water from the quarry exploded with terrific force. It went crashing through the timbers of the shed in which it was enclosed as if the structure were made of paper and was thrown a distance of seventy-five feet. The engineer, Frederick Zimmerman, had left the shed but a few seconds previous to the blow-up and thus probably escaped death. Fortunately no one was hurt in the least. The loss will amount to about $500.

TOW-BOAT (65).— The tow-boat *J. C. Richer*, exploded her boilers while passing Wood's Run below Pittsburg, Pa., May 2d. A man named Hayes was instantly killed, and two others whose names are as yet unknown, were fatally injured. Engineer James Campbell and the fireman were fatally scalded. Hayes's body was blown to fragments. The steamboat is badly shattered.

SAW-MILL (66).—A terrible explosion of a boiler occurred at Glencoe, in New Trier, twenty miles from Chicago, Ill., May 3d, which resulted in the death of two persons. Two miles west of Glencoe is a patch of timber in which Charles Harms, a milkman who resides at 198 North Desplaines street in this city, was engaged in preparing railroad ties, using a circular saw. There were four men at work, and when the two who were the farthest away recovered from the shock, they found that Alfred Harms, the son of the owner, and Charles Carroll, the engineer, had been instantly killed.

LOCOMOTIVE (67).— As a switch engine, in charge of engineer Berdell and fireman W. D. Bates, was coming out of the Belle Dock round-house at New Haven, Conn., May 3d, the boiler exploded. The engineer, fireman, and several other employees were badly hurt. The shock was felt throughout the lower part of the city. The injured are: engineer Berdell, firemen William Booth and W. D. Bates, John Askell, Roger Feely, Edward Reynolds, and Michael McNulty. The round-house was wrecked and two other locomotives near by were badly damaged. The loss to the railroad company will exceed $20,000.

PAPER MILL (68).— The boiler of the Richmond Paper Manufacturing Company's mill, Richmond, Va., exploded May 14th, totally demolishing the engine-house, and scattering brick and timbers in all directions. The only person reported killed is Charles Mettert, son of a watchman at the paper mill, who had gone to see his father.

SAW-MILL (69).— A boiler at the saw-mill of Betz & Morrison, Gallipolis, Ohio, exploded May 17th, wrecking the mill and injuring five men, three fatally. James Salgue, fireman, had a leg broken, and is terribly scalded; James Valentine, scalded nearly all over; John Dray, leg crushed and scalded from head to foot; Jesse Stone, bad cuts and bruises on the head. Charles Brown happened to be in the mill at the time of the accident and had his brains blown out.

SAW-MILL (70).— A special dispatch from Fulton, Ky., reports the explosion of the boiler in the furniture manufactory of Lecornu & Brothers, May 19th. The disaster resulted in the death of John Rascoe, teamster; Fred George, foreman of the factory, and Lucien McLauren, engineer. A half-dozen people were severely injured, among them James D. Lucas, who, it is thought, cannot recover. Portions of the boiler fell a quarter of a mile away. The factory is a total wreck.

SAW-MILL (71).— Pablo Crispiv's saw-mill in Cañon Largo, thirty miles east of Albuquerque, N. M., was the scene of a terrible boiler explosion, May 22d, which entirely destroyed the property. The men went to work at 7 o'clock, and at 8.30, while the eight employees of the mill were engaged in their usual occupations, the explosion tore the building from its foundations, splintering the heavy timbers, and threw the debris into the gulch over which the mill was built. Five men were in the sawdust pit, and these escaped, though their injuries are serious. Two men were hurled into the air as if shot from a catapult and dashed to the earth a hundred feet away. They were picked up lifeless. Their bodies were frightfully mangled, their limbs broken and heads crushed. Thomas Vataw, a sawyer, was thrown a considerable distance.

Mine (72).— The boiler at an iron mine at Hurley, Wis., exploded May 23d. No one was injured.

Saw-Mill (73).— By the explosion of a boiler in a portable saw-mill near Leisenring, Pa., May 25th, James Naylor was killed, and the proprietor and Alexander Work were badly, but not fatally, burned and cut. Naylor's remains were horribly mangled.

Cotton Mill (74).— The boilers in the Natchez cotton factory, Natchez, Miss., exploded May 28th, tearing to pieces the engine-room, picking-room, and the center portion of the main building, burying many beneath the ruins. The mill started to work at six o'clock, and was under full headway at the time the accident occurred. Over two hundred and fifty hands were at work, and out of this number there are five killed. In less than ten minutes after the explosion the firemen were at work removing the debris and looking for those buried beneath it. The first one brought out was A. R. Foster, whose head and body were so badly bruised that he died in a few moments. The next one was Jesse Heathcock, who was so badly injured and scalded that he expired in a short time. Ernest Alexander (colored), the driver of a coal cart, was instantly killed by scalding water and steam. Marion Price was taken out badly injured, and will die from his injuries. George McNeill was dug out with his head crushed to a jelly. Emma Scott was the only one of the female hands badly hurt. She was caught by falling timbers and had both of her legs broken. Many of the girls jumped out of the windows, receiving slight injuries by so doing. Mamie Printt jumped from the third story window, holding a bale of batting under her. She, too, received but slight injuries. John Anderson, Tom Anderson, E. Jenkins, and several others are badly injured, but the physicians think they will recover.

Saw-Mill (75).— The boiler of a saw-mill near Columbus, Ga., exploded May 28th, killing two men and injuring one other.

Wagon Manufactory (76).— The boiler of the Hitchcock Manufacturing Company at Cortland, N. Y., exploded May 30th, demolishing the engine-room and part of the blacksmith shop, and burying three men in the debris. Clifford Fuller was taken out of the ruins dangerously injured, and Frank Scott was found with his head crushed and cannot live. Bricks and large pieces of iron were thrown 300 feet. H. A. Webster's body was taken from the ruins at ten o'clock. Life was extinct. He was one of the firemen. W. P. Ballard, and a man named Couch were seriously injured. The cause of the explosion is unknown.

Grain Elevator (77).— The boiler on the elevator at the foot of Twentieth street, Huntington, W. Va., exploded May 30th, killing T. H. Reece, aged 45, and married, John Kelly, single, and W. K. Albertson, married, and badly injuring John Cox, engineer, George Newman, boss of the gang, and Chauncey Bossinger, son of H. C. Bossinger, one of the Chesapeake & Ohio foremen, besides a dozen or more others whose wounds are not considered dangerous. John Perry is known to be missing, and as there were about thirty men on the elevator at the time, the bodies of others will likely be found. A skiff is now dredging. The engine was run by an old locomotive that had been condemned, and the engineer was inexperienced. The elevator was the property of the Chesapeake & Ohio Company, and is completely wrecked. Several box cars which were waiting to be loaded, and barge *Philo*, full of corn, were damaged.

Locomotive (78).—A locomotive boiler exploded at Ironton, Ohio, May ——, fatally injuring William Mundell, the engineer.

Tug-boat (79).—The boiler of the tug *Whale* exploded May 31st, while towing a raft down the Little Kanawha, near Parkersburg, W. Va., killing the engineer, Peter Walters, injuring the fireman, Jackson Smith, fatally, and blowing off the right arm of a ten-year old son of the engineer. The cause of the explosion is not known.

Saw-Mill (80).—One of the boilers in Cannon & Shipman's mill at Turnbull's lake, four miles west of Big Rapids, Mich., exploded May ——. No one was seriously injured, though the fireman and engineer were near the boiler when the explosion occurred.

Dredge (81).—A defective boiler on a sand dredge owned by the Craig & McRoberts Sand Company, Kansas City, Mo., exploded May 28th, hurling engineer William Ross twenty feet into the river and throwing debris and pieces of timber on to the river bank at the foot of Lydia avenue. The boat was a total wreck.

Photographic etching upon box-wood blocks, such as are used in wood engraving, has been deemed a practical impossibility. We learn, however, that it has recently been accomplished in Russia, and by a method simple and ingenious. The block in its natural condition is of course unsuitable. The first step is to fill its pores with insoluble carbonate of copper, by means of two separate solutions, in which it is boiled sufficiently. A polish is then imparted to its surface, asphalt in solution applied to its back and sides, and finally a sensitized gelatine film placed over the polished face. The subject to be etched is now photographed on the surface, and, by washing, the soluble and unprinted parts of the gelatine removed. A coating of asphalt is next applied to the raised parts, the block steeped in nitric acid of suitable strength (the stronger the better), where it remains one hour, when it is removed and subjected to the action of sulphuric acid for the same time. The portions unprotected are thus changed into nitro-cellulose, which by brushing is readily removed in the form of a greenish powder. To complete the process, the block is dried, and briskly brushed with a stiff brush. The asphalt is lastly removed with benzine and the block is ready for press. The practical value as to depth and retention of details, we cannot state. It is an innovation, however, that may prove worthy of attention.—*Exchange.*

Using a Locomotive for a Boot-jack.—"It is not very often you hear of a man using a locomotive for a boot-jack," said an engineer on the Atlantic road last night, "but I happen to know of an interesting incident that occurred down in Indiana the past winter. Walt Coleman, a brakeman on a freight train, set out one bitter cold night to flag a passenger, just south of Hammond. He was out about two hours, and when he came back his fingers and ears were badly frozen. After we had got some whiskey down him and had rubbed his hands and ears in snow, we tried to remove his boots, but his feet were so badly swollen that they could not be pulled off. Coleman was an economical cuss, and he would not let us cut them off his feet. He said that the boots had cost him $7 but two weeks before, and he could not afford to lose them so soon, even if by so doing he would be relieved of his sufferings. It was finally agreed to take Coleman out to the locomotive, stick his boot-heels between the slots of the cow-catcher, and then back up. When everything was ready the engineer reversed his engine, while we clung to Coleman's arms and shoulders. The boots came off quick enough, but Coleman's legs came so near going with them that there was no fun in it. As it was, we had to cut the heels on the boots to save any portion of them. That was the queerest boot-jack I ever saw. It may appear novel to many other people."—*Chicago Herald.*

The Locomotive.

HARTFORD, JULY, 1887.

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

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

Paper manufacturers who use rotary bleachers or digesters are often troubled by the passage of the bleaching liquid and of rags from the bleacher back toward the steam boilers. Strange as it may appear, the use of check valves in the pipes supplying steam to the digester is not sufficient to prevent this annoyance. Rags will pass through check and reducing valves, to boilers fifty feet away. They have been found tightly forced into the springs of the pressure gauges used to register the reduced pressure, thus rendering the gauge inoperative. They also frequently find their way into the safety-valve, even though it be placed on the top of a vertical pipe several feet high, and by rendering it inoperative, introduce a grave element of danger. The use of any number of check valves seems only to diminish the trouble, it does not prevent it.

We would suggest as a remedy for the difficulty the use of two stop valves in the steam supply pipe, one located between the reducing apparatus and the boiler, and one between the reducing apparatus and the digester. When turning steam on to the digester, open the valve between steam boiler and reducer first, let the reducer and the pipe beyond it fill up to the proper pressure, then open the valve between reducer and digester. When shutting off steam, shut the valve between reducer and digester *first*, then the other one may be closed. We intend to illustrate the complete connection in an early issue.

"Short Talks by an Engineer," is the title of a neat little book of fifty pages, by John Erwood, M. E., of Chicago, Ill. It is addressed to proprietors of manufacturing establishments, and contains chapters on Steam Boilers, Heat Utilized, Boiler Explosions, Connections and Piping, Shafting, Belting, Steam Heating, Engines, etc., all of which subjects are succintly treated from a thoroughly practical standpoint. It is well worth reading, and contains more valuable points than some more pretentious works. The author's address is 125 So. Clinton St., Chicago.

Mechanics for June, is a splendid issue. Its first page is adorned with the portraits of all the presidents of the American Society of Mechanical Engineers since its organization. There is also a Supplement of fifty-four pages containing a complete report of the fifteenth semi-annual meeting of the above mentioned society, with abstracts of all the papers read, and the discussions thereon. We congratulate the publishers, the Journal of Progress Company, 907 Arch Street, Philadelphia, on the production of such a number, which alone is worth five times the subscription price for the entire year.

The Cornellian of '88, published by the junior class of Cornell University, just received, contains the usual college statistics, class histories, and good portraits of various officers of the University. It is very handsomely printed and bound.

The *Cornell University Register* for 1886–7, just received, is a well-printed pamphlet of 224 pages, containing the calendar, organization, and government, list of officers, catalogue of students, and very full and complete information relative to the courses of study, admission of students, and all information generally required by prospective students. Sent on application to the Treasurer of Cornell University, Ithaca, N. Y.

The *Boston Journal of Commerce* is publishing a very interesting and valuable article on the "Structure of Wool," being a report of Wm. McMurtrie on this subject, to the Department of Agriculture. Those interested in the question should not fail to read it.

Boiler Explosions in England in 1886.

The Annual Report of Mr. Henry Hiller, Chief Engineer of The National Boiler Insurance Company, Manchester, England, is at hand, and from it we extract the following relating to boiler explosions in the United Kingdom during the past year.

There were reported during the past year 32 actual explosions of steam boilers, causing the death of 30 persons and severe injury to 57 others. In 1885, 36 explosions caused the death of 30 persons and injury to 57, exactly the same number as the past year. In the five years ending December 31, 1870, there were 282 explosions causing 358 deaths, or an average per annum of 56.4 explosions, and 71.6 deaths; against an average per annum for a similar period ending December 31, 1885, of 37 explosions and 30 deaths —a decrease, compared with the above, of 34.4 per cent. in the number of explosions, and 58.1 per cent. in the number of deaths. Mr. Hiller justly observes that this reduction is doubtless due in a great measure to the efficient service rendered by the boiler insurance companies, and adds that the average could be much further reduced if the advice given by the inspectors were always heeded by the owners of the boilers.

Of the 32 explosions reported, the largest number, 19, occurred from defective condition of the boilers; 5 arose from mistake, negligence, or mismanagement; 5 from defects due to mal-construction or original weakness; and 3 from other causes. The explosions of vertical boilers with internal fire boxes heads the list, being 8, or one-fourth of the total of the year.

Of the six boilers which exploded from general deterioration two were vertical with internal fire boxes, one a Cornish boiler, one plain cylindrical, one balloon or haystack, and one of the marine type. The vertical boilers were both very old, and in both cases the explosions were caused by the collapse of the firebox. The Cornish boiler was also of great age and had never been properly inspected. The furnace tube was reduced by corrosion until it was too weak to withstand the required pressure when it collapsed. The plain cylinder boiler was entirely unhoused, and rain from an adjacent roof had fallen on it until it wasted away by corrosion until too weak to sustain the pressure. The Balloon boiler was corroded at the ring seam in the lower part, the bottom of the boiler was blown to fragments. The marine boiler was in a tug-boat. It had passed through various hands, and had been many times repaired in an improper manner. The shell was so weakened by corrosion that it gave way on the lower part of the shell. The tug-boat was destroyed, three persons killed, and four others injured.

External corrosion caused six explosions, four of the boilers being plain cylinders, one vertical with internal fire-box, and one Cornish. One of the plain cylinders was corroded at the back end, which was blown out; another had a tub for collecting rain water set above it, the leakage from the tub fell upon the shell and rusted it until it let go; the third was at an iron works, leakage at the feed valve caused the mischief; the fourth was corroded by the overflow from a tank situated above it.

Six explosions were due to internal corrosion. One was a locomotive boiler, two were portable boilers of the locomotive type, one Cornish, one vertical with internal fire-box, and one cylindrical one-flued.

The locomotive boiler exploded in consequence of internal grooving at a longitudinal seam, one of the portable boilers exploded from a similar cause. The other portable boiler failed at the upper part of the flanging of the fire-box and end plate. In the Cornish boiler the flue plates were so weakened by the corrosive action of the water used that the flue collapsed. The vertical fire-box boiler was so corroded by the action of the water that the fire-box collapsed. The one-flued boiler was only occasionally used; when not in use it was left with water lying in the lower part. This caused corrosion of the plates at this point until the boiler exploded from weakness.

The boiler of a traction engine exploded from a defective condition of the screw-stays in the fire-box. They had been defective for some time, and it was believed that an excessive pressure was on the boiler at the time of the explosion.

Four explosions were due to overpressure simply. Two of the boilers were of the vertical type with internal fire-boxes, one was of the marine type, the fourth was a portable of the locomotive type. One of the vertical boilers was in use at a steel works, and the safety-valve was rendered inoperative by dross from a converter falling upon it. The other vertical boiler was a donkey boiler on board a steamship. The safety-valve was found inoperative through the negligence of the chief engineer, and he was committed to trial for manslaughter. The safety-valve of the marine boiler was found jammed fast by a pin and loose plates inserted between the lever and the cover which rendered it inoperative. The tug on which this boiler was located was completely wrecked by the explosion, and six persons were killed. The portable boiler was of weak construction and it is believed the safety-valve was set at too high a pressure.

Two explosions of a minor character occurred through deficiency of water. One was a two-flued boiler fired by gas from a puddling furnace. The other was a Cornish boiler. In both cases the flues were overheated and ruptured.

Overheating through accumulation of deposit led to rupture of the "pot" inside the fire-box of a vertical traction engine boiler.

The total collapse of a tube and the combustion chamber of a "breeches-flued" boiler arose through their defective construction and weakness. The lower part of the chamber had stay-plates, secured by five-eighths inch bolts to angle irons, which were riveted to the shell, the bolts being removed to facilitate cleaning the bottom of the shell. The bolts were not properly re-inserted, and the shell with the furnace tubes attached were thrown forward, the back end plate and collapsed tube being thrown in an opposite direction.

The tube of a Cornish boiler about 30 feet long, 44 inches in diameter, was only three-eighths inch thick and unstrengthened. It collapsed at 40 pounds per square inch.

A brass dome on a vertical steam launch boiler exploded in consequence of being so located that it was repeatedly overheated, which reduced its thickness and strength.

Fracture at the seams caused the explosion of two cylinder boilers, both in use at collieries. The explosions in both cases were of great violence.

In addition to the above-mentioned explosions of boilers, there were eleven other accidents consisting of explosions of economizers, feed water heaters, stills, kiers, steam pipes, etc., which caused the death of 8 persons, and injury to 12 others.

RESEMBLES THE U. S. NAVY.— There is a little railroad running between Hillsboro and Chapel Hill, N. C., a distance of ten miles. It has a president, three vice-presidents, a secretary, an auditor, a general traffic manager, a general freight agent, a general ticket agent, a purchasing agent, a superintendent of motive power, and an assistant general manager,— 13 officers in all. It is said that when the telegraph wire is down the officers string themselves along the road, and all messages are passed along by word of mouth.

— *Exchange.*

Steam and Mud-Drum Connections.

While we deny the necessity for mud and steam-drums in many cases where they are used, we are aware that many experienced engineers claim them to be indispensable, and many boiler owners insist upon having them, and due regard must be paid to their opinions. At the same time if they will have them there is no reason why they should be connected to the boilers in such a manner that every joint is strained up to the point of chronic leakage, seams are ripped, and constant trouble ensues.

It is a very common thing to connect a steam or mud-drum to a battery of three or four boilers, by means of short, rigid cast or wrought iron necks, so rigid in fact that the least independent movement of one of the boilers is almost sure to start a leak, or break something. We submit that this is not right, and a sensible man will not recommend

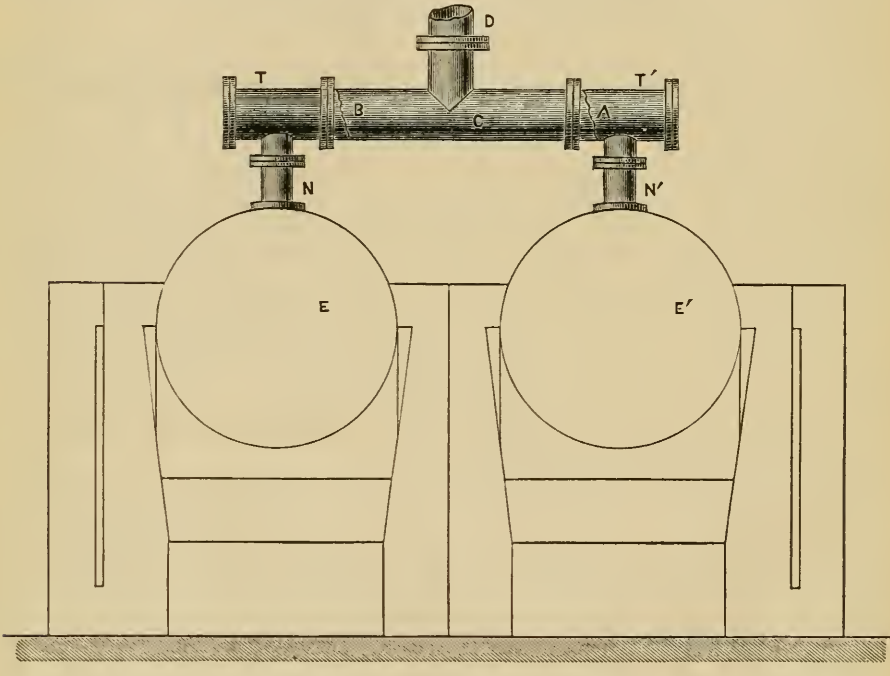

FIG. 1.

such a contrivance, especially when it is *easier* and *cheaper* to make a connection that will give no trouble. Numberless accidents have occurred from the use of too rigid steam connections, and always will occur so long as they are used.

In calling attention to this matter we cannot do better than to reproduce the cuts and substance of an article which originally appeared in our issue of July, 1885. The cuts scarcely need explanation, but we will mention the fact that if any one wishes a large steam-drum instead of the main steam-pipe, shown in Figures 2 and 3, it can be attached precisely as the pipe is attached, by simply putting either a screw or flanged nozzle on the side of the drum.

If one mud-drum is used for a battery of two or more boilers, the same principles should be observed in their connection.

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

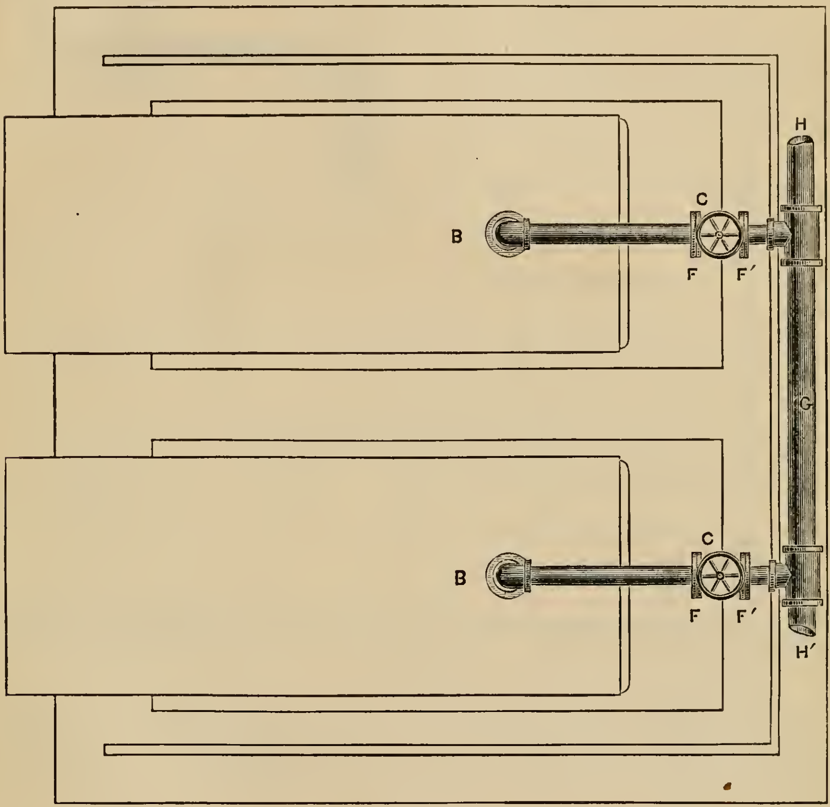

Fig. 2.

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

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

By this arrangement it will be seen that the movements of the boilers, and the piping itself are compensated for by the spring of the pipes, and no trouble will ever

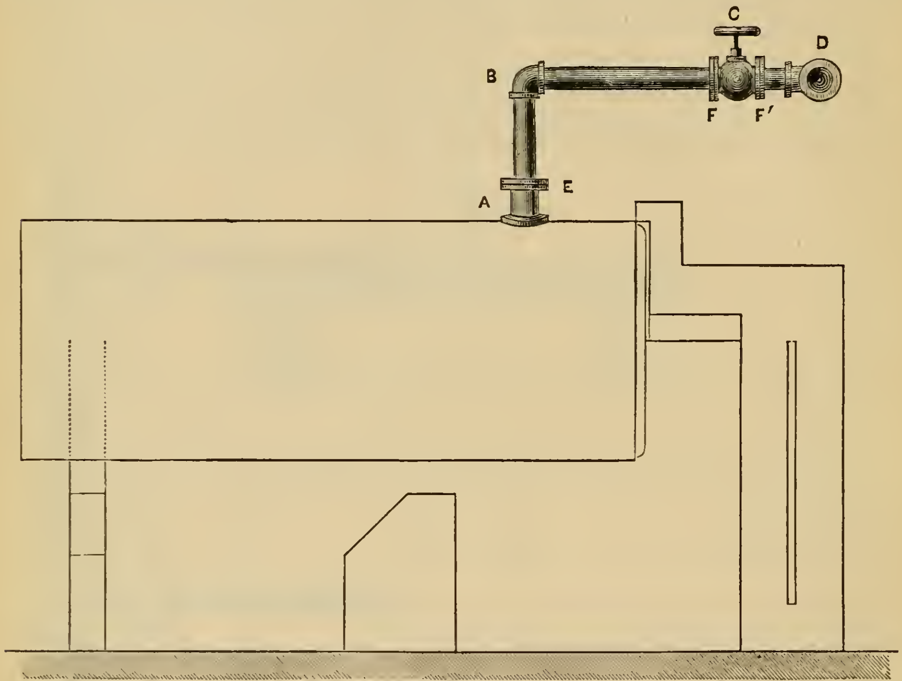

FIG. 3.

occur. The height of the risers should never be less than three feet, and when there are eight or ten boilers in one battery, they should be, if room permits, six to eight feet high, and the horizontal pipes leading to main steam-pipe should be ten to twelve feet or more.

Photography in Natural Colors.

Almost any silver solution brought into contact with almost any reducing agent, and then treated with HCl, gives rise to the formation of photo-chloride. Almost any chlorizing influence brought to bear on metallic silver has the same result. Or when silver is brought into contact with almost any oxidizing agent and HCl, it may be said without exaggeration that the number of reactions that lead to the formation of photo-chloride is much larger than that of those leading to production of normal chloride.

Exposed to ordinary diffused light, all the bright shades of silver photo-chloride quickly change to purple and purple black. The darker shades are more slowly influenced.

Mercuric chloride gradually changes it to a dirty white.

Mercuric nitrate dissolves it easily and completely, but apparently with decomposition, as it can only be recovered as white chloride.

Potassic chloride seems to be without effect.

Potassic bromide soon converts it to a dull lilac, which at the end of twelve hours showed no further change.

In contact with potassic iodide, the color instantly changes to blue gray; this change is produced by a quantity of iodide too small to dissolve even a trace of silver; the filtrate is not darkened by ammonium sulphide. With a larger quantity, silver is dissolved abundantly. By acting with renewed iodide solution, the substance continually darkens and diminishes until only a few black points, barely visible, are left.

Treated with dilute solution of potassium chlorate and HCl, the red substance gradually passes to pink, to flesh color, and finally to pure white.

The action of heat on the photo-chloride is very curious; its tendency is generally toward redness. Specimens appearing quite black are rendered distinctly purple or chocolate by heating to 212° Fah. in a drying oven. Often when the substance first separates by addition of HCl, it is pure gray; this gray will often be changed to pink by simply heating to 212°. (This happens when a gray form is produced; if the grayness is due to admixed metallic silver, it is only removed by boiling with nitric acid.)

The somewhat surprising change of color which is often seen when the crude substance is boiled with nitric acid (sometimes from dull dark gray to crimson) is due to three concurrent actions — that of the mere heat, the removal of the silver, and the breaking up of uncombined subchloride.

RELATIONS OF PHOTO-CHLORIDE TO HELIOCHROMY.

The photo-chloride was examined both with the spectrum and under colored glass.

The rose colored form of photo-chloride was that which gave the best effect. In the violet of the spectrum it assumed a pure violet color, in the blue it acquired a slate blue, in green and yellow a bleaching influence was shown, in the red it remained unchanged. The maximum effect was about the line F, with another maximum at the end of the visible violet, less marked than the one at F.

Under colored glass the colors obtained were brighter; under two thicknesses of dark ruby glass the red became brighter and richer. Under blue glass some specimens gave a fair blue, others merely gray. Under cobalt a deep blue was easily obtained, and under manganese violet a fine violet, very distinct in shade from the cobalt. Green produced but little effect; yellow was sometimes faintly reproduced, but rarely. But the yellow glass of commerce, even the dark yellow, lets through portions of nearly the whole spectrum, as can readily be seen by testing it with the spectroscope.

The dark purple forms of chloride do not give as good results as the rose and coppery shades. These last have many points of resemblance with the material of Becquerel's films — resemblance of color, probably of composition, as far as we can judge of the constitution of those films from their origin; they were far too attenuated to admit of analysis; and resemblance in the curious way in which their color is affected by heat, so that the conclusion seems inevitable that they are at least closely related.

There is certainly here a great and most interesting field for experiment; hardly any two specimens of photo-chloride give exactly the same results with colored light, and this suggests great possibilities. There is the very great advantage in this method over any previous, that the material is easily obtained in any desired quantity, and in a condition most favorable for experiment.

The action of light on proto-chloride can be a good deal affected by placing other substances in contact with it. Any substance capable of giving up chlorine seems to influence the action somewhat; ferric chloride often acts favorably, also stannic and cupric chlorides.

Evidently an important point in all heliochromic processes is that as white light must be represented by white in the image, it is an essential condition that white light must exert a bleaching action on the sensitive substance employed. Red chloride does not bleach but darkens in white light, but the property of bleaching, to a very considerable extent, may be conferred on it by certain other chlorides, and particularly by lead chloride and zinc chloride.

This I look upon as very important.

Another matter of interest is exaltation of sensitiveness, and this I find is accomplished in quite a remarkable way by sodium salicylate, the presence of which at least trebles the action of light on these substances, and probably on others.

I am persuaded that in the reactions which have been here described lies the future of heliochromy, and that in some form or other this beautiful red chloride is destined to lead eventually to the reproduction of natural colors. — M. Carey Lea, *in Am. Journal of Science.*

The Locomotive.

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Some Examples of Corrosion.

Our illustrations this month show the serious results that may and frequently do follow when the water supply for boilers is contaminated by sewage, by the contents of privy vaults, and other impurities of a similar character, which may either be discharged

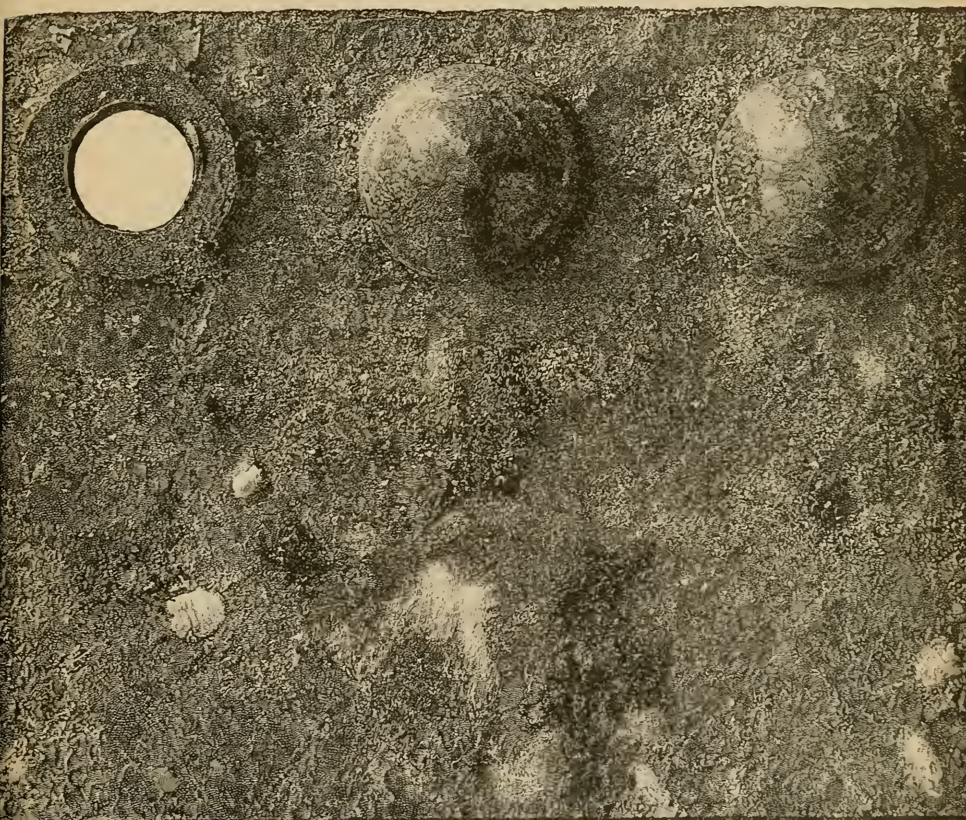

Fig. 1.

directly into the source of supply, or may filter through the ground into it by reason of leakage through walls or pipes, resulting from accidental breaks or imperfect construction.

Fig. 1 shows, nearly full size, a portion of a plate cut from the bottom of a boiler about fourteen months after it was put in new. It was eaten entirely through in several places. The surface where the corrosion occurred was found very rough and uneven, the character being very difficult to show in a wood cut; the original photographs show it much better.

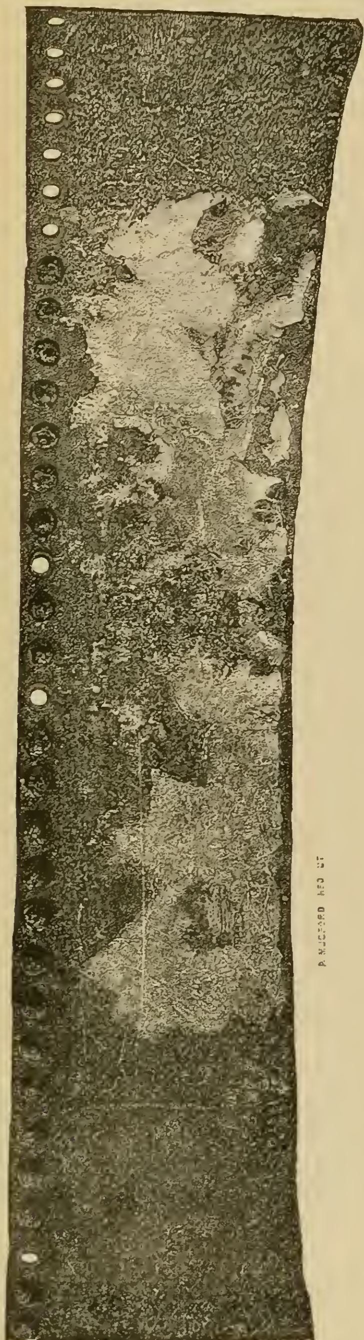

FIG. 2.

Fig. 2 shows the entire portion of the plate which it was found necessary to remove. The light colored portions show a scale formation, nowhere more than one-sixteenth of an inch thick, covering a portion of the plate, and the peculiarity of the corrosive action was it occurred only beneath this scale; those portions of the shell which were clean being as sound as they were the day they were put in. Corrosion arising from causes similar to those in this case is very apt to occur in a similar manner, and is very difficult to detect under most circumstances.

In Fig. 3 is shown a portion of a patch which lasted just twelve months from the time it was put on. The action was exactly similar to that which occurred in the preceding case, although the localities of the two boilers were widely separated. The engraver has admirably shown the nature of the corroded surface in this cut. The patch was eaten quite through, the corrosion taking place only beneath the thin coating of hard scale, similar to that shown on the plate in Fig. 2.

This corrosive action seems to be caused by the presence of ammonia in some form, probably as sal-ammoniac, which if concentrated to any great degree, forms a very active agent in the destruction of the plates.

In one of the above-mentioned cases the damage was attributed by the owners to the use of a patented boiler compound, designed to remove scale and prevent its formation. We do not think the facts in the case justified this conclusion; still it is possible that if the compound used contained sal-ammoniac the damage might be caused by it, as the chlorine contained in this substance would combine with the lime in the water, forming chloride of lime, while the ammonia would form with the other constituent of the scale, carbonate of ammonia, which would be very likely to attack the plates in the manner described.

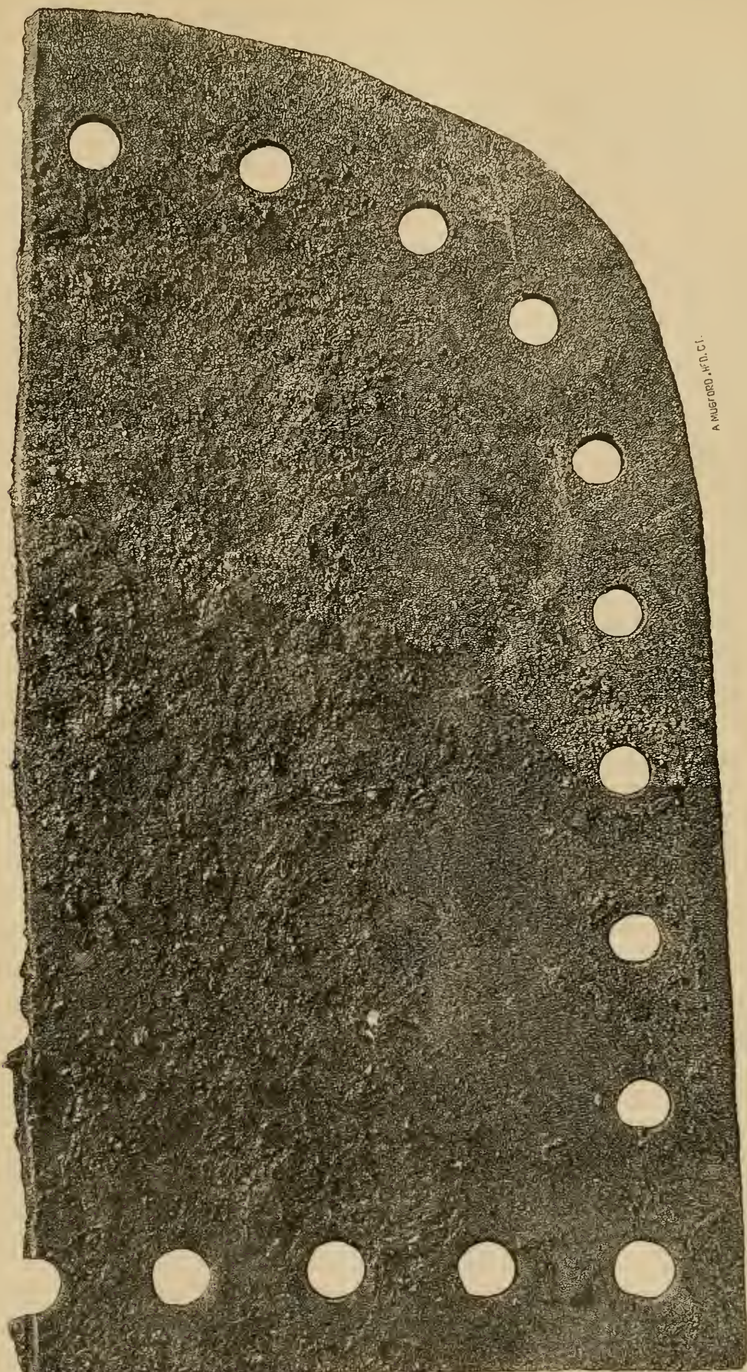

FIG. 3.

Inspector's Reports.

JUNE, 1887.

In the month of June, 1887, our inspectors made 3,879 inspection trips, visited 7,583 boilers, inspected 2,836 both internally and externally, subjected 475 to hydrostatic pressure. The whole number of defects reported reached 8,567, of which 938 were considered dangerous; 52 boilers were regarded unsafe for further use. The defects in detail were as follows:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	454	27
Cases of incrustation and scale,	663	39
Cases of internal grooving,	26	7
Cases of internal corrosion,	176	20
Cases of external corrosion,	330	48
Broken and loose braces and stays,	386	36
Settings defective,	147	9
Furnaces out of shape,	218	12
Fractured plates,	154	41
Burned plates,	84	13
Blistered plates,	220	16
Cases of defective riveting,	3,318	194
Defective heads,	42	15
Serious leakage around tube ends,	1,167	318
Serious leakage at seams,	664	54
Defective water-gauges,	101	13
Defective blow-offs,	43	9
Cases of deficiency of water,	7	3
Safety-valves overloaded,	36	7
Safety-valves defective in construction,	27	11
Pressure-gauges defective,	251	37
Boilers without pressure gauges,	4	0
Defective hangers,	34	5
Split tubes,	8	2
Defective man-hole rings,	4	2
Defective dome construction,	3	0
Total,	8,567	938

Defective riveting still continues to furnish a large number in our statement of defects, for which there can be no sort of *excuse* whatever. The *reason* therefor is found in the sharp competition between boiler manufacturers, with its resulting tendency to lower prices, quality of materials, and skill in workmanship. Defective riveting generally indicates cheap boilers.

Low-priced boilers are not generally the *cheapest* that can be bought, although there is an almost universal opinion that they are. On the contrary they are, in the majority of cases, the dearest that can be used. First-class boilers at the present time do not command an excessive price, no fancy profits are made on them, nor have been made for some years past. What then does it avail a man to buy a boiler for say $500, get an article made of the poorest material that can be worked, put together in the slouchiest possible manner, generally be stopped several times during the first year to have repairs made which never ought to have been needed, and would not have been required had the boiler been made properly, when by paying perhaps $200 more in the beginning he would have avoided all trouble, actually have expended less money at the close of the first year and probably have run his business uninterruptedly.

It is needless to say that some manufacturers always buy the very best of everything they can get to do their work with. Such men always have the best of boilers and engines, they are cared for in the best possible manner, and it is generally noticed that they are, as a general rule, more prosperous than their slipshod brethren who are always after something cheap.

Boiler Explosions.

JUNE, 1887.

Phosphate Works (82).—A boiler exploded at the Etiwan Phosphate Works on Cooper River, about five miles from Charleston, S. C., June 1st, blowing off the top of the building and scalding six men, three of them perhaps fatally. The names of the injured men are Kirkman, MacWilliams, and Founches, dangerously scalded, and Roseborough, Max Hamilton, and Thompson, badly scalded. They are all colored men except Thompson. Dr. Winstock, who was called to the spot soon after the disaster, set Williams's leg, which was broken, and rendered every possible attention to the others. Williams was brought to the Charleston City Hospital. He presented a pitiable spectacle, the skin having peeled from his body in many places. His condition was very critical. The details of the disaster could not be ascertained at the company's office on Broad street, as they had not received a full account of the explosion. An employee of the company, who had been in the boiler-room at the time, told a reporter that no cause could be assigned for the explosion. The exploded boiler had been in use for some time and was supposed to be in good working order. The other two boilers have been undergoing repairs for some days. The superintendent of the works was not there at the time of the accident.

Saw-Mill (83).—The boiler of a saw-mill at McGregor's, Wisconsin, exploded June 2d, instantly killing the son of the proprietor, who was in charge of it.

Locomotive (84).—The boiler of a locomotive attached to a south bound freight train on the Philadelphia & Baltimore Railroad (Baltimore & Ohio), exploded in front of the passenger station in Chester, Pa., June 7th, killing one man and seriously injuring several others, one of them fatally. John Murphy, aged 21 years, telegraph operator of Chester, was fatally scalded. The following persons were more or less severely cut or scalded: A. S. Benjamin, station agent; James B. Clarke, a carpenter employed on the road; Mrs. William Showers (colored), station janitress; H. L. Blakely, the fireman, residing at No. 620 North Caroline street, Baltimore, who was standing on the sandbox of the locomotive, was hurled many feet in the air, and was severely injured by the fall. Some of those mentioned above as injured may die. Half-a-dozen other persons sustained slight injuries. The station building was wrecked and five dwellings opposite damaged.

Saw-Mill (85).—The boiler of a saw-mill near Manhattan, Kansas, exploded June 9th, killing one person.

Saw-Mill (86).—The boiler of a saw-mill at Bristol, Va., exploded June 12th, killing three persons and badly injuring three others.

Mine (87).—A boiler used at a mine in Dahlonega, Ga., exploded June 14th, killing two, and injuring four others, two mortally.

Colliery (88).—A boiler exploded June 17th, at the Eckley colliery of Cox Bros. & Co., Hazelton, Pa. George Carper, the foreman, was killed, and Christian Bock, assistant fireman, was seriously injured. One-half of the horizontal boiler, which measured about thirty feet, was blown 100 yards. The boiler-house is a complete wreck and the damage will exceed $10,000.

Threshing Machine Engine (89). — The boiler of a threshing machine engine at Shepardsville, Ky., exploded June 18th, killing three persons and injuring three others.

Threshing Machine Engine (90). — The boiler of a threshing machine engine exploded near New Lisbon, Ohio, June 22d, killing one person and badly injuring three others.

Saw-Mill (91). — A saw-mill boiler near Tuscumbia, Ala., exploded June 22d, killing one man and injuring two others.

Saw-Mill (92).— A terrible explosion occurred at the steam mill of Charles Ada, at Brandon, Franklin County, N. Y., June 23d. The boiler was hurled forty rods, cutting a swath through the woods like a scythe. A spruce tree twelve inches thick was cut off and carried ahead of the boiler. Three men were badly hurt. One was horribly cut. Lack of water was the cause of the accident.

Oil Refinery (93).— A battery of four boilers at the Standard Oil Company's large refinery, one mile and a half southwest of Lima, Ohio, exploded with terrific force June 25th, shattering the boilers, demolishing the brick boiler-house and injuring several employees seriously. The engineer, Levi Myers, was at the feed pump in the act of turning water into boiler No. 2, when the explosion took place. He was thrown against one of the walls and pinned to the floor by debris, consisting of brick, mortar, and pieces of boiler. Daniel Callihan was thrown some distance. Frank Lewis was struck with brick and pieces of falling timber. They were seriously injured, Myers being badly scalded with water. Other employees were struck with flying brick and some of them rendered senseless. All of the boilers were raised from their resting places, and one of them hurled high into the air. When it came down it fell within a few inches of the prostrate body of Lewis, who was knocked down by a brick. The works are shut down on account of the accident. The loss is several thousand dollars.

Portable Boiler (94). — A portable boiler near Fort Wayne, Ind., exploded June 29th, badly scalding one man.

Saw-Mill (95). — A saw-mill boiler at work at Mt. Sterling, Ky., exploded June 30th, killing one man and badly injuring two others.

Instantaneous Steam Generators.—Foreign papers are again giving their attention to the instantaneous steam generator which was first proposed in Germany, we believe, several years ago. The same extravagant claims, in point of economy, are made for it now that were advanced at that time, though in design the generator seems to have undergone some change. It is now described as a copper vessel, cylindrical in shape, with a semi-spherical bottom. The cover, also of copper, is pierced by two holes. Through one, an injection tube passes into the generator, until within a short distance from the bottom. At the other hole is fixed a tube which serves as an escape orifice for the steam. The generator, the dimensions of which do not exceed 20 inches in height and 18 inches in diameter, is filled with copper fragments. It can easily be raised to and maintained at the requisite temperature of from 700° to 900° F. The feed-water pipe terminates at a very small pump, which can be connected with the machine to be supplied with steam, or worked by a small independent engine, either way, so long as the pump injects only a regulated quantity of water according to the working of the machine. The water, forced down the injection tube, is thrown against the closed end, and is ejected laterally through small holes as a spray. Coming into contact with the heated metallic fragments, it is instantly converted into steam, which, rising through the upper layers of heated metal, passes to the steam escape-pipe.—*The Iron Age.*

The Locomotive.

HARTFORD, AUGUST, 1887.

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

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

Steam-Power.

It is next to impossible to form a just estimate of the benefits to the civilized that have arisen in connection with the use of steam-power. It has become almost a necessity to every condition of civilized life, and through its influence the material comforts of mankind have been multiplied to an extent unparalleled in the history of nations. To enumerate these benefits would be a difficult task, for they are interwoven with all that makes civilized life comfortable and enjoyable. Compare the means of transportation as it existed before the introduction of steamboats and railways with the facilities for traveling, and moving the products of one part of the country to another, to-day; also the facilities with which we communicate with the nations of the earth. Transportation is no longer delayed by wind and tide. The development of steam-power has greatly changed our relations with all nations, commercially and socially. We are brought nearer together, know each other better, and are beginning to feel that the world is not so very large, nor are its inhabitants in one section so very different from those of other sections, except so far as opportunities of education and cultivation are encouraged and enjoyed to a greater degree by some nations than by others. Old prejudices are breaking down and the light of civilization is penetrating the darkest and remotest corners of the earth, and it is largely due to the agency of steam-power. But let us look at the influence of this powerful agency nearer home. The material of which our homes are constructed have been wrought into beautiful and attractive forms, our furniture and furnishings, our clothing from sole to crown, all are the products of machines, lathes, and looms, behind which is steam-power. Without it our material progress would come to a stand-still, and we with other nations would lapse into a condition akin to that of the sixteenth century. Thus we see how dependent we are upon this wonderful agency for our material comforts. It is estimated that there are at least 75,000 stationary steam engines in this country, representing 2,500,000 horse-power, and it is rapidly increasing. The horse-power represented by all the steam engines in the world is estimated at not less than 20,000,000. This method of representing the work done daily by all the steam engines of the world is somewhat indefinite, it is true, but supposing it to be only approximate, we can form some idea of the immense amount of work that could be accomplished by 20,000,000 of horses. We have thus given a few moments' consideration to the influence of steam-power in developing the resources of our own country as well as those of other nations. What is the source of this power? It certainly does not generate itself. Some will say it lies in the coal which is burned on the furnace grates. No, it is not there, it lies back of the coal. It is in the sun. "A cubic foot of wood is formed by the decomposition of a certain quantity of carbonic acid by the vital function of the plant excited by the solar rays, which are involved in the mass which nature by her wondrous alchemy has made." Eventually the wood is ignited by a single spark; combustion follows, its carbon combines with oxygen to form carbonic acid, its hydrogen to form water, which is returned to the air and a large amount of light and heat is produced. This is exactly equivalent to the amount which was engaged in its formation. Indeed the sunshine which fell upon the leaves of the forest trees ages ago has been hoarded up and we again develop it in its original state of heat and light. The vast coal fields of the world are but the rapid growth and decay of the trees and plants of the carboniferous age. They have been buried deep below the surface of the earth for millions of years, but are now brought to the surface again in the form of coal. By combustion we develop the heat and light in our stoves and grates to comfort and cheer us in the cold winters. We also develop it in the furnaces of our boilers to set in motion the acres of spindles and looms in our manufactories, and in the locomotive furnaces to draw the long and heavily loaded trains. By these processes we are simply developing the sun, heat, and light, which fell upon the earth millions of years ago.

J. M. A.

The Latest Novelty.

The latest invention in the steam line is a "Tricyclic Inexplosible Boiler," which is thus described, "by an eye witness."

"A boiler on a new system has been invented which has received the name of the tricyclic inexplosible generator. It differs from any other which has ever been built. The metallic surface submitted to the action of the fire does not touch the water; in no condition can the boiler get red-hot; it is enveloped all over by the same temperature, hence an immense vaporization; and steam can be produced to the very last drop of water without the least danger."

It will readily be seen that such a boiler as that described above possesses decided advantages over those now in common use. In fact it has more meritorious features than are at all necessary to constitute it a perfect boiler. It beats the "triple thermic" apparatus clean out of sight, and many people know that that was a very successful affair, in one way, if not in another. As the heating surfaces of this boiler are not brought into contact with the water, we can reasonably infer that the water is not brought into contact with the heating surfaces. This being the case it would seem that all manner of feed apparatus would be unnecessary; scale, incrustation, corrosion, and the many other annoyances arising from what has hitherto been considered a necessary condition for the generation of steam, are all avoided. Why not go a step farther in this same direction, and abolish the use of feed-water altogether, discard it entirely as fit for nothing but purposes of irrigation, etc.?

Another fact of interest, and one which would seem to indicate great economy, is the fact that all parts of this boiler are exposed to the same temperature. This is a new departure. If all parts of this boiler are exposed to the same temperature, it is evident that the temperature of the products of combustion must be just as high where they leave the heating surface, as they are when they first come in contact with it, and it would be very interesting to know just where the heat comes from to produce the "immense vaporization" which is claimed. Can it be possible that all this "immense vaporization" spoken of lies entirely within and forms an integral part of the inventor's claims?

Another peculiar feature, and one which would seem to render this boiler peculiarly adapted to those back counties where all explosions are said to be caused by low water, is the fact that "under no condition can the boiler get red-hot," and "the last drop can be vaporized without the least danger." These features, it will be seen, render this boiler peculiarly adapted to the use of those who have never had an engineer in charge, and who are continually blowing up some one from a lack of water. Imagine the fiendish glee with which the portable saw-mill man would seize upon such a construction.

And what use he could make of it. He could run without any water at all and no danger to any one would result.

The next thing we shall look for will be the formation of a company with a capital of at least three million dollars, and the public will then be let in upon the ground floor, for a consideration.

Speed of Locomotive Engines.

The following table shows the speed in miles per hour of locomotives with 48-inch, 55-inch, 58-inch, and 61-inch driving wheels, at various revolutions per minute. It was handed to us by Mr. A. G. Kilbourne, M. E., of this city. No allowance is made for slip of the driving wheels upon the rails:

Speed in miles per hour.	48-inch Drivers. Revs. per minute.	55-inch Drivers. Revs. per minute.	58-inch Drivers. Revs. per minute.	61-inch Drivers. Revs. per minute.	Speed in miles per hour.
5	35.02	30.56	28.98	27.55	5
10	70.04	61.12	57.96	55.10	10
15	105.06	91.67	86.93	82.65	15
20	140.08	122.23	115.91	110.21	20
25	175.11	152.79	144.89	137.76	25
30	210.13	183.35	173.87	165.31	30
35	245.15	213.90	202.84	192.86	35
40	280.17	244.46	231.82	220.41	40
45	315.19	275.02	260.80	247.96	45
50	350.21	305.58	289.78	275.52	50
55	385.23	336.13	318.76	303.07	55
60	420.25	366.69	347.73	330.62	60

The Resistance of Trains.

[From the report of the Brake Committee of the Master Car-Builders' Association on the Burlington tests.]

The following figures give briefly the results of the No. 7 special tests made to determine the frictional resistances of the various trains. The trains were composed of 49 or 50 empty cars with dynamometer and way-car, and American type engine and tender. The track and rails were in good condition and the wind light.

Each train was tried once on a slightly descending tangent, and once on a curve, situated on an average descending grade of 50.6 feet per mile. The resistance was ascertained on the tangent by running up to stop-post No. 1 at about 20 miles per hour, and then shutting off steam and allowing the train to run until it came to a stand-still.

The resistance on the combined grade and curve was ascertained by running the train up to stop-post No. 3 at a low speed (about 5 miles per hour), and then shutting off steam, and allowing the train to run until stop-post No. 4 was reached. The speed at the moments of passing each stop-post was carefully noted.

It will thus be seen that the resistances given below include not only the resistance of the cars, but of the engine running without steam. This is probably greater per ton than that of the cars, but the weight of the engine (about 40 tons) is so insignificant in comparison with that of the cars (700 to 800 tons) that the influence of the engine in running without steam may be neglected, and the resistances given may probably be taken to represent fairly the resistance of new empty cars:

1887.

Pattern of Cars.	Brake.	Tangent.			Curve.		
		Speed.		Resistance lbs. per ton of 2,000 lbs.	Speed.		Resistance lbs. per ton of 2,000 lbs.
		Average Miles.	Mean Miles.	Lbs.	Average Miles.	Mean Miles.	
Pennsylvania, - -	Westinghouse,	15	15	5.87	19	23¼	8.72
Illinois Central, - -	Carpenter, -	14½	15	6.22	15¾	22¼	9.09
Chica., Burl. & Quincy,	Eames, - -	11½	14¼	7.51	13¾	20	11.00
St. Joseph & St. Louis,	Hanscom, -	11½	15	12.00	4	4	19.8
Average, - - -	- - - -	13¼	15	7.90	16¼	22	9.60

In making this average, the Hanscom results on the curve are excluded, as they are not based on sufficient data to be trustworthy. The "mean speed" is the average of the squares of the speeds.

The cars were new, and were tried empty. The Pennsylvania cars were lubricated with dope. The Eames cars, when loaded, after these trials, gave trouble from hot boxes. The great resistance of the Hanscom train was caused by the brake-shoes binding on the wheels. The brake-shoes on the Eames trains were also in some cases very close to the wheels, and apparently affected the friction of the train on the curve. The brake-shoes on the Westinghouse train were hung inside; all the others were hung outside the wheels.

The trials on the curve were made between stop-posts Nos. 3 and 4. About half the total distance is on a 2° 40′ curve (2,149 feet radius) extending over nearly a quarter of a circle (80° 40′ 10″) and the remainder of the distance is on curves averaging about 1°, or say about 6,000 feet radius.

The results given in similar trials of brake trains over the same ground in 1886 were as follows; the trains were, however, composed of 25 cars, 12 loaded to their full capacity and 13 empty:

1886.

Pattern of Cars.	Brake.	Tangent.		Curve.	
		Average Speed. Miles.	Resistance lbs. per ton of 2,000 lbs.	Average Speed. Miles.	Resistance lbs. per ton of 2,000 lbs.
Chicago, Burl. & Quincy,	Westinghouse, - -	20½	4.32	26¼	6.07
Ind., Decatur & Sprigfi'd,	Eames, - - -	16¾	6.84	21¾	9.42
Lehigh Valley, - - -	Widdifield & Button,	16¾	6.84	21¾	9.42
St. Louis & San Francisco,	American, - - -	11½	8.50	21¼	8.94
Average, 1886, - - - - - - - -		16¼	6.62	22¾	8.46
Average, 1887, - - - - - - - -		13¼	7.90	16¼	9.60
Average of both years, - - - - -		14¾	7.26	19½	9.03

The Committee are indebted to Mr. A. M. Wellington for the calculations giving the results of the trials in 1886.

The results for the two years agree fairly well. The average difference between the resistances on the tangent and on the curve was 1.84 lbs. in 1886 and 1.70 lbs. in 1887. One train of cars (Westinghouse, 1886) gave a resistance of only 4.32 lbs. on the tangent, while another train (Hanscom, 1887) had a resistance of 12.00 lbs. per ton on the tangent, or nearly three times that of the Chicago, Burlington & Quincy cars in the lighter running train. This difference was apparently principally due to the brake-shoes rubbing against the wheels, and was equal to a constant grade against the train of 20 feet per mile. In running from New York to Chicago, 1,000 miles, the extra resistance would be thus equivalent to surmounting an elevation of 20,000 feet, or more than the height of the highest mountain in North America. The importance of keeping the brake-shoes clear of the wheels is thus very evident.

In the 1886 trials the Chicago, Burlington & Quincy, the Indianapolis, Decatur & Springfield, and the Lehigh Valley trains, were composed of cars that had been running some time. The St. Louis & San Francisco cars were new. The Chicago, Burlington & Quincy cars (Westinghouse) had the brakes hung from the trucks and inside the wheels. All the other cars had the brake-shoes hung outside from the body.

The following figures, based on the average results obtained in 1886 and 1887, show the increased friction on the curve as compared with the tangent.

	Increase lbs. per ton.
Shoes hung from the truck and inside the wheels, - - - -	2.30
Shoes hung from the body and outside the wheels, - - - -	2.84

These results tend to show that the resistance on curves is increased considerably when the shoes are hung outside and too close to the wheels. When the truck swivels, the shoes, being hung from the body, are lifted and brought closer to the wheels by the greater inclination of the hangers. When the shoes are hung from the trucks no such action occurs, and the shoes remain the same distance from the wheels, whether the car is running on a tangent or on a curve.

The fact that outside-hung shoes rub more forcibly against the wheels on curves, is not only shown by the figures given above, but was also observed when the trial trains were being hauled over frogs and curves in the yard at West Burlington.

The size of journal bearing has, doubtless, an important influence on the friction of trains, and the subjoined figures give the sizes of the journals in three of the trains tried at the 1887 tests, together with the weight of each car, empty, and loaded to its full marked capacity, and the resultant load per square inch on the journals. The bearing area of the journal is assumed as the length and diameter multiplied together:

Cars.	Journal length and diameter.	Weight of car.		Pressure per square inch on journal.		Friction Tangent.
		Empty.	Loaded.	Empty.	Loaded.	
	Inches.	lbs.	lbs.	lbs.	lbs.	lbs.
Pennsylvania, - - -	8 × 4	30,577	90,577	119	354	5.87
Illinois Central, - - -	7 × 4	27,351	67,351	122	301	6.22
Chicago, Burling. & Quincy,	7 × 3¾	25,509	65,509	121	312	7.51

As the frictional resistance given was obtained with empty cars, where the load per square inch on the journal is practically identical, the variation found in the resistance is due to other causes than insufficient bearing surface. The highest amount of friction was shown in 1887 by the Chicago, Burlington & Quincy cars, which in 1886 showed the least. In both years the cars were of the same design, but in 1887 the cars were new, whereas in 1886 they had run over 10,000 miles. The difference was, therefore, probably due to less accurate fitting and workmanship as compared with the Pennsylvania and the Illinois Central cars, which were also new, but showed, respectively, 1.64 and 1.29 lbs. per ton less friction than the Chicago, Burlington & Quincy cars. These differences, insignificant as they may appear, would, in running 1,000 miles, necessitate an extra amount of haulage power equivalent to surmounting summits 4,330 and 3,415 feet high, respectively, or greater than that of any line between the Mississippi and the Atlantic. The importance of good fitting is further shown by the Chicago, Burlington & Quincy cars running hot when loaded after the resistance tests.

The Pennsylvania and the Illinois Central cars were built at the company's shops, and the Chicago, Burlington & Quincy cars were built by a contractor.

Your Committee believe from these experiments that the following figures represent the frictional resistance of long trains of freight-cars, in good repair, running over a track in good condition, the weather being fine and warm, and the wind light. The resistance appears to be constant at speeds of from 12 to 25 miles per hour, and does not appreciably increase with an increase of speed within these limits:

Frictional resistance, lbs. per ton of 2,000 *lbs. Speeds* 12 *to* 25 *miles per hour.*

	New Cars. lbs.	Old Cars. lbs.
On tangent, - - - - - - - -	8.00	6.00
On 3° curve, - - - - - - - -	10.50	8.30

Good lubrication and carefully fitted boxes and journals may, with cars that have been running some time, decrease this resistance to a minimum of 4 lbs. per ton on the tangent, while brake-shoes rubbing against the wheels, and other unfavorable conditions, may increase the friction on the tangent to 12 lbs. per ton, and to considerably more on curves. The use of outside-hung shoes seems to increase the resistance on curves when the shoes are very near the wheels. —*Railroad and Engineering Journal.*

The Production of Coal in the United States in 1886.

Mr. Chas. A. Ashburner of Pittsburgh, has compiled for the United States Geological Survey the following statistics, principally from the direct returns of the operators of individual coal mines, supplemented by valuable contributions from State officials: The total production of all kinds of coal in 1886, exclusive of that consumed at the mines known as colliery consumption, was 107,682,209 short tons, valued at $147,112,755 at the mines. This may be divided into Pennsylvania anthracite, 36,696,475 short or 32,764,710 long tons, valued at $71,558,126; all other coals, including bituminous, brown coal, lignite, and small lots of anthracite produced in Arkansas and Colorado, 70,985,734 short tons, valued at $75,554,629. The colliery consumption at the individual mines varies from nothing to 8 per cent. of the total product, being greatest at special Pennsylvania anthracite mines and lowest at those bituminous mines where the bed is nearly horizontal and where no steam-power or ventilating furnaces are employed. The averages for the different States vary from 3 to 6 per cent., the latter being the average in the Pennsylvania anthracite region. The total production, including colliery consumption, was: Pennsylvania anthracite, 34,853,077 long or 39,035,446 short tons; all other coals 73,707,957 short tons, making the total absolute production of all coals in the United States 112,743,403 short tons, valued as follows: Anthracite, $76,119,120; bituminous, $78,481,056; total value $154,600,176. The total production of Pennsylvania anthracite, including colliery consumption, was 699,473 short tons in excess of that produced in 1885, but its value was $552,828 less. The total production of bituminous coal was 1,086,408 short tons greater than in 1885, while its value was $3,866,592 less. The total production of all kinds of coal shows a net gain of 1,785,881 short tons compared with 1885, but a loss in spot value of $4,419,420.

The total production and the spot value in each State and Territory, exclusive of colliery consumption, are shown in the following table:

States and Territories.	Quantity. Short Tons.	Value at Mines.
Pennsylvania:		
Anthracite,	39,696,475	$71,558,126
Bituminous,	26,160,735	21,016,235
Illinois,	9,246,435	10,263,543
Ohio,	8,435,211	8,013,450
Iowa,	4,312,921	5,391,051
West Virginia,	4,005,796	3,805,506
Indiana,	3,000,000	3,450,000
Maryland,	2,517,577	2,391,698
Missouri,	1,800,000	2,340,000
Alabama,	1,800,000	2,574,000
Tennessee,	1,714,290	1,971,434
Kentucky,	1,550,000	1,782,500
Kansas,	1,400,000	1,680,000
Colorado,	1,368,338	3,215,594
Wyoming,	829,355	2,488,065
Virginia,	684,951	684,951
Indian Territory,	534,580	855,328
Washington Territory,	423,525	952,931
New Mexico,	271,285	813,855
Georgia,	223,000	334,500
Utah,	200,000	420,000
Arkansas,	125,000	200,000
California,	100,000	300,000
Texas,	100,000	185,000
Michigan,	60,434	90,651
Montana,	49,846	174,460
Oregon,	45,000	112,500
Dakota,	25,955	41,277
Idaho,	1,500	6,000
Total,	107,682,209	$147,112,755

We may add that the above totals are larger than generally expected. It is likely that former unofficial statistics understate the product, since Mr. Ashburner's figures are known to be the result of a very exhaustive inquiry. —*The Iron Age.*

Remarkable Breaks in a Reservoir.

From a paper entitled "Some Remarkable Breaks in a Reservoir," presented by Mr. L. N. Lukens at the last meeting of the Engineers' Club, of Philadelphia, we take the following interesting particulars: The reservoir was built in 1873 on the top of the Conshohocken hill, about 200 feet above the level of the Schuylkill River, from which the water is pumped. In plan it is a square of 151 feet at the top of the embankment, with a division embankment rising half way to the top of the side walls. When ordinarily full it holds about 1,000,000 gallons. The earth of the locality is of a rather light character, with enough talc in it to make it feel rather greasy. The general rocks of the locality are limestone, and the variety quarried and sold as Conshohocken stone. In constructing the reservoir the banks were raised about as much above the natural level as the excavation was beneath it, the earth from the excavation being used for the embankments. These were well rolled and allowed to settle as much as possible in the course of construction. The bottom and sides were then lined with eighteen inches of stiff fire-clay, put on in layers of about three inches, each layer being well rammed. Above this there was put a brick pavement and this was washed over with hydraulic cement. The inlet and outlet pipes were cast-iron pipes laid in masonry. This masonry was composed of ordinary undressed stone, laid in hydraulic cement and extended out to about the middle of the embankment. The reservoir was finished in the fall of 1873, and water was let in soon after. In December, 1873, only a few months after the water was let in, the first break occurred. This break commenced just above the outlet pipe and followed the line of the pipe through the embankment, laying bare some of the masonry described as surrounding the pipe. It broke the embankment just about at the natural level of the ground, and was about fifteen feet across at the top of the embankment, narrowing, of course, toward the bottom. The curious part was, however, that instead of the ground below showing evidences of such a large body of water passing over it, it showed that only a comparatively small part of the water had escaped that way and covered the low land just below. The larger part of the water must have escaped by some other channel, necessarily a subterranean one. This first break was repaired by filling in with stiff fire-clay and finishing as before. In the summer of 1876 the second break occurred. This was in the middle of the west compartment and was an absolute giving way of the bottom, there being no break in the sides. It was simply a hole of about twenty-five feet in diameter and of indefinite depth. A line was let down at least eighty-five feet without finding bottom, and stones thrown in seemed to rattle down indefinitely. The ledges of rock seemed to be inclined toward each other, thus V, and the slippery talcous earth had been washed from between them, nobody knows where. Whether the water from the first break started it is of course not known, although it seems, at least, possible. In repairing this, the crevices between the rocks were filled up and arched over with masonry, going as deep as necessary to get a solid support for the masonry, in one case as much as thirty-four feet below the bottom of the basin. The hole was then filled in with stiff clay and iron ore screenings, principally clay. The top was then planked over with hemlock planks, and the clay lining rammed down and covered with brick, as before.

In the spring of 1879, three years after, the third break occurred. This was in the other compartment, taking away part of the partition wall and part of the bottom, and was a good deal like the preceding one. An interesting fact is that a well near by, eighty feet deep, and which had eight or ten feet of water in it, was completely emptied the night the break occurred and has not held any water since. There must have been some underground channel by which the water from both found its way to the river. This hole was filled up with masonry and clay, like the other. The clay lining was then taken off, and the whole basin — sides, bottom, and partition embankment — were planked over with heavy hemlock plank. The clay was then put on again to a depth of fourteen inches, and the whole surface bricked as before. This time it lasted for eight years, until last fall, when a small break occurred. Some small quantity of water had washed the earth from between two rocks, in the side of and near the bottom of the end embankment, in the same old way. The weight of the superincumbent water had then sprung back the side planks, and the water had escaped by some underground channel. Being relieved of the weight the planks had sprung back. The fact of the springing back and subsequent release is shown by there being a number of small fish caught and crushed in the cracks. This was repaired, as usual, by filling in with fire-clay, and at that particular place there is now three feet of fire-clay rammed in between the rocks, then the planking, then fourteen inches more clay, and then the brick lining. It is hoped now that it will last.

Ancient Toys.

Puppets, or marionettes, writes the author of the "Romance of Invention," were patronized by both the Greeks and Romans, and automata, which are the inventions with which principally he deals, also go back to a remote period. Vulcan's tripod on wheels has the authority of Homer; Dædalus made moving statues; Archytas of Tarentum, 400 B. C., invented a wooden pigeon that could fly in the air. In the fifteenth century Regiomantamus made an iron fly that moved through the atmosphere, and afterward an automatic eagle, which, on the arrival of the Emperor Maximilian at Nuremberg, flew forth to meet him. Albertus Magnus is credited with constructing a head that moved and talked, and which so frightened Thomas Aquinas that he smashed it into pieces, Albertus exclaiming when he saw his achievement destroyed, "So perish the work of thirty years." Roger Bacon made a speaking head of brass, which excited awe among all who heard it. Speaking automata have been frequently attempted of late years, but the great difficulty lies in simulating the human voice. The most successful of these efforts was that of Professor Faber of Vienna, exhibited in London forty years ago under the name of Euphonia. Faber worked twenty-five years at the automaton. The figure enumerated words and also sang. There was an arrangement of hollow pipes, pedals, and keys, which the inventor played to "prompt the discourse."

Willars de Hanecort, in the 13th century, constructed an angel that "would always point with his finger to the sun." The Marquis of Worcester made an artificial horse that would carry a rider as swiftly as if he were a genuine barb. Philip Camuz invented a wonderful group of automata for Louis XIV — a coach and four horses, that started off with the crack of a whip, the horses prancing, trotting, and galloping in turn; it ran along until it got in front of the king, when it stopped, when a toy footman descended, and, opening the carriage door, handed out a lady "with born grace." The lady made a courtesy, presented a petition to his majesty, and, re-entering her carriage, was driven away. Gen. de Gennes, a Frenchman, who defended the colony of St. Christopher against the English about 1686, amused himself by making an automaton peacock, which walked about in all its pride of extended feathers, and picking up corn from the ground swallowed it.

The king of automata constructors was Jaques Vaucanson, born at Grenoble in 1709. While quite a boy he made several self-moving figures. The bent of his mind was determined by a rather peculiar circumstance. Being left to himself in the house of a friend, to which he went with his mother, he perceived through the crack of a partition an old clock with a slowly swinging pendulum which excited his attention. Next time he visited this house he had a pencil and paper with him, and made a rough sketch of the clock. By earnest study and investigation he succeeded in making a clock of his own out of pieces of wood, and his wooden clock kept time fairly well. Then began his experiments with automata. He made a wooden chapel, with moving figures of priests. He invented a hydraulic machine for the city of Lyons, and later in the same place, perfected a machine for silk weaving that caused the people to rise against him in arms. His first great achievement in automata was his flute player, which was one of the wonders of his time. He had been ill, and made it during his convalescence. The several parts of it were made by different workmen to prevent its discovery. Only a faithful servant aided him in his secret. According to D'Alembert, the remarkable figure stood on a pedestal, in which a portion of the mechanism was concealed, and the player not only blew into the instrument, but with its lips increased or diminished the sound, performing the legato and staccato passages with perfection, and fingering with complete accuracy. It was exhibited in Paris in 1738, and made a great sensation. Vaucanson next made a flageolet player, and later a mechanical duck, which waddled, swam, dived, and quacked, and like De Gennes' peacock, picking up and swallowing its food. He was engaged on an endless chain when he died. He willed all his automata to the king.

Maetzel, the inventor of the metronome and of several musical automata, opened an exhibition in Vienna in 1809, with a life size automaton trumpeter as the chief attraction. When the audience entered all they saw was a tent. After a time the curtains parted, and Maetzel appeared leading forward a trumpeter in the full regimentals of an Austrian dragoon. By pressing the left epaulet of the figure he made it play cavalry calls and a march, and an allegro by Weigl, accompanied by a full band of living musicians. Nor was this all. The figure retired and reappeared as a trumpeter of the French Guard. Maetzel wound it up on the left hip, pressed once more on the left epaulet, and it played the French cavalry calls, a French cavalry march, a march by Dussek, and one of Pleyel's allegros, the full band again accompanying. Knauss exhibited at Vienna an automaton that wrote, and the Drozes, father and son, constructed several mechanical figures that both wrote and played musical instruments. A pantomime in five acts was performed by a troupe of puppets in Paris in 1729, and Blenfalt, in 1746, got up a representation of "The Bombardment of Antwerp," by automata. Another piece performed by Blenfalt's automata, which he called "comediens practiciens," was "The Grand Assault of Bergop Zoom."

Incorporated 1866.

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The Locomotive.

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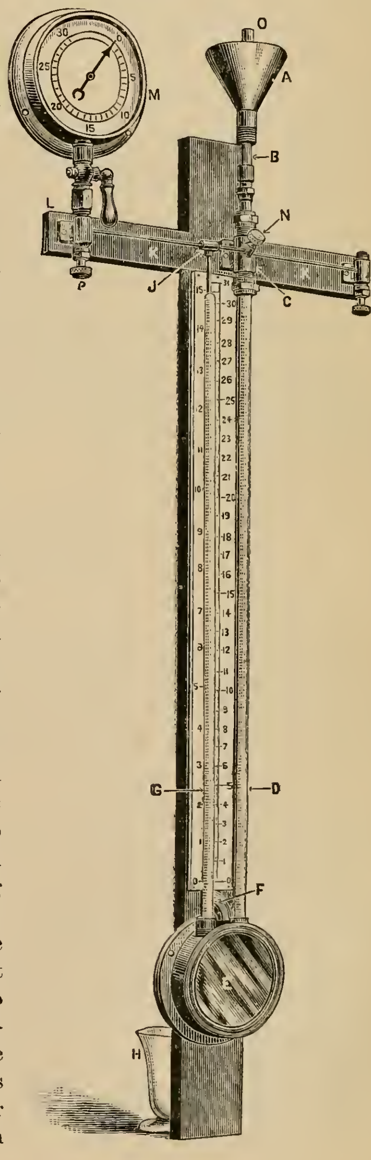
Air Pump for Testing Vacuum Gauges.



We have recently designed and constructed for our own use in this office an improved form of apparatus for testing vacuum gauges, and believing an account of its method of construction and operation will be of interest to engineers and others, we illustrate it, and append a brief description.

It is a modification or rather an adaptation of what is known as Sprengel's Air Pump. A glass tube *D*, 36 inches long (or any convenient length greater than the maximum height of the barometer), is fastened in a vertical position to a thick board which, with the cross piece near its upper end, is fastened to the wall and forms the support for the entire apparatus. The lower end of this tube dips into a reservoir of mercury *E*, open at the top and provided with an overflow *F*, which passes out through the supporting board, and discharges the mercury which overflows into the vessel set below.

To the upper end of the tube *D* is attached a cast-iron piece *C*. This cast-iron connection has a hole through it vertically, which forms a continuation to the hole through the glass tube *D*, and is provided with an extension about 12 inches long, *B*, of one-eighth inch iron pipe, the whole surmounted by the cast-iron, funnel-shaped piece *A*, into which mercury for expelling the air is poured. This receptacle is provided with a valve, the stem of which is shown at *O*, and which is automatic in its action, opening when mercury is poured into the funnel, and closing before it has entirely run out, which prevents the possibility of air entering the apparatus at this point.

A second glass tube *G*, of about the same length as the one first described is seen to the left of *D*. The lower end of this tube also dips into the reservoir E, while its upper end is in communication through the small tubes *J* and *K* with the opening in the cast-iron connection *C*, and the glass tube *D*, which may be called the pump tube, or exhausting tube, while the second one, *G*, which has a scale divided into inches and pounds placed just back of it, forms a standard gauge with which the gauge to be tested is compared. The gauges to be tested are attached at *L L*, in the usual manner as shown in the cut.

The operation of the apparatus is as follows: The gauge to be tested is attached in the usual manner at *L*, care being taken to make as perfect a joint as possible, as the slightest leakage of air makes it a matter of great difficulty to obtain satisfactory results. The connection made, communication is established between the gauge or gauges, and the remainder of the instrument by opening the valves *P P*. Mercury is then poured into the funnel *A*, whence it runs down through the tube *D*, into the reservoir *E*. As the mercury runs down it carries the air contained in the tube *D* along, with in much the same manner that water is carried into a boiler by an injector. The air thus carried down escapes into the atmosphere from the reservoir through the overflow, while the mercury escapes through the same channel and pours into the vessel set to receive it, whence it is poured back from time to time into the funnel, and thus the operation goes on until the desired degree of exhaustion is attained.

Of course as the air is exhausted from the tube *D*, that contained in the interior of the gauges, and in the upper portion of the tube *G*, flows in through the connecting tubes *K K*, and is expelled.

As the exhaustion proceeds the air is removed from the tube *G*, and its lower end being submerged in the mercury whose surface is exposed to atmospheric pressure, mercury rises in the tube *G* exactly as in a barometer, and its height measures the degree of exhaustion attained, and is read off directly on the scale seen back of it. This reading is compared with the indications of the gauge as the operation goes on and errors noted. The gauges are of course corrected in the usual manner.

From 4 to 6 minutes are sufficient to attain a more perfect vacuum than is generally maintained in the condenser of a steam engine. If the joints are all tight there is no difficulty in obtaining a practically perfect vacuum by merely continuing the operation for a sufficient length of time.

Inspector's Reports.

JULY, 1887.

During the month of July, 1887, there were made by the inspectors of this company, 3,658 inspection trips, 7,508 boilers were examined, 3,726 were thoroughly inspected, both internally and externally, 508 were subjected to hydrostatic pressure, and 51 we condemned, being found unfit for further use. 9,194 defects were reported, of which 900 were considered dangerous, as per the following detailed list:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	598	46
Cases of incrustation and scale,	883	46
Cases of internal grooving,	72	7
Cases of internal corrosion,	321	17
Cases of external corrosion,	384	44
Broken and loose braces and stays,	342	57
Settings defective,	233	17
Furnaces out of shape,	278	13
Fractured plates,	184	51
Burned plates,	119	21
Blistered plates,	298	24
Cases of defective riveting,	3,216	179

Nature of Defects.	Whole Number.	Dangerous.
Defective heads,	50	13
Serious leakage around tube ends,	998	205
Serious leakage at seams,	632	40
Defective water-gauges,	96	20
Defective blow-offs,	53	6
Cases of deficiency of water,	7	5
Safety-valves overloaded,	38	12
Safety-valves defective in construction,	38	22
Pressure-gauges defective,	285	39
Boilers without pressure-gauges,	18	1
Defective hangers,	46	13
Defective man-hole plates,	1	1
Defective man-hole rings,	4	1
Total,	9,194	900

Defective tubes in many cases are the source of an almost unlimited amount of trouble and annoyance. While it is no uncommon thing for the ends of tubes in new boilers to show a slight "weeping," it should in all cases where the workmanship is good take up in a few days, and show no further signs of it. Where in the case of new boilers there is continued leakage around the ends of the tubes, and the boiler is known to be clean, and the water good, it may generally be reasonably inferred that there is something wrong either in the material or workmanship.

In case of continued leakage the advice of an inspector should be sought to ascertain the exact cause of the trouble, and the best remedy therefor. Severe expanding of the tubes whereby their ends have been split and badly injured has been done many times, when this is the case, the boiler will always be tender at this point, with a tendency to leak badly on very slight provocation. A tube which has once been split can never be made whole again.

Tubes are sometimes found to be split open as they come from the makers. When such find their way into a boiler, the hydrostatic test will generally reveal its presence, and it should of course be at once removed. This is not always done however.

Leakage arising from use may be caused in many different ways. Low water will generally start the ends of the upper rows, and of course if it is long continued they pull out and an explosion may follow. If the low water stage is not long continued, so that a small number of the tubes only are over-heated and the pressure is not sufficient to start off the head, all that is necessary generally to repair the damage is to expand the leaking tubes and look out that the accident does not occur again.

The presence of grease in a boiler, or the improper introduction of cold feed-water near the heads is a prolific source of leaky tubes.

Another frequent cause of leakage around tube ends is a thick formation of scale on the tube sheet, which prevents contact of the water with the tube sheet and the ends of the tubes so that they become over-heated. In many cases where boilers have not been forced, this accumulation of scale has gone on for a long time, and the tube ends and tube sheet have become well burned out, and the only thing that prevents leakage is the mass of scale, sometimes three or four inches thick, which forms a solid mass against the tube sheet and fills in completely between the tubes. In such cases (which are nearly always dangerous, as the scale is liable at any time to break up under the influence of a high temperature and allow the steam pressure to force the head out resulting in an explosion) the use of a solvent will nearly always set up bad leakage around the tubes, as soon as its action loosens the scale sufficiently to allow the water to find its way beneath it. This should not cause alarm, as it frequently does, but should be taken as proof that the solvent is doing its work properly. As soon as a tube under these circumstances shows distress, it should be attended to. The boiler should be stopped if possible, a man should go inside, and with a long chisel detach all the loosened scale possible, and remove it from the boiler, which should be thoroughly cleaned out before starting up, and if the leaking tubes have not been too badly injured they may be lightly expanded, sometimes they will be found to be so badly cut, especially if the boiler has been neglected for a long time, that the only remedy will be to replace the old tube with a new one, and in many cases it has been found necessary to replace nearly all the tubes of a boiler, where if intelligent care had been used, no repairs at all would have been needed.

But whatever the cause of leakage around tube ends, it should always be sought out and the difficulty removed when trouble first manifests itself, if allowed to go on indefinitely, the tube sheets and ends of tubes will be so badly corroded that the only remedy may be new tubes and tube sheets throughout.

Boiler Explosions.

JULY, 1887.

Threshing-Machine Boiler (96).— The boiler of a steam threshing-machine on the farm of John Barth, three miles south of Mascoutah, Ill., exploded July 1st with terrific force. John Plab was blown 200 feet away, and literally torn to pieces. Peter Plab, his brother, had both legs torn off, and will die. Henry Lempemeyer had an arm torn off and is otherwise injured, and Henry Shelterer was also badly hurt. The machine was completely wrecked. After the explosion the straw stack caught fire, and, together with two valuable houses, was entirely burned. The explosion was the result of low water in the boiler.

Machine Shop (97).— The Pittsburgh & Lake Erie Railroad shops, located at Chartiers Station, McKee's Rocks, Pa., were completely destroyed by fire July 7th. The flames had been in progress but a short time when a terrific explosion occurred. The boilers, where the fire started, exploded, and pieces were scattered in different directions for hundreds of yards around. Several narrow escapes were made by the men who were fighting the fire from fragments of flying boilers. No one was injured but a boy.

Threshing-Machine (98).— A threshing-machine engine exploded its boiler on a farm near Sandoval, Ill., July 12th, killing one man andinjuring two others.

Threshing-Machine (99).— A threshing-machine engine exploded its boiler at Arkansas City, Ark., July 8th, scalding one person.

Mine (100).— A terrible boiler explosion occurred at No. 2 shaft of the Excelsior Mine, Oskaloosa, Ia., July 8th, in which three men were injured, one, a Hungarian named Mike Huluska, probably fatally. Master mechanic Sam Sport was thrown thirty feet into the reservoir, and was severely scalded. Gus Thompson was badly injured.

Threshing-Machine Boiler (101).— A serious accident occurred about half a mile from Mountain View, Cal., July 12th, on the farm of Z. H. Martin, by the explosion of an engine boiler of the threshing-machine owned by Mockbee & Choates, resulting in the death of Edwin T. Carr, engineer, and Louis Salicita, fireman. A few others were very slightly injured. Cause, defective boiler. Fragments of the engine were blown for a distance of a half a mile. *Later*— Edwin T. Carr had one arm mangled and his breast badly crushed. He died three hours later. Louis Salicita, the fireman, was thrown backward about twenty-five yards from the engine, and one leg was broken in four places, and his breast was badly crushed. He died about fifteen minutes after the explosion. Philip Espinosa, a water-hauler, was bruised on the head and arms and burnt. J. H. Choate was bruised on the arm and thrown about ten feet.

Locomotive (102).—The boiler of locomotive No. 20, of the Buffalo, Rochester & Pittsburgh railroad, exploded July 13th. The engine and twenty-eight cars were standing on the siding at Crawford's. Just as an Erie freight passed, the boiler of No. 20 blew up. Four or five of the Erie cars were wrecked and blown from the track by flying fragments. Arthur L. Eckles, aged twenty-six, the engineer, was found three-quarters of an hour after the explosion in a clump of bushes fully 500 feet from the wreck. He was horribly burned and unconscious, and died at nine o'clock. John M. Wilson, the fireman, was blown over the passing Erie train, and was found on the hill-side. He was fatally burned. The engine is a complete wreck, only the driving-wheels and truck being left. A fragment weighting fifteen tons was carried 200 feet. Nine of the trainmen were slightly injured. Low water in the boiler is supposed to have been the cause of the disaster.

Alcohol Refinery (103).—The boiler at L. A. Salomon & Brother's alcohol refinery, at No. 6 Gouverneur slip, New York, exploded July 16th, and after a flight of over two blocks landed in the rear yard of No. 194 Monroe street. The excitement in the neighborhood caused by the explosion was intense. Much damage was done by the explosion, and several people were hurt. Mr. Dailey Doyle, who for years has suffered from a crooked neck, was lying on a pier near the scene of the explosion. Five minutes later he found himself running up Gouverneur slip with his head perfectly straight.

Kier (104).—The large iron tank in the dye-house of the Warren cotton mills, West Warren, Mass., in which the cotton is boiled, exploded with terrific force July 19th, demolishing the larger part of the inside of the building, the machinery, etc., and scattering the cotton promiscuously about. The force of the explosion was felt throughout the whole village, and the people rushed out of doors expecting to be visited by an earthquake. The watchman had just left the building, after having examined the boiler and found it all right. One or two others had left the place shortly before, otherwise loss of life might probably have happened. Quite extensive repairs on the building had recently been completed.

——— (105).—A boiler explosion occurred at Canal Dover, Ohio, July 19th, killing one person and badly scalding two others.

Saw-Mill (106).—The boiler of E. L. Chamberlain's saw-mills, Natchez, Miss., exploded July 21st, wrecking the mill, killing Dorsey Scott, a colored fireman, and injuring Mr. Chamberlain, the engineer and proprietor, and two or three others.

Threshing-Machine Boiler (107).—Edward Stroud, a farmer, who resides about three miles from Elkton, on the Newark & Elkton road, and a colored boy named Walter W. Crawford were instantly killed by the explosion of a steam boiler July 20th. Mr. Stroud was engaged in threshing his wheat crop, and had employed Edward Bowen's steam-power thresher. Mr. Bowen was acting as engineer, and says he had started his engine but a short while after shutting down for dinner, and that his boiler was full of water. The steam-gauge registered sixty pounds, and was fixed to blow at seventy pounds. At the time of the explosion he was standing leaning on the engine talking to Frank Stroud, a son of the man that was killed, and Lewis Pritchard. Without a moment's warning, the head of the boiler blew out, and the engine and boiler, which were on wheels, rushed backwards towards the thresher. Mr. Stroud and the colored boy were standing at the thresher measuring grain as it came out, and Frank Sterling was also alongside of them. Mr. Stroud was struck by the boiler, and his breast and head were crushed to a jelly. The back of the boy's head was torn off and he was crushed in the breast. Sterling was knocked under the thresher, and, save a few bruises, escaped injury. The engine next came in contact with a horse that was used for hauling away the straw from the thresher. The horse's neck was broken, and he also was instantly killed. The engine and boiler were not stopped until they buried themselves in some straw stacks ninety-five feet from where the engine was first stationed. The wheels and running-gear attached were all torn away. A wagon standing near by was blown 200 feet. Young Stroud and Lewis Pritchard, who were near the boiler, were both painfully scalded, while a singular fact is that the engineer, who was closer to the boiler than any one at the time of the explosion, escaped without a scratch. Mr. Stroud was a prosperous farmer, and leaves a wife and four children. He was about fifty-six years of age. The colored boy killed was a farm hand, and about fifteen years old.

SAW-MILL (108).— The boiler of the Houston Lumber Company's saw and planing-mill, Houston, Texas, exploded July 28th, killing A. G. Wells, general manager of the company, and four laborers. Three men are also reported missing. Fragments of the boiler were carried three-quarters of a mile, falling upon and wrecking a car-load of lumber and damaging the track of the Southern Pacific Company.

CULINARY BOILER (109).— The inmates of Brodbeck's Hotel, on High street, Dedham, Mass., were suddenly aroused from sleep shortly after 12 o'clock, July 29th, by a loud explosion and the hissing of steam. It was found that the large copper boiler in the culinary department of the house had burst. It appears that shortly before 12 o'clock a break was discovered in the main pipe of the Dedham water works on High street, near the new railroad bridge. In order to repair the break, it was necessary to shut off the water just above Mr. Brodbeck's place of business. The boiler was fed by a pipe connected with the works of the water company, and in shutting off the water from the main pipe, it was also shut off from the boiler, and as there was some fire still left in the range, the water became low and the boiler collapsed.

PHOTOGRAPHED BY LIGHTNING.— A curious electric phenomenon is reported from Fayette Township, Hillside County. Thursday evening a lively thunder shower passed over that region, during which the play of lightning was peculiarly frequent and vivid. Just before the storm broke, Amos J. Biggs, a farmer living midway between Hillsdale and Jonesville, who is quite bald, his head being smooth and shiny, went into his back-yard to frighten away some cats that were fighting on the woodpile. So intent were they on exterminating one another as to allow Farmer Biggs to approach within a few feet of them. At the same instant there was a great crash, and an electric bolt struck the woodpile, scattering it and stiffening the cats in an intense *rigor mortis.* Aside from a prickly sensation and sudden contraction of the muscles, Mr. Biggs experienced no unpleasant effects. The fluid passed down his body, tore the works of his watch to pieces, breaking the cover, ripped his left trousers leg from top to bottom; and burst his left boot, tearing the upper clear from the sole. When he entered the house his wife fainted. Unconscious of the cause the farmer hastened to bring her to. The first words she uttered, "O, Amos, the Devil has set his mark on you," excited his curiosity, and he looked in the glass and found the image of a black cat photographed in silhouette on his bald front. The picture was perfect. It was about five inches from tip to tip, and in perfect proportion. The cat's "whiskers," teeth, and even the hairs on its tail were reproduced with exquisite minuteness. Curiosity being satisfied, they tried to remove the obnoxious marking, using such homely remedies as soapsuds and scouring-brick, vinegar, etc., but to no purpose. However, in the morning the picture was much faded, and by noon it had quite disappeared.— *Chicago Tribune.*

The Locomotive.

HARTFORD, SEPTEMBER, 1887.

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

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

MR. JACKSON BAILEY, of the *American Machinist*, died at his home, No. 577 Monroe street, Brooklyn, July 7th. Mr. Bailey has been actively identified with trade journalism for the past fifteen years in New York, and was at the time of his death, first vice-president of the New York Press Club, of which he had been one of the most active members for years. Funeral services were held at two P. M. Sunday, July 10th, at the family residence. Interment was at Cypress Hill.

A CORRESPONDENT in Ohio sends us a sketch and description of a safety-valve (?) which is furnished with a *stuffing box on the valve spindle.* He says: — "It is an old affair, and may have been made forty years ago; but I wondered that a boiler insurance company would pass anything of the kind, for some jackass might take a notion to pack it some day. . . . The boilers are running in the city of Cincinnati, and the valve is on the drum connecting a two boiler battery; boilers each forty-two inches diameter, and twenty-four feet long; two fourteen inch flues each."

Evidently the man who designed such a valve never intended to grind it, if it got to leaking. However the boilers are not under the care of the Hartford company, the inspector mentioned by our correspondent not having been employed by us for many years.— (ED. LOCOMOTIVE.)

IF, through accident or carelessness, as very frequently happens in making silver prints, a negative gets stained with nitrate of silver, the stains may be easily removed, without injury to the negative, by the following process:

First lay the negative in clean water and let it soak until the gelatine is thoroughly wetted, then immerse in a sufficient quantity to well cover it, of a solution made in the following proportions: —

Iodide of Potassium, ...	20 grains,
Water, ...	1 ounce,

and let it soak from five to thirty minutes, according to the age and density of the stain. Pour off this solution, rinse off the plate slightly, and immerse it in a sufficient quantity to cover it well, of the following solution: —

Cyanide of Potassium, ...	30 grains,
Water, ...	1 ounce.

If the stain is slight or of recent date, it will disappear immediately, if it has existed for a long time, or is very dense, it may be necessary to prolong the immersion in both baths, or even make them stronger, and rub the spot lightly with the tip of the fingers, a soft brush, or a small tuft of cotton, but under ordinary circumstances this will not be found necessary.

EDISON'S latest invention is an apparatus for the production of electric currents directly from heat, without the intervention of a steam engine and dynamo. This is not new in principle as many seem to think. The thermo-electric pile described in all works on physics fulfills the same purpose. But Edison's apparatus is claimed to give a much greater efficiency than the old form of thermo-pile, so much greater in fact that it is available for industrial purposes, which is not the case with the thermo-pile of the ordinary form.

Before electricity supplants steam power to any appreciable extent for general use, it will be necessary to generate it in this manner, or by the utilization of earth currents. But in the present state of our knowledge of electricity this cannot be done *economically*. At the present time the most economical method of generating electricity, is by means of a dynamo run by steam or water power, but when the electric current so generated is used to drive an electric motor, the power realized is much less than that originally developed by the engine to drive the generating dynamo. In ordinary practice we believe about forty to fifty per cent. would be lost. In some experiments which have been made, we believe 70 per cent. of the original power has been utilized, but this could hardly be expected as an everyday result.

The trouble thus far with the thermo-battery has been but a very small portion of the energy due, to the heat applied to the battery, has been transformed into electricity In other words it is not so perfect a machine as the steam engine in combination with an ordinary dynamo. But improvements may and probably will be made some day, whereby a greater amount of this energy will be utilized. It is not theoretically impossible, but *great* improvements must be made before there can be serious thoughts of using electric power generally.

There would however seem to be a field in the large towns and cities broad enough for electric power to be used and made to pay. Many people want a small amount of power, but the expense of maintaining even a small steam engine and boiler is too great for the purpose for which it would be required. A large central steam plant could drive a large dynamo, and furnish electricity for many small electric motors, and we believe the expense for small powers could in this manner be made much smaller to the consumer than it would be essential to maintain the steam plant required. But this arrangement would be economical only where the consumers of power are scattered about. Were they located in one or two large blocks, as *shops* generally are found, the direct use of steam power would still be preferable.

WE have had unhappy experiences with many soft patches, some of which were so "soft" that their very softness made them "hard" things to deal with, but we never happened to run across anything quite like that described below, which we clip from the press report of a recent boiler explosion:

"Mr. Fred Blank says he was standing at the end of the boiler trying to *patch a leak with mud*, so they could *raise and keep up steam*, when the boiler let go."

Mr. Blank was badly bruised about the head and body, was scalded slightly, and injured internally. Very likely he was hit by flying fragments of that "patch."

The report further informs us that "the explosion must have been entirely unexpected to those working about the mill." This appears rather strange in view of the fact that they all appeared to be standing in just the right positions to get killed when the thing went off. The reporter also adds, somewhat superfluously, we think: "We were unable to ascertain the cause of the explosion."

If this method of patching boilers comes into general use boilermakers will no longer be needed on repair jobs; their places will be filled by the political editors of the daily newspapers.

At a recent meeting of the Detroit Association of Stationary Engineers, in a discussion of boiler explosion theories brought out by the publication of the views of the municipal inspector of that city upon the subject, Mr. John Trix, a former president of the Association, made the following remarks, to every word of which we can heartily subscribe. He said:

"How boilers explode has been a question that has been of moment since boilers were first invented. Theories are plentiful, but as one man put it, 'I cannot tell what makes a boiler explode, for I never was inside of one at the time,' and until a man has, there will be theories and theories.

"It is necessary, however, to get a good understanding of boilers, for gentlemen of our profession, during the last six years, have exploded 1,000 boilers in this country, killed 1,500 people, crippling many more, and caused a loss in damaged property and delays of $3,000,000. A theory was introduced a few years ago that friction of particles of steam and water generated electricity and in some way exploded the boiler. The Franklin Institute of Philadelphia made a thorough examination and concluded that no such combination of circumstances from this source could be brought about in a boiler as to cause it to explode. The theory that explosive gases were generated and exploded has itself been exploded, as has the super-heated water theory.

"The low water theory holds good to-day, inasmuch as under government supervision a boiler was heated red hot and cold water injected. After several such attempts to explode it, a crack in one of the sheets was finally made. The summary of all experiments by experts has been over-pressure, ignorance, and carelessness.

"Many proprietors seem to think that so long as the boiler holds water it is good for service. Iron will crystalize and lose its strength in a boiler, just as it will in railroad bridges, as has been illustrated by recent disasters. Poor workmanship is another undoubted cause. My opinion of a cause of explosions is as follows: About 80 pounds is usually carried at a temperature of 324 degrees Fahrenheit, and there is also 14 7-10 pounds atmospheric pressure. At this heat why does not the entire amount of water in the boiler go into steam? Because there is 80 pounds downward pressure. Relieve this pressure and an immediate evaporization follows. Therefore, if my boiler exploded, I prefer to have very little water in it, because, the more water there is, the more terrible the explosion. One cubic foot of water has an explosive quality of 1,700 times its unit. The rapidity of the steam is 1,450 feet per second.

"Engineers, in looking in their boilers, find at the water line and along the joining lines, a corrosion which may be dangerous if pronounced enough. You want to tell your employers about them. Be intelligent enough to explain to them, and I'll warrant that there is not one who wants to risk a boiler explosion.

"The last theory which I have encountered was that introduced by Boiler Inspector Carroll, of this city, to the effect that, through defects in boilers when they are shut down, cold air penetrates into them, which he accounts for by saying that when the boiler is cooling off the condensation forms a vacuum. When the boiler is fired up in the morning this air cannot be forced out rapidly. There is, then, in the boiler, 60 per cent. of water and 40 per cent. of air. The first revolution mixes water and air together. At 75 pounds pressure the air is expanded with great force, and at this time the boiler explodes.

"Now, the air has nothing to do with it. The air stays above the water line, and air will not 'mix' with water, as he claims. At the first revolution it enters the engine and goes out of the exhaust. The gravity of air and water cannot, under any circumstance, be called equal."

Several other engineers said they considered the inspector's theory impracticable and absurd.

WE are indebted to Mr. T. W. Anderson of Houston, Texas, for a copy of the *Houston Post* of July 29th last, containing a very complete account of the explosion of the boilers of the Houston Lumber Company, which occurred at that place on the 28th. Mr. Anderson also forwards a fragment from the shell of one of the exploded boilers, which shows that the iron was of an inferior quality, but no worse than is frequently put into boiler shells by makers of fair reputation who have to contend against sharp competition.

From the account in the *Post* we are led to understand that there were three boilers set in one battery with a common water connection, and that one of them had settled, owing, probably, to an insufficient foundation, so that it was necessary to keep it nearly full of water in order to keep enough in the other two to cover the flues. This being the case it was probable that the strain brought on the shells by the connections was sufficient to rupture one of them, or to suddenly break some of the connections, in which case, if the boilers were full of water, and under a good pressure, the catastrophe, as described, would be almost certain to follow, as a natural consequence. The violence of the explosion was in itself conclusive proof that it was not due to low water.

EXTRAVAGANT claims have been made for some time past for the merits of the microscope objectives made by Zeiss, of Jena, Prussia, of a newly discovered kind of optical glass. These claims seem to be based upon the two facts that, first, objectives *may* be made of this glass which shall have their visual and photographic foci co-incident; and second, the glass is soon destroyed, or at least *rendered worthless* by simple exposure to the atmosphere.

As to the first of these claims we can only say: the writer is not an optician, therefore he bears in mind the fate of Wenham, and will not discuss the *possibility* of making of the ordinary optical glass an objective which shall have the chemical and visual foci co-incident, so he he contents himself with saying he has had in his possession for several years objectives ranging from 3 inches to $\frac{1}{8}$ inch focal length, made by American opticians before the new glass was discovered, or even thought of, which make photographs by white light *just exactly* as they are focused. Their chemical and visual foci *may* be a mile apart for all he knows — or *cares* — with such results !

As to the second claim, he sees no possible benefit that can arise from it to any one but the makers of the glass, and the opticians who make lenses from it. It would doubtless be money in their pockets to duplicate orders for expensive lenses every two or three years.

Setting Globe Valves.

To the Editor of THE LOCOMOTIVE:

DEAR SIR,— In the July number of the *Locomotive* I find one bad piece of advice in an otherwise excellent article on the piping of steam boilers. I allude to placing a *globe* valve vertically in a horizontal steam pipe, which should never be done, because if placed with the *under* side of the seat next the boiler, it forms a dam which keeps the whole line a little over half full of water when the engines are not running, and on the other hand, if the *upper* side of the seat is toward the boiler, it makes a regular U water trap, the depth of which is just equal to the thickness of the valve seat, which by successive vacuum formations, gradually charges the pipe outside of the valve with solid water up to any point not less than thirty-three feet above the valve. *Have been there* myself, for the pipers changed the location of our gong, and we could not make it blow till it had thrown out several hundred pounds of water on the roof, if more than two hours had elapsed since the last blow. Investigation showed me what the trouble was, so I turned the valve down flat, and have never had any trouble with it since. Since I have been here I have turned down the globe valves in one factory, and in the other three have taken them out altogether, substituting angle valves with the outlets facing up, and the steam pipe line running on top of them, thereby insuring perfect drainage with no loss of heat, as would be the case with a waste drip. Another point is, that an angle valve does not make much more of an obstruction than one elbow, while a globe valve makes as much as three or four, according to the size of the body.

Respectfully yours,

A. HEATON,

Chief Engineer Wheeler & Wilson's, Bridgeport, Conn.

We must plead guilty to the charge of showing the valves wrong in the cuts referred to. It was an inadvertence in making the cuts, and attention should have been called to it in the article accompanying them, but we neglected to do so.

Globe valves should be placed nearly horizontal in all cases where possible, although in the case of the main steam connections shown, the pipes are generally so large and short they would not give trouble by the pipes filling with water. Still they should always be put in horizontally, and an angle valve is better. A straight-way gate valve is better still.

Neither should a globe valve be placed *exactly* horizontal. Its stem should be raised so that the water of condensation will not collect in the threads of the nut and stem, if it does it will be found difficult to keep it in with packing, it will always blow out and "sizzle," and make a nasty mess generally. The same trouble would be experienced with angle valves connected as described by Mr. Heaton, still it is the only way they could properly be set, for if they were placed with the upper side of valve toward the steampipe, the nipple between valve and main steam pipe would fill with water when the valve was closed; this water would lay against the stem, and it would be impossible to prevent leaking.

An Imperfect "Sheet of Paper."

No such misleading, inaccurate, and incomplete article on the paper industry has probably ever before been published as R. R. Bowker's article in *Harper's Magazine* for June, entitled "A Sheet of Paper." The writer pretends to give a comprehensive account of the industry from the time when paper was made of papyrus down to the present time, and to trace its development, particularly in the machine period, ending with a pretended intelligent description of the present processes of manufacture and the present attainments of the business. If the public accepts this as an authoritative statement, covering the ground that it pretends to cover, it will be greatly misled.

When Mr. Bowker says that "to this day our finest paper comes from the far East," he evidently neither knows what fine paper is nor where it is made. "The hard paper," reads another ridiculous statement, "made wholly or chiefly of linen, and pressed by 'super-calender' rollers into great compactness, used for the fine illustrated work of this magazine," etc. *Harper's Magazine* made out of linen paper! If that were the case, the publishers could not buy the paper for what they sell the completed magazine for.

In connection with this blunder, there are unpardonable omissions. Why did not the writer explain that "the fine illustrated work" of some publications appears on paper coated with Silesian white and then calendered. It is a prepared paper, made solely in the United States, and is now almost a necessity for displaying the exquisite work of our wood engravers.

This magazine, or, more technically, book paper, "requires little or no sizing. But with most fibers, unsized, the ink would be absorbed into the pores and would partly disappear from the surface, leaving a dingy instead of a sharp, clean print." This very superficial mention of printing on unsized paper leads to the false inference that most printing is done on sized paper. It was evidently not known that the lightning printing presses would be useless without a paper of considerable absorptive power, such as the news and book papers, which are composed largely of wood.

The man who attempts to write a history of paper manufacture in the United States, no matter how brief, and makes no mention of John Ames and his inventions, discloses his incompetency at once. The work of that remarkable inventor in breaking down hand work and in developing machine manufacture, no intelligent review of paper making can ignore.

The cylinder machine, which the writer of the article under criticism allows to make, chiefly, "the thicker and cheaper grades of paper, such as straw boards," is a far more useful machine. He is so far wrong that the machine makes tissue paper and any amount of news and book paper, as he might have found out by referring to the Paper Mill Directory of the World. There are seven cylinder machines in Bellows Falls, Vt., alone, working principally on tissue and news papers.

The manufacture of bank note paper is slighted with the mention of the Wilcox mill in Pennsylvania, a very necessary mention of course, but one that is now only an introduction to the subject. The work and achievements of Crane & Company would fill a good many pages. No reference is made to Dalton, that Mecca of every European paper manufacturer who comes to this country. Nothing is said of the best record, ledger, and bond papers made in the world, for which several mills in New England, chiefly in Massachusetts, are noted. Nothing is said of the exquisite stationery made in New England, outrivaling all competitors from abroad.

We learn that plate finishing "has now given way to super-calendering," though every one who knows anything about paper, knows that platers are in use in all the fine writing paper mills. And again, "what are called boards, as Bristol board, card board, binders' board, press board, and the like, are simply as many sheets of paper as are needed to make the desired thickness, consolidated by pressure." This is, of course, an absurd misrepresentation of the fact, which is merely that wedding board and one or two others kinds, all bearing but a small proportion to the vast quantity of boards made, are composed of pasted sheets of paper.

No one can quote the census of 1880 regarding the paper industry with any pretense of believing the reports, without compromising his character as an accurate and well-informed person; yet Mr. Bowker does this with the utmost reliance. His sins of omission, moreover, are as glaring as those of commission, as every paper manufacturer knows who has read the article. The errors are often ludicrous, as, for instance, when the polish on glazed paper is ascribed to varnish! Not to continue this destructive criticism to an unpleasant length, we may say that it is surprising that the editor of *Harper's Magazine* should permit the publication of such a blundering, misleading, and incomplete article as the one referred to. — *The Paper World.*

The Keely Motor Secret.— C. J. Bloomfield Moore takes it upon himself to unfold the possibilities of a new philosophy and a new philosopher, in the work and personality of Mr. Keely, who from time to time has allowed to get to the public accounts of a wonderful self-propelling motor. In this age of good humored skepticism, inventors rise up from time to time announcing perpetual motion machines, and then disappear, under a volley of newspaper squibs, and are forgotton. But Mr. Keely is not that kind of a man. He keeps right on tampering with the eternal forces of creation, as much a philosopher as an inventor, and, if his apologist Moore can be believed, hitching his wagon to the star of religion itself, with implicit faith that he is to move along a great highway of success. It will not do to make too much fun of an original thinker like Keely. All discoveries are first scouted, then listened to and honored. But no man of this age of mechanical wonders has made greater demands upon credulity, than has Mr. Keely. The secret of the Keely motor still remains behind a veil, but certain conclusions and principles are given out as a ground for the working out of the power which the inventor claims to have chained. Says Mr. Moore: "The Keely motor secret teaches, that the various phenomena of the human constitution cannot be properly comprehended and explained, without observing the distinction between the physical and material, and the moral and spiritual nature of man. It demonstrates incontrovertibly the separate existence aud independent activity of the soul of man." When one expects a mechanical combination that will by self-renewing energy draw a train of cars, or grind wheat, this explanation simply staggers the student. Mr. Moore explains that Mr. Keely's subject of investigation is the universal ether or medium of life principle that acts between molecules. Mr. Keely has said: "The true study of the Deity by man, bring in the observation of his marvelous works the discovery of a fundamental creative law of as wide and comprehensive a grasp as would make this etheric vapor a tangible link between God and man, would enable us to realize in a measure the actual working qualities of God himself (speaking most reverentially) as we would those of a fellow-man." Mr. Moore expects to see the inventor give a mechanical demonstration that, "the universal ether which permeates all molecules is the tangible link between God and man." The simple, bald, statement then, in reference to the Keely motor secret, is that the perpetual motor machine is to be run by Divine power, if it ever runs,—and many people have long had that opinion. Does C. J. Bloomfield Moore own stock in the Keely motor company?—*Springfield Republican.*

Traction Increasers for Locomotives.

At the recent St. Paul meeting of the American Railway Master Mechanics' Association a report was submitted by a specially appointed committee on "Traction increasers: their various types and relative merits; also cases in which their use can be recommended." The committee, consisting of R. H. Briggs, D. O. Shaver, and T. J. Hatswell, issued a circular of inquiry. Their report consisted principally of thirteen answers, and very little information of any value was elicited. Mr. James Meehan had tried traction increasers, and did not believe in them. He believed that using the weight of the tank for this purpose put an unnatural strain on the frame of the tender and engine, besides requiring too much attention from engineer as regards fluctuation of coal and water constantly going on. Again, the driving springs, if arranged to carry with flexibility the ordinary weight of engine, would be too light for such an increase; and if made heavy enough to meet said increase would obviously become too rigid for normal weight of engine. Mr. Lauder has tried several traction increasers, and abandoned the use of all. Mr. McKenzie has tried one of Dees' patent, and advised its use on all eight-wheel engines. Cost of maintenance for two years was nothing. Mr. Barnett thought they might be of use "on a tank engine or pusher too light for her work, but only engine available—the tank to be short, so that but few miles are run each day, thus permitting her while standing and waiting for trains to be assisted to accumulate full boiler of hot water and full head of steam, so that she will have steam enough to utilize the additional adhesive weight." He would not think of applying one to a new engine, and considered the theory a mistake. The committee had had no opportunity to investigate any device except the Dees'. Mr. R. H. Briggs, chairman, had used this device and obtained from 10,000 to 15,000 pounds extra weight on the drivers at will, the advantages of which were apparent. — *The Iron Age.*

Sixty Thousand Copies an Hour.

This is the producing power of a new newspaper printing press made by R. Hoe & Co., for the New York *Mail and Express*. It can make 60,000 four-page papers an hour, folded half-page size; or 60,000 six-page papers, the half-sheet being inset and pasted to the center margin; or 30,000 eight, ten or twelve-page papers, inset, pasted, and folded. One man has appliances with which he can place an immense roll of paper nearly seven feet long, in its proper place in the machine. The upper cylinder of the first pair carries eight stereotype plates of one page each, and the lower one is an impression cylinder. Running in from the bottom of the roll, the paper passes first under what is known as a pipe roller, then through between the two cylinders mentioned and down around another large impression cylinder. Before completing the revolution with this cylinder, the second plate cylinder is encountered and the second side is printed.

The paper, still the full width of the web, now runs up along the line of the top of the frame and over the passageway to a turning bar, fixed diagonally across the frame, over which it is led, changing its course to one at a right angle with its first course; thence (if a four or six-page sheet is desired), the broad web passes over rollers and thence to the longitudinal folders, the main web having been divided by a circular knife into two narrow webs, each the width of a four-page paper, taken across its columns. The supplement press then prints the supplement with pages in duplicate. The supplement web is then divided into narrow webs, each the width of a single page, and these are led to their respective folders, where, as they underlay the webs of the main press, they come together so that each main web has its half-width supplement web underlying, its inner edge being in line with the center margin of its main web, to which it is pasted. A perfect register is secured and each of the webs is longitudinally folded with the supplement inside. The papers are finally folded to a half-page size and at each revolution of a knife two papers are cut off. The papers are automatically counted into piles, and carried out to the delivery.

The *Mail and Express* also has two presses, each with a producing power of 30,000 papers per hour, so that its press equipment is now equal to the production of 2,000 copies a minute, or 120,000 copies an hour.—*The Paper World*.

THE *Paper World* says: — "A London exchange cannot understand how it is 'that in face of the surpassing superiority (as we are told) of the native product in this line, these English papers find a sale [in America], and at a price greater than that which is paid for the genuine American article. This is indeed a mystery, and one that we should like to see solved.'"

It is an absurd and ignorant prejudice on the part of the common customer in favor of anything "imported." The shoddiest goods that foreigners please to send here, can often be sold in competition with American goods, and at higher prices. A man may be a good judge of a hat or a pair of shoes, and a woman of a dress pattern or any article of clothing, but what on earth does either of them know about paper, anyhow? The Englishman or German sends over bi-sulphite notepaper, as thin as tissue, and as inelegant as one could hope to see, and the principal of a young ladies' school buys it for "Bankok Court Stationery," or some other.

But we can tell our querist across the water, that no one in the United States, who has even the crudest appreciation of good paper, takes any English paper in preference to "Distoff Linen," or "Satin Finish," or "Clover Leaf Linen," or "Whiting's Standard," or in preference to the product of a score of mills in New England. Men who use record and ledger papers here, wouldn't take the English paper as a gift. Our best stationers use American papers exclusively. Of course Marcus Ward's and Pirie's papers are excellent, but no more so than many mills in this country make; and as a general thing, British paper is not sold to anyone in the United States who knows a sheet of paper from a side of leather.

Military Infallibility.

STRANGE SIGNIFICANCE OF THE SUNSET GUN.

A correspondent thinks that the recent order of the Secretary of War for discontinuing the firing of the sunrise and sunset guns at Governor's Island and other military stations is hard on the army, as it forces the men to consult the almanac to ascertain when the sun rises and sets.

This recalls a good story that is told of the late Colonel Robert N. Scott, who died recently, leaving unfinished his important work of editing the War Records. After the war he was stationed at some small fort in New York state, over a garrison of less than twenty men, and there was very little work to be done other than performing the military ceremonies and keeping up the garrison farm and garden.

An amateur astronomer in the vicinity took considerable interest in timing the morning and evening guns, and became seriously disturbed when their irregularity caused his chronometer to appear to vary. He had too much respect for the military regulations, which said the gun should go off exactly with the sun, to doubt that error was at the fort. He made the calculations for that meridian and found his chronometer correct. But his respect for the government outweighed even his reliance on his figures ; so he sent his figures for verification to the Dudley Observatory at Albany.

On getting them back, with the Observatory endorsement of their correctness, he was startled and shocked, and saw no way but to lay the facts before the commandant at the fort. Colonel Scott received him with affable dignity, and listened to his tale of perplexity. Having heard him through, the Colonel said:

"My dear sir, I think I can enlighten you on this matter. The man that fires that gun is the ordnance sergeant. He is also the orderly sergeant, quartermaster sergeant, sergeant-major and hospital steward, and he likewise milks my cow. Now, his orders are to fire that gun as soon as he has milked my cow, and while there may be some uncertainty about your timing the sunrise and sunset by the report of that gun, you may feel mighty tolerably sure that my cow has been milked." — *Exchange.*

"Mr. Cooper was in the Boiler."

An account of ex-Mayor Cooper of New York, which I recently got from a manufacturer's agent, is interesting as suggesting three things.

I must premise that what is known as the Peter Cooper horizontal multitubular boiler has some of the central vertical rows of tubes, and some of the side tubes, omitted from the usual style of construction; one of the objects being to facilitate circulation.

Inquiring where Mr. Cooper was, he was informed that he was "in the boiler." Hunting him up, he found the millionaire ex-Mayor with a lamp, crouched down among the flues and inspecting each tube for its whole length. "Why, Mr. Cooper," said the agent, "what are you doing here? This is no place for you." "Oh yes," said Mr. Cooper, right here is my proper place. I always pay personal attention to my boilers and then I know just exactly in what condition they are."

We may think of three things in connection with this anecdote: —

(1.) The only way to know what is going on inside a boiler is to get right inside of it and find out.

(2.) The omission of the central and side tubes facilitates critical and detailed personal inspection as well as water circulation.

(3.) The manufacturer who attends to things personally and is not afraid of straining his neck, cramping his knees, and smutting his face, will get better service out of men and materials than he who plays the part of heavy dignity.—*R. T. in Mechanical News.*

The Locomotive.

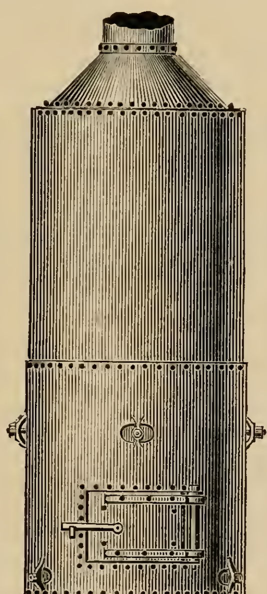
PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

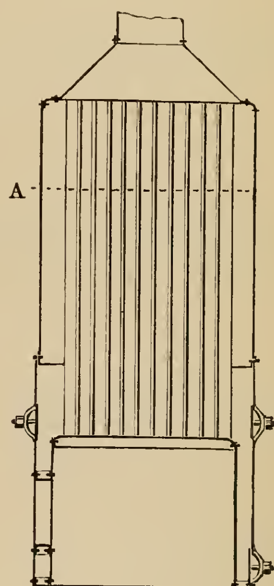
NEW SERIES—VOL. VIII. HARTFORD, CONN., OCTOBER, 1887. No. 10.

Heating Surface of Upright Tubular Boilers.

The usual method of reckoning the power of the ordinary form of upright tubular boiler seems to be to figure everything from the bottom of the water-leg to the top of the upper tube sheet in a lump, and call it effective heating surface. Sometimes a little more seems to be added to the amount thus obtained, for the purpose, evidently, of making the nominal power figure just right according to some standard.

That this method of computing the heating surface of this class of boilers is liable to lead to serious errors may be easily shown. That portion of the fire-box surface below the surface of the layer of fuel is of very little use for making steam. The fuel lays dead against these surfaces within a very short time after making the fire, and unless the fire is very skillfully handled there will soon be a non-conducting layer of ashes in contact with the sides of the furnace, which will effectually prevent the transmission of heat to the water in the water-leg. It will be perfectly safe to omit the lower six inches or so of the fire-box in estimating the power of the boiler.





But the most serious source of error consists in estimating that portion of the tubes above the water line as heating surface. In some boilers this forms about 35 per cent. of the total surface exposed to the fire, and it may easily be seen that great discrepancies may sometimes be found between the nominal power of a boiler where such surface is estimated and the actual power it may be enabled to develop.

For the sake of illustration, we have taken the amount of heating surface given in the catalogues of several makers of this kind of boiler, and compared it with the amounts obtained by figuring the same from the dimensions of the boilers as given by them in the same tables. In every case the amounts given exceed, in some cases, considerably, the figures we obtained by calculating the entire internal surfaces of the boiler, from the bottom of the mud-ring to the upper tube sheet, and when proper deduction is made for the useless portion of the upper ends of the tubes, the discrepancy in every case is found to be very great.

Of course it makes no difference in the actual power of a boiler whether this surface is estimated or not, the point we wish to call attention to is the fact that in designing steam plants if the surface is figured this way, and no margin is allowed, the boiler power will generally be found, when the plant is started, much too small.

A single case will illustrate this point. A heating system was put into a large building, and it was thought that upright tubular boilers were the most available for the space allotted for boiler-room. They were put in, the amount of heating surface being figured very close as is generally the case with such contracts where there are several competitors for the work. When the plant was started up it was found that holding steam was simply impossible, a calculation of the heating surface (actual) of the boilers showed it was just sufficient to maintain steam in the supply and return pipes of the system, (which owing to the peculiar arrangement necessary, were very numerous and of large size,) and in cold weather this was all that could be done. Every expedient was resorted to that could be thought of, but all to no purpose whatever, until more boiler power was added, when everything worked as smoothly as could be wished.

In our illustration, which represents a thirty-six inch boiler drawn to a scale of about three-eights of an inch per foot. the water line would be at the point marked A, it will easily be seen that the tube surface above this line compromises about twenty-five per cent. of the entire heating surface in the boiler, and it cannot make steam, for there is no water in contact with it to make steam of.

Inspector's Reports.

August, 1887.

Total number of inspection trips made during the month of August, 1887, 3,767, boilers examined 7,205, boilers inspected internally 2,989, subjected to hydrostatic pressure 534. In all there were reported 9,191 defects, which led to the condemnation of 48 boilers. Our usual analysis of defects is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	478	46
Cases of incrustation and scale,	691	41
Cases of internal grooving,	34	9
Cases of internal corrosion,	198	17
Cases of external corrosion,	272	25
Broken and loose braces and stays,	571	19
Settings defective,	155	10
Furnaces out of shape,	228	9
Fractured plates,	203	43
Burned plates,	158	22
Blistered plates,	212	9
Cases of defective riveting,	3,448	113
Defective heads,	49	21
Serious leakage around tube ends,	1,306	358
Serious leakage at seams,	727	27
Defective water-gauges,	72	13
Defective blow-offs,	33	6
Cases of deficiency of water,	10	5
Safety-valves overloaded,	39	7
Safety-valves defective in construction,	35	17
Pressure-gauges defective,	243	22

Nature of Defects.	Whole Number.	Dangerous.
Boilers without pressure-gauges,	3	0
Defective hangers,	13	7
Defective man-hole rings,	2	0
Defective dome construction,	1	1
Defective nozzles,	3	0
Defective fusible plugs,	7	1
Total,	9,191	848

Many of the plates reported as blistered in our monthly statement of defects are in reality laminated plates found in new boilers, generally at the time the hydrostatic test is applied when the boiler is finished. A laminated plate only needs the application of a little heat to blister it, and the two may be considered one and the same thing.

Lamination, which leads to blistering, is due to imperfect welding of the different layers of which iron plates are made up, and is never found in steel plates. The very best iron plates sometimes blister, even those made of the best material, and which have been made with the utmost care. This is due to the fact in rolling plates, as in every other kind of work where iron has to be welded, an imperfect weld will sometimes result, in spite of any amount of care and skill.

Where the lamination exists at the edge of a plate, it should always be seen during the construction of the boiler, and if of considerable extent the plate should be rejected. But unfortunately this is not always the case. The lamination is more apt to be somewhere away from the edge of the plate, than anywhere else, and then its detection is difficult and in most cases impossible, until it begins to blister under the influence of heat.

The treatment of a blister depends entirely upon its character and size. In the majority of cases judicious trimming at the proper time will be the only thing necessary, in other cases the lamination is so deep, and extends over so large a surface that the entire sheet has to be removed.

Boiler Explosions.

August, 1887.

Saw-Mill (110). — The boiler of a saw-mill near Goldsborough, N. C., exploded July 29th, killing two colored men and badly scalding four others.

Planing Mill (111). — A boiler exploded August 10th in the planing mill of Renn & Co., Chicago. No one was injured, and the damage to the building was slight.

Saw-Mill (112). — Herndon, Ky., was the scene, August 8th, of a terrible boiler explosion, in which John Crimes, colored, lost his life in a most horrible manner. The explosion occurred about 1 o'clock. Crimes, who had only been employed the Saturday before, was standing in close proximity to the boiler at the time. The fragments of the machine tore the shed overhead into kindling wood; Crimes was killed instantly, his body being cut completely in two. The legs and bowels were hurled against a saw-log about twenty yards distant, while the chest and arms were found at 100 yards above the I., A. & T. railroad track. The unfortunate man's brains and bits of flesh and head were scattered in every conceivable direction. He was nineteen years old. The saw-mill was owned by Page & Vaughan, who estimate the damage to property to be about $500. The boiler was not an old one, having been in use only two weeks at the mill.

Hoisting Engine (113). — A boiler explosion occured August 13th on the exchange dock in the rear of the Knickerbocker Ice Company's office, Savannah, Ga. The boiler was an upright one used for hoisting ice, and it was being used at the time in discharging a load of ice from the bark, *Mina A. Reed* of Boston. Guy Grimke, the engineer, and William Bennett, the striker, were within the little shed in which the boiler stood, and Tom Alexander, a stranger, was standing in the doorway talking to the two on the inside. Suddenly there was a puff of steam from the furnace door and immediately it was followed by an explosion which knocked Bennett and Grimke down, and threw Alexander twenty feet away. The steam and hot water flew in every direction, scalding the three men most frightfully. The boiler was thrown out of plumb about three feet, and the inside plate, grate bars, and base were blown out. The explosion set fire to the shed and a pile of shavings in which the ice had been packed, but the blaze was soon extinguished. A man named Jerry Marshall, who was at work on the gangway, twenty-five feet above the boiler, was struck on the shoulder with what he thought was a piece of coal when the explosion occurred, but he was not seriously hurt.

MINE (114). — A boiler used for hoisting at a mine near Leadville, Col., exploded August 17th, killing the engineer and wrecking the boiler house.

CANNING FACTORY (115). — The boiler in Johnson's corn-canning house near Gorham, Me., exploded August 26th, with a report that was heard for a long distance. John Hamlin was so badly hurt that he died within a short time. Fred Hamblen is so seriously injured that he cannot survive. Mr. Johnson himself was severely scalded, and Henry Palmer was also injured, but not seriously. The bath-room was blown to pieces. Mr. Johnson estimates his loss on the building, stock, and machinery at about $1,000.

BOILER SHOP (116). — A boiler in Kane & Ryan's boiler-shop on Hilton street, Bradford, Pa., while being tested preparatory to being shipped away, exploded August 30th. James Kane, one of the proprietors, was instantly killed. His body was found between two buildings entirely stripped of its clothing and terribly mangled and the head completely severed from his body. An employee named Godfrey was slightly injured. A portion of the boiler weighing two or three tons was thrown a distance of 400 feet and struck the tender of an Olean, Bradford & Warren engine standing at the union station.

THRESHING MACHINE (117). — While farm hands were threshing on the farm of Lyman Curtis, five miles east of Flint, Mich., August 30th, the grain stacker caught fire and while the men were fighting the fire the steam boiler exploded, killing Daniel Steegar and severely injuring William Rockwood, John Bennett, and three young women who were assisting. The barns with the entire crop of the season were destroyed.

FOUNDRY (118). — A peculiar boiler explosion occurred August 31st, at Lord & Erhart's foundry and machine shop, 842 to 850 West Sixth street, Cincinnati, Ohio. The building is two-story brick. In the western extremity was a two-flued boiler, 42 inches by 20 feet. It was inclosed in a brick setting, and the boiler-room consisted of a small frame addition, partly within and partly without the foundry proper. Some eighteen or twenty men were at work at the time, handling the molten iron, and doing other work within a few feet of the boiler-house. Suddenly there was a dull, rumbling sound, and the air was immediately filled with flying bricks and mortar. The boiler-shed was torn to pieces, and the large cylinders thrown out of place. When the dust cleared away, it was found that one of the boilers had collapsed in the center. A large flap, extending two-thirds around, was flattened like a door on hinges. William E. Erhart, Jr., was painfully burned about the breast, arms, and face, but whether by the iron or steam he could not tell. He was removed to his home close by, but his condition is not serious. The foreman, Fred Smith, had his foot mashed by a flying brick. These were the only two men injured, although a score stood close to the boilers. Opposite and within twenty feet of the boiler-room was the elder Erhart's residence. Mrs. Erhart was sitting at the window sewing. On the porch a little eight-year-old girl, Ada Dennis, her niece, was playing. There was a shower of bricks, and the marks on the house show with what violence they were thrown. The window-shutters were shattered, but Mrs. Erhart escaped entirely uninjured. One of the bricks hit the little girl in the head, and made a painful, but not serious, scalp wound. James Stone, the engineer, tried the gauge a few seconds before the explosion. There was then between forty and fifty pounds of steam, which amount was usually carried. The safety-valve would blow off at sixty pounds. The boilers were built and put in in May, 1883. The explosion must have been due to some weakness in the iron. The windows in the foundry were broken, and the firm estimate their loss at between $700 and $800.

Steamer (119). — A collapsing flue on the steamer *Kissimmee*, which plies between Bridgeport and New Haven on Sundays, caused a wild panic among the passengers on the last trip, August —. The flue burst with a loud report, and the sound of escaping steam, started the 225 passengers in hot haste after the life-preservers. The danger of death to the weaker ones by being trampled under foot was imminent, and Capt. Marvin told the passengers there was no danger, in a laughing way, which brought them to their senses. The passengers were taken ashore and returned to New Haven.

A Foreign Sample. — Twenty-two boilers belonging to a blast furnace and iron works at Friedenshutte, in Selisea, exploded July 25th, killing two men and wounding twenty others. After the explosion a fire broke out, which consumed six houses and a shop.

Ignoble Defeat. — A peculiar horror has always been attached to the tiger which has become a man-eater. If we stop to formulate our impressions in regard to him, we realize that he seems to us an unexceptionally ferocious beast of his kind, one who disdains the pursuit of any prey but the highest. This, however, is not always the case though, in spite of the following rather ludicrous incident, we do not think any tiger that has the breath of life in it is a contemptible foe.

Phil Robinson relates an amusing story of the ignoble death of a man-eater. The beast was a creature of immense proportions, and was the pride of the Calcutta zoölogical collection. Alas, for such an animal that it should have been killed under the circumstances that covered it with ridicule.

It happened that a fighting ram belonging to a soldier in one of the regiments cantonned in the neighborhood became so extremely troublesome that the colonel ordered it to be sent to the Zoological Gardens. There, however, it was as great a nuisance as formerly, and being no curiosity, though excellent mutton, it was decided to give it to the great tiger.

So ferocious was this creature supposed to be, that it had a specially constructed cage, and its food was let down through a sliding grating in the roof. Down this, accordingly, the ram was lowered.

The tiger was dozing in the corner, but when it saw the mutton descend, it rose, and after a long sleepy yawn began to stretch itself.

Meanwhile the ram, who had no notion that he had been put there to be eaten, was watching the monster's lazy preparation for his meal with the eye of an old gladiator, and seeing the tiger stretch himself, supposed that the fight was commencing.

Accordingly he stepped nimbly back to the farthest corner of the stage, just as the tiger, of course, all along expected he would do, and then, which the tiger had not the least expected, put down his head and went straight at the striped beast. The old tiger had not a chance from the first, and, as there was no way of getting the ram out again, the agonized keeper had to look on while the sheep killed the tiger! — *Elmira Gazette.*

The Locomotive.

HARTFORD, OCTOBER, 1887.

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The Locomotive *can be obtained free by calling at any of the company's agencies.*
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We have received from Mr. John J. Hogan, M. E., 87 Center Street, N. Y., copies of his formulas for specifications for steam and water heating apparatus. Mr. Hogan issues twelve different forms for as many different styles of heating, and the specimen copies sent us are as full and complete as one could possibly wish. Any one having specifications for this class of work to make, will find it to their advantage to communicate with Mr. Hogan.

The latest candidate for favor in the steam engine line is a four-cylinder affair that exhausts back into the boiler, or is said to do so. The saving is to be fifty per cent. of floor space, and seventy-five per cent of fuel. There are "no valves, eccentrics, steam-chests, cut-offs, link motions, etc., to get out of order," and it has various other advantages, but as they do not save more than a paltry twenty-five to thirty per cent. of anything they are hardly worth enumerating.

The above claims look like absurdities, but as *a drawing* has been exhibited to the chamber of commerce in one city, and *is to be* exhibited on the New York Stock Exchange, and a company has been formed with a capital of $500,000, we are forced to believe that — the gullible had better look out for their money!

It is useless to say anything more about it. There is no such thing as cylinder condensation; on the contrary, steam becomes superheated at every turn from the time it enters the cylinder until it leaves it. Peter Van Brock *says so.* "Way back in '56" — but never mind the demonstration. Peter Van Brock *says so*, and that settles it.

One of the worst accidents that has happened recently, occurred a few days since on the English steamer *Elbe.* She had been fitted with new engines and boilers, and was making her trial trip in Stokes Bay, Southampton, when her main steam pipe, which ran fore and aft through the fire-room, burst, and ten men who were in the room were boiled to death. The rupture occurred with a sharp report about three o'clock in the afternoon. The report was followed by a rush of steam from the "stoke-hole," which continued for two hours before it subsided sufficiently to allow any one to enter the room to aid the unfortunate men. The pipe was of copper, full one-fourth inch thick and nine and one-half inches diameter. The break was three feet long and opened out to about nine inches wide at the widest part. The break occurred close to but not through the seam where it was brazed. An investigation is being made by the Board of Trade.

Several genuine and very destructive explosions of so-called safety or non-explosive boilers have occurred recently, and it may not be amiss to say a few words upon the subject. To begin with there is no boiler made that is non-explosive. The most that has been done to render them non-explosive has been to sub-divide the water into small divisions; this diminished the risk of big explosions, and substituted for it the risk of a much greater number of minor accidents, all of which, it should be borne in mind, are just about as likely to scald any one who happens to be near the boiler at the time, as would a much larger explosion. No boiler having a connecting or mud-drum several inches in diameter, or a steam-drum the size of an ordinary boiler-shell, can lay any sort of claim to be any safer than the ordinary form of tubular boiler. The subdivision of the water into many small portions means increased first cost of boiler, increased bills for repairs and attendance, and diminished economical performance.

The Construction of Boilers for High Pressure.

The increasing demand for boilers of large size, strong enough to safely bear the high pressures now insisted upon, calls for improved methods of construction, as well as the very best materials.

It was but a few years ago, comparatively speaking, that the greater number of boilers built for ordinary purposes were single riveted throughout, the rivets were generally pitched without reference to the amount of material punched out. Sheets rarely exceeded $\frac{5}{16}$ of an inch in thickness; from forty-eight to fifty-four inches in diameter were the majority of sizes, sixty inches in diameter was an exceptional size for a boiler of the horizontal, tubular type. Sixty to seventy-five pounds per square inch was about the limit of pressure; eighty pounds was considered high.

At the present time things are different. Instead of being contented with a 54-inch boiler and seventy-five pounds pressure, the manufacturer insists upon having boilers at least seventy-two inches in diameter. He would rather have them larger; he insists upon carrying one hundred pounds per square inch, and wants to carry one hundred and fifty pounds. This tendency is in the direction of greater economy, and is therefore to be commended; but the limit of reasonable safety should not be passed in the general endeavor to beat somebody else's record.

In designing a boiler of large diameter to carry safely a very high pressure, several things must be borne in mind. To begin with, only the very best materials that can be made should be thought of in their construction. The materials should be guaranteed to pass the severest tests that can reasonably be applied, and *every sheet should be tested*, to see that it fulfills the conditions of the guarantee. The plate maker may be ever so conscientious, but unless he tests a coupon from every plate, he himself cannot tell just what its qualities are.

A single case will illustrate this point. A large order for boilers was given, and as it was desired to have them first class in every respect, it was specified that the tensile strength and ductility of the plates should reach a certain standard. This was not put at an excessive figure, but only what a steel maker could comply with by using ordinary care. The plates were purchased of a well-known firm of steel makers, who readily guaranteed every plate to pass the specified tests. It was probably thought by the makers of the plates that their guarantee would be considered sufficient, and that no tests would be made, but in this particular case it was *not*, and the consequence was that about *one-third* of the plates were rejected, they failing utterly to fulfill the requirements of the specification. If the tests had not been made the purchaser would have paid for the best *fire-box* steel, and received a considerable quantity of a very poor article of *shell* steel.

There is no doubt that if the trouble was taken to test plates as they run, the average would show considerably below the strength stamped on them.

Fire-box steel plates of good quality should have a tensile strength between 55,000 and 60,000 pounds per square inch, parallel test pieces four thicknesses wide should show a reduction of area at point of fracture *not less* than fifty-six per cent., and the elongation in a length of eight inches should be *not less* than twenty-five per cent. The same pieces should also bear bending double when cold, when hot, and after being heated red hot and quenched in cold water, without any sign of fracture. The possession of such qualities would indicate a good ordinary best steel, but special heats can always be made if the quantity wanted is sufficient to warrant them, possessing much greater ductility than that mentioned above. A reduction of area of seventy per cent. can be attained, sixty-five per cent. is common, while the elongation in a length of eight inches may run as high as thirty per cent.

The possession of a high degree of ductility is an essential quality for material which is to be worked under the maximum strain allowable, especially in the thick plates which are used in the larger sizes of boilers, and which are necessary to obtain the requisite strength.

Improvements in machinery have been made within a few years which not only tend to reduce the cost of producing first-class work, but also enable a better boiler to be made. Flanging machinery turns out heads almost perfect at a minimum expenditure of time and labor, and bending rolls of great length enable the entire lower half of the shell to be made of one sheet, thus giving a perfectly smooth surface for the bottom, one which is kept clean with the least possible trouble. Another advantage of this form of construction, but one to which attention has not been called as yet, so far as we are aware, is this: The bottom of the shell being free from transverse laps, a considerably thicker plate may be safely used than has been possible heretofore. The limit of thickness, where seams have been exposed to the fire, has been found to be about $\frac{1}{2}$ inch; with this improved construction, where there are no girth seams, and the longitudinal seams are kept above the fire line, a thicker plate may be used, the longitudinal seams may be riveted with double butt straps, and a much greater strength attained than has hitherto been deemed possible, or if a manufacturer were satisfied with ordinary pressures, a much larger shell could be made, and safely used. Plate makers should equip themselves with facilities for turning out plates twenty feet long and twelve to fifteen feet wide. Such plates could be used very advantageously.

The riveting of joints is receiving much more attention now than it formerly did. It used to be almost universal practice to pitch rivets any distance apart that the boiler maker fancied was right. In double riveting the pitch was rarely increased, but made the same as in single riveting, and Sir W. Fairbairn's word was taken for it that the strength of the joints were respectively fifty-six and seventy per cent. of the solid plate. Now experiments are being made, not only with different pitches, but with different forms of joint. Very satisfactory results have been attained with some of these joints, and further improvements may be looked for. Joints which under test gave ninety per cent. of the strength of the solid plate have been made already. As the riveted seam is the weakest part of the shell, any increase in its strength, however slight, is of great importance.

Bracing of the heads is as easily accomplished for high pressures as for low, it offers no special difficulties and need not be considered here. There is one point, however, to which we would call attention: We see no good reason for always making the tube sheet thicker than the shell. There is no more strain per unit of area on the head of a 72-inch boiler than there is on the head of a 36-inch boiler, yet the head will always be found thicker in the former case than in the latter. One-half an inch is thick enough for the head of any boiler of the ordinary type, no matter what the diameter and thickness of the shell may be. It is thick enough to afford all necessary bearing for the tube ends, and if it were in a 36-inch boiler would be considered all right, if well braced, for a pressure of 225 pounds per square inch. Why it should not serve the same purpose in a 72-inch boiler, even when the shell is more than ½ inch thick, the writer is unable to see.

The usual method of supporting boilers is to carry them on the side walls of the setting by means of brackets riveted to their sides. Ordinarily this answers the purpose admirably, but it may be questioned if in the case of very heavy boilers, where the best attainable results are desired, it would not be well to hang the boilers from overhead beams, such beams to be very stiff, and rest on posts or piers disconnected entirely from the boiler setting. This construction would be more expensive, but there would be less liability of the boilers changing their position and straining or breaking the steam pipes. However if care is taken in putting in foundations, and good sized wall plates are used under the brackets, to distribute the weight of the boilers, no trouble will result from carrying the weight of boilers upon setting walls. Where there has been trouble caused by walls settling or cracking, it has invariably been found that the foundations were insufficient, or that the wall plates were too small to distribute the weight of boilers over any considerable area of the wall. H. F. S.

Annealing and Tempering Fine Tools.

Having had about twenty-five years' experience as a tool-maker, I feel confident that I can give some good points on annealing and tempering fine tools.

I have occasion to visit railroad machine shops and other large shops that use quantities of fine steel tools, such as taps, reamers, thread cutting dies, milling cutters, etc., and I find that almost all of them lose from ten to fifteen per cent. of these expensive tools when they are first tempered, or as soon as they are put into use, and at least twenty-five per cent. the second time they are hardened, and about fifty per cent. the third time. To avoid this large loss and annoyance, have your steel annealed by the steel manufacturers in short bars from five to six feet long, the sizes you may want, and cut off the required length you may wish for your tools. This will save the forging and consequently much expense, and your tools have not been overheated, and there is no uneven strain on the tool. If your tool is of such a shape that you have to have it forged, do not heat it too quickly, but thoroughly all the way through, and do not hammer.

Forged tools should be annealed and roughed out by planing or turning off below the hammer marks, and then annealed again. This will avoid springing when hardened. To anneal small sizes of steel, use iron pipes, plug up one end, and fill up with the tools. Sift in fine charcoal dust, plug the other end, and heat it slowly until it is at a good red heat all the way through; then bury it in fine charcoal or wood ashes. If you have no wood ashes, use dry sawdust, and in a short time you will have the ashes and the most perfect annealing preparation in the world. Have this in a good tight iron box with a close cover. For annealing taps, reamers, and milling cutter, dies, etc., use find wood ashes, dish out the center, and replace the ashes with dry sawdust. Heat your steel slowly to a good blood red, and bury it in the sawdust and cover it over with fine charcoal dust or fine dust from around the forge, put on your cover, and let it remain until cold. I always make it a point to get my annealing in on Saturday if I possibly can, and let it remain until Monday or until cold. Heat your tools slowly and thoroughly all the way through, then immerse. If a tap or fluted reamer, put it down in the center of the tube as straight as you possibly can, and move it up and down slowly from one to two inches, so as to avoid a water line, until it is chilled about half way or one-third through, as near as you can judge. This you can determine quite accurately by the tremble of the tongs, caused by the condensing steam around the tool. The tremble will cease when the tool is chilled about half way through. Then drop it into the oil, and let it remain until cold, then take out, brighten, and test the hardness with a small sharp file, and you will find that you have about the right temper required. For cast-iron and brass you will require the tool much harder than you will for wrought-iron.

Large tools after remaining in the oil will sometimes draw the temper a little more than required. If the oil commences to boil by the heat of the large tool, have a pail of boiling hot water close to your oil tub, take your large mill or whatever kind of tool it may be, and immerse in the hot water for eight or ten seconds as near as you can judge, and then return it as quickly as possible to the oil, and let it remain until the oil stops boiling. We will suppose this to be a large mill cut on top and sides. If you are in a hurry for this tool, and cannot wait until it is quite cold in the oil, you may take it from the oil and put it over a clean slow fire, brighten a few of the teeth, and draw the temper to suit your work, then return again to the oil and let it remain until cold. It is the safest way to draw the temper on large tools a little on the outside at the same time the temper is drawing from the inside, but there is no occasion to draw the temper on most of your tools from the outside. With this process you will see that the temper is drawn from the inside of tools instead of the outside — the old-fashioned way. By tempering tools in this way, you have a *soft-centered steel.* The brine has hardened the tool so far as it required to be hard, and the oil keeps it hard and allows the center or thick part to cool slowly. It will not throw your tool out of round, but will run on the centers as true as before it was hardened. Milling cutters, taps, and fluted reamers only require to be hard on the cutting parts, and with this process you have just what you want, and you can anneal and harden them a dozen times and never break them. The teeth will not crack off as they do in the old-fashioned way of hardening tools.

Chipping chisels, after forged, should be heated slowly at least three inches from the cutting edge, to take off the uneven strain caused by forging. Never hammer a cold chisel after the red has disappeared, especially on the edges. The corners will break off if you do. Immerse in clean soft water about two inches, and move the tool up and down slowly, keeping the point in the water at least one and one-half inches, until the water will not hiss on the tool. Then brighten and draw the tool to a sky blue.

If a tap or any other fine tool should by chance get too hot or burnt, do not take the tool from the fire, but shut off the blast. Get some resin, put it on the tool freely, and let it remain in the fire ten or fifteen minutes, occasionally putting on the resin, and letting the tool cool down to a good cherry red, and then immerse as above described, and your tool is as good as if it had not been overheated. I do not recommend overheating steel. It should not be heated more than a cherry red for hardening, and should be heated in a furnace if possible. If you have much tempering to do, it will pay to have one built. A furnace suitable for heating will cost about one hundred and twenty-five dollars. — *C. B. Hunt, in Scientific American.*

Another Glance at the Sea Serpent.

By GRANVILLE B. PUTNAM, FRANKLIN SCHOOL, BOSTON.

And though they hide themselves in the top of Carmel, I will search and take them out thence; and though they be hid from My sight in the bottom of the sea, thence will I command the serpent, and he shall bite them. — *Amos* ix : 3.

Not long after my story of the sea serpent, as given in the *Congregationalist*, October 14, 1886, I received letters, upon each of three successive days, from three different States, calling my attention to the above text, which seemed to add scriptural authority to the accumulated opinions of naturalists, and the unimpeachable testimony of scores of trustworthy eye witnesses, as to the existence of this marine monster. I am confident that much of the skepticism concerning it arises from the ridiculous accounts which appear so often of some impossible monster, in some improbable locality, and reported by some unknown individual; but a careful investigation of facts will lead any fair-minded person to distinguish between these and those statements which are worthy of belief. Senator Tazewell of Virginia, while dining at the White House, informed President John Quincy Adams that he never knew a Unitarian who did not believe in the sea serpent. Such faith was, however, not confined to this denomination, for the Boston *Recorder* of August 19, 1817, has an article upon the "Monstrous Serpent," a copy of which has been sent me from the attic of the General Putnam birthplace, where, for nearly sixty years, it had been preserved with a sacredness akin to that which guards the Bible and the hymn book. This article describes a "prodigious snake" that had just made its appearance in the harbor of Gloucester and its vicinity. It was first reported on one of the earlier days in August, by the skipper of a Maine coaster, who visited the auction room of William Lipple. So little credence was given to his story that he soon left the store and the harbor in disgust, without giving his own name or that of his vessel.

As reports of almost daily visits of this monster were now sent from Gloucester to Boston, the Linnean Society of New England, which was the Natural History Society of those days, appointed, upon the 18th of August, a committee, consisting of its president, Judge John Davis, Jacob Bigelow, M. D., and Francis C. Gray, "to collect evidence with regard to the existence and appearance of a sea serpent said to have recently been seen in the harbor of Gloucester." The committee selected Hon. Lonson Nash, State senator, and one of the most prominent men of that town, to aid them in their investigations. Under his supervision, the depositions of Capt. Amos Story and ten others, mostly mariners, were secured with the utmost care. All testimony was taken down in writing, and, after each witness had related his observations, twenty-five questions were proposed to each separately, if not rendered unnecessary by his previous statements. Judge Nash, who twice had a good view at a distance of 250 yards, presented his own observations under oath, and also bore witness that all who had deposed were "men of fair and unblemished character."

This testimony, while dissimilar in some minor points, as would be expected, presented a very substantial agreement, as will be seen by reference to the printed report of this committee, which declared "the testimony obtained sufficient to place the existence of the animal beyond doubt." The details are, in general, so like those given of my own observations at Pigeon Cove a year ago, that I will not take the space to repeat them. These twelve were by no means the only spectators; for at one time more than 200 people watched him as he sported nearly a whole afternoon not far from the shore under Windmill Point. He was sometimes seen moving slowly, as I saw him, and sometimes with wonderful rapidity, darting as straight as an arrow's path across the harbor, and then doubling upon his track so as to present the form of a staple.

At first men were satisfied to watch his movements from the shore; but soon the desire to secure him became prevalent. This was intensified by a reward of $5,000 offered for his capture, and the zeal displayed was intense. On the 14th, four boats filled with "adventurous sailors and experienced gunners" were out in search, and three muskets were discharged at him from a distance of but thirty feet. One of those who fired was Matthew Gaffney, who had the reputation of being the best shot upon the cape. The shooting was of no effect, except that he moved off to the outer harbor, and was seen no more that afternoon. For many days the harbor was constantly patrolled by boats completely armed and manned by Gloucester men. In addition to these, two fishing vessels came from Sandy Bay, now Rockport, each under the command of a Captain Pool, "both valiant and brave men," who brought stout nets made of "rattlings," and who remained a week, watching by night as well as by day.

Two Marblehead vessels also came, each with a crew of experienced whalemen, who volunteered their services. They brought swivel guns, gags and axes, weapons both offensive and defensive. Strong hooks used for catching sharks, and some stronger still, made for the purpose, were baited and placed in favorable positions, and nets were located in nearly every port of the harbor. These preparations seemed to make him more wary than at first, and all efforts to capture the prize were without avail. He was last seen by Capt. Sewell Toppan of schooner *Laura*, on the 28th of August, off Brace's Cove, two miles or more from the shore.

While the pursuit was being continued, some enterprising individual, whose name I have been unable to ascertain, actually built a shed near Faneuil Hall, Boston, in which to exhibit him, so sure was he that these efforts to secure his capture would meet with success.

Testimony concerning this visit of 1817, apart from the depositions already referred to, is not wanting. Col. Thomas H. Perkins, one of the best known and highly esteemed Bostonians of that period, was upon a visit to Gloucester, and was able to secure an excellent view. Upon his return home he gave to his family a narrative of what he had seen, and awakened so much interest that his wife and daughter insisted that he take them to Gloucester at once. The trip was made in the family carriage on the following day, but the sight so eagerly longed for was not secured. To a friend he writes thus: "All the town were upon the alert, and almost every individual, both great and small, was gratified with a sight of him. I left the place fully satisfied that the reports in circulation were essentially correct."

Hon. David Humphreys, a Fellow of the Royal Society of London, in a series of letters written in the months of August and September to Rt. Hon. Sir Joseph Banks, president of that society, gives much of interest which came to his knowledge during his investigations in this vicinity. In one of these he makes use of the following language:

"I repeatedly visited Gloucester Bay (Cape Ann), including all the neighboring coves as far as Manchester, with the hope of obtaining a sight of him. Disappointed in this object, it remained for me to collect the most authentic evidence from those who had seen him which could be obtained upon the spot. I hope my communications will forever settle the question of the existence of the sea serpent, by proving from incontestable evidence that, at least, one species has been for a considerable time past a constant visitor in the ports, bays, and coves, contiguous to Cape Ann. This evidence appears too credible and conclusive to admit of doubt in the mind of any candid man."

This testimony seems to have had its effect upon the mind of Sir Joseph, for he afterwards expressed full faith in the existence of the "Serpent of the Sea."

I have briefly described the visits of a single year to one locality. Many others of equal interest and authenticity, especially that of 1818 off Nahant, are on record; and if the youthful editorial writers for a portion of the daily press would look them up, they would display more wisdom, if less wit, in their writings upon the subject. I believe, with the editor of the Washington *Post*, that "the sea serpent is no longer a myth, no longer the invention of hyperbolical sea captains, or the nightmare of tipsy clam-diggers." I welcome, also, the sober second thought of the New York *Tribune:* "The weight of evidence in his behalf, added to the scientific reasons for not rejecting the legend of him, will probably in time overcome the inertia of conventional habits of thinking, and the sea serpent will be accepted, not merely as a possibility, but as a solid and sinuous fact." I am confident, too, that old Obadiah Turner was right in his conclusion, though his fears were groundless when he made the entry in his journal, September ye 5, 1641: "I doe believe yt a wonderful monster in forme of a serpent doth visit these waters. And my prair to God is yt it be not yt olde serpent spoken of in holie scripture yt tempted our great mother Eve, and whose poison hath run downe even to us, so greatlie to our discomforte and ruin." —*The Congregationalist, September* 1, 1887.

The Condition of the Blast Furnaces of the United States, October 1st.

During September the product of the blast furnaces of the United States increased considerably, both so far as anthracite and coke plants are concerned. While the former have not reached the high figures of the summer, we seem likely to do so in the near future; the latter are now turning out iron at a heavier rate than ever before. The effect of the coke strike is now practically over, and in addition to general activity in Western Pennsylvania, Ohio, Illinois, Wisconsin, West Virginia, and the South, some new plants, like those of the Troy Steel and Iron Company, and a number of remodeled furnaces, like the Jupiter, the Belmont, and others, are producing. The total output is enormous, and yet there come to us from all quarters reports of moderate or of exceptionally low stocks. So far as we can learn from present indications this great rate in the make is likely to continue at least in the near future.

The status of the anthracite furnaces at the beginning of the month was as follows:

ANTHRACITE FURNACES IN BLAST, OCTOBER 1ST.

Location of Furnaces.	Total number of stacks.	Number of furnaces in blast.	Capacity per week.	Number of furnaces out of blast.	Capacity per week.
New York,	29	14	4,038	15	3,891
New Jersey,	15	5	1,944	10	2,998
Spiegel,	3	2	127	1	105
Pennsylvania:					
Lehigh Valley,	48	38	12,384	10	2,972
Spiegel,	1	0	0	1	40
Schuylkill Valley,	40	23	7,081	17	2,793
Lower Susquehanna Valley,	24	18	5,765	6	1,310
Lebanon Valley,	15	12	5,073	3	720
Upper Susquehanna Valley,	18	10	2,738	8	1,370
Maryland,	4	1	290	3	455
Total,	197	123	39,440	74	16,654

	Furnaces in blast.	Capacity per week.
October 1,	123	39,440
September 1,	125	38,338
August 1,	129	37,930
July 1,	138	40,742
June 1,	138	44,188
May 1,	137	43,802
April 1,	139	43,585
March 1,	141	43,724
February 1,	137	41,951
January 1,	130	40,736
December 1,	119	36,820
November 1,	116	36,348
October 1,	114	35,819
September 1,	112	33,207
August 1,	120	36,841
July 1,	117	36,762
June 1,	121	38,239
May 1,	119	36,924

In New York, No. 1 Onondaga went out on the 1st inst. In New Jersey, the product has been light, not reaching 8000 gross tons, only five furnaces and two spiegel furnaces being running. Chester, however, has blown in since the beginning of the month. Pequest, we may note, was working the greater part of the month on non-Bessemer pig. The Passaic spiegel furnace has completed relining, and when this reaches our readers is probably again producing. In the Lehigh Valley one of the Crane furnaces is out, but otherwise no important changes have taken place until now, so far as the number of furnaces in blast is concerned. We are informed on good authority, however, that some of the stacks have been working very poorly of late, on account of changes in the character of the fuel used — a result of the strike in the Lehigh anthracite coal district. It is possible even that at an early date the banking of some of the plants so affected may be decided upon. In the Schuylkill Valley, Swede has gone out of blast. There is nothing of interest from the Lower Susquehanna district, while in the Lebanon Valley the most significant event during September was the blowing in of the second Colebrook furnace. In the Upper Susquehanna Valley one of the Duncannon furnaces resumed on the 29th ult.

On the 1st of the current month the status of the bituminous and coke furnaces was as follows:

BITUMINOUS AND COKE FURNACES IN BLAST. OCTOBER 1ST.

LOCATION OF FURNACES.	Total number of furnaces.	Number in blast.	Capacity per week.	Number out of blast.	Capacity per week.
New York,	3	2	1,500	1	750
Pennsylvania:					
Pittsburgh district,	19	18	18,850	1	400
Spiegel,	1	1	450	0	0
Shenango Valley,	18	16	9,503	2	988
Juniata & Conem,	22	13	6,039	9	2,310
Spiegel,	1	1	210	0	0
Youghi. Valley,	5	3	1,148	2	715
Miscellaneous,	3	2	1,185	1	120
Maryland,	2	0	0	2	340
Virginia,	11	6	2,996	5	2,400
West Virginia,	6	4	2,281	2	370
Kentucky,	3	2	580	1	280
Ohio:					
Mahoning Valley,	15	12	8,189	3	1,640
Hocking Valley,	15	7	1,249	8	1,076
Hanging Rock,	13	11	2,153	2	420
Miscellaneous,	16	13	8,566	3	1,010
Illinois,	16	12	12,414	4	1,790
Missouri,	8	4	2,098	4	1,750
Wisconsin,	3	3	1,504	0	0
Indiana,	2	1	195	1	140
Michigan,	1	0	0	1	290
Alabama,	12	10	3,563	2	831
Tennessee,	9	8	3,416	0	0
Georgia,	2	1	539	1	242
Colorado,	1	1	495	0	0
Total	227	152	89,123	55	16,112

As compared with previous months these figures stand:

	No. of furnaces.	Capacity per week.
October 1	152	89,123
September 1,	145	83,124
August 1,	113	62,091
July 1,	98	47,319
June 1,	98	44,865
May 1,	148	83,509
April 1,	148	81,796
March 1,	146	79,682
February 1,	145	79,257
January 1, 1887,	137	73,422
December 1, 1886,	139	73,795
November 1,	140	73,013
October 1,	136	70,802
September 1,	135	69,206
August 1,	133	68,852
July 1,	132	71,316
June 1,	129	70,766
May 1,	129	67,888

In the Pittsburgh district there is nothing new to report, all but one of the Schoenberger furnaces being active. The stack named is being prepared and will be ready before the close of the year. In the Shenango Valley the Henderson went in on the 10th ult., but, on the other hand, one of the Stewart furnaces went out. In the Juniata and Conemaugh valleys the same number of furnaces were blowing, but the output was heavier, chiefly because of the increasing make of the plant of the Cambria Iron Company. The second Powelton furnace has since begun work. In the Youghiogheny Valley Dunbar made a good month's work in September, and Fairchance is coming up to capacity after rebuilding.

In the Hanging Rock region Eliza has gone in, and Ironton, which was banked until the 26th ult., resumed work. In the Hocking Valley one of the Fannie furnaces had just started at the close of last month. In the Mahoning Valley the only change of any consequence is that Phœnix is repairing. The aggregate output of the district has been heavy, Anna, Brier Hill, Himrod, Grace, Haselton, Mary, and the two Hubbard furnaces particularly showing good records. Among the other furnaces in Ohio, the three furnaces of the Cleveland Rolling Mill Company made a good record, and large figures are reported also from the Steubenville, Zanesville, Emma, and Bellaire. All of the Illinois furnaces show a heavy make, the official returns from every one of the 12 aggregating 53,202 gross tons. Among those on the active list in the State, the only one not running on the first of the month was one of the four Union. In Missouri the Western Steel Company have one of their plant of three running, and are working, too, the leased Jupiter, the latter now making a large output. In Wisconsin there have been no changes.

In Virginia, Lynchburgh furnace blew in on the 14th ult., and is reported to be doing well. With the exception of the Low Moor, the other Virginia furnaces did not quite reach the product of the preceding month, the aggregate make being 12,215 gross tons. In West Virginia, the Belmont, Riverside, and Top Mill furnaces did well in September. In Kentucky, only Ashland and Norton are running. In Alabama, one of the Woodward furnaces was out of blast on the 1st of this month, and one of the two Alices has stopped running. In Tennessee, every furnace is at work, the second South Pittsburgh falling into line on the 25th ult. The September output was 12,649 tons. In Georgia, the Cherokee ceased producing on the 15th ult.

Below is the status of the charcoal furnaces on the 1st of October:

CHARCOAL FURNACES IN BLAST, OCTOBER 1ST.

Location of Furnaces.	Total number of furnaces.	Number in blast.	Capacity per week.	Number out of blast.	Capacity per week.
New England,	14	5	373	9	612
New York,	10	3	638	7	585
Pennsylvania,	23	5	497	18	689
Maryland,	13	4	423	9	520
Virginia	24	6	270	18	770
West Virginia,	3	0	0	3	165
Ohio,	17	10	975	7	285
Kentucky,	2	2	213	0	0
North Carolina,	2	1	92	1	80
Tennessee,	9	5	931	4	203
Georgia,	2	0	0	2	114
Alabama,	9	9	2,136	0	0
Michigan,	24	14	3,868	10	2,540
Minnesota,	1	0	0	1	220
Missouri,	4	2	551	2	443
Wisconsin,	11	4	976	7	914
Texas,	2	0	0	2	330
California,	1	0	0	1	245
Washington Territory,	1	1	175	0	0
Oregon,	1	0	0	1	100
Total, October 1,	173	71	12,118	102	8,815
Total, September 1,	175	67	11,505	108	9,619

In New England, Katahdin furnace has gone out of blast, to be enlarged to 11 x 50 feet. Only one Richmond is blowing, and Kent furnace is temporarily idle. In Pennsylvania, Eagle, Hecla, Greenwood, Isabella, and Pine Grove were reported in blast on the 1st inst., while in Maryland, Laurel, Muirkirk, and one Maryland, and one Stickney, were in operation, with a September output of 1387 gross tons. In the South there is little to report. Both Ironton and Jenifer did not make their usual product in September, the former being out two weeks. They are now, however, both running well. In Michigan, a second Antrim furnace is building. Gogebic furnace was to blow in on the 1st of this month.— *The Iron Age.*

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

NEW SERIES—VOL. VIII. HARTFORD, CONN., NOVEMBER, 1887. No. 11.

Pipe Hangers.

Steam pipes are often hung up in a most slipshod and inefficient manner. No proper allowance is made for the movement of the pipe by expansion, and as a consequence, joints are strained and leak continually; flanges are broken off, and in many instances the hangers are pulled out and the whole or a portion of the line tumbles down bodily.

The usual support for steam pipes is shown in Fig. 1. It consists simply of a ring or loop which is slipped over the end of the pipe, and supported by the gimlet-pointed hook screwed into the beam above, and which admits of no adjustment. With a pipe of any considerable length the ring assumes the position shown by dotted lines in Fig. 1, when steam is turned on. The pipe is raised, the covering is badly torn, unless, indeed, a section is left uncovered where the support comes, and severe strains are thrown on the joints. Few realize the severity of the strain set up in a long line of large pipe by using a hanger of this kind. We have seen the extreme end of such a line lifted up clear of the hangers by the upward curvature thus produced, so that the hangers along the middle of the line supported the entire weight of the pipe. In many cases the ring will be found lifted clear out of its supporting hook. Of course it is evident that when this is the case those hangers which do remain in place have to carry a greatly increased load, so that unless they are of excessive strength they are apt to give way. When one breaks the shock throws a severe strain on the next one, and if that gives out the whole line of pipe is pretty sure to come down.

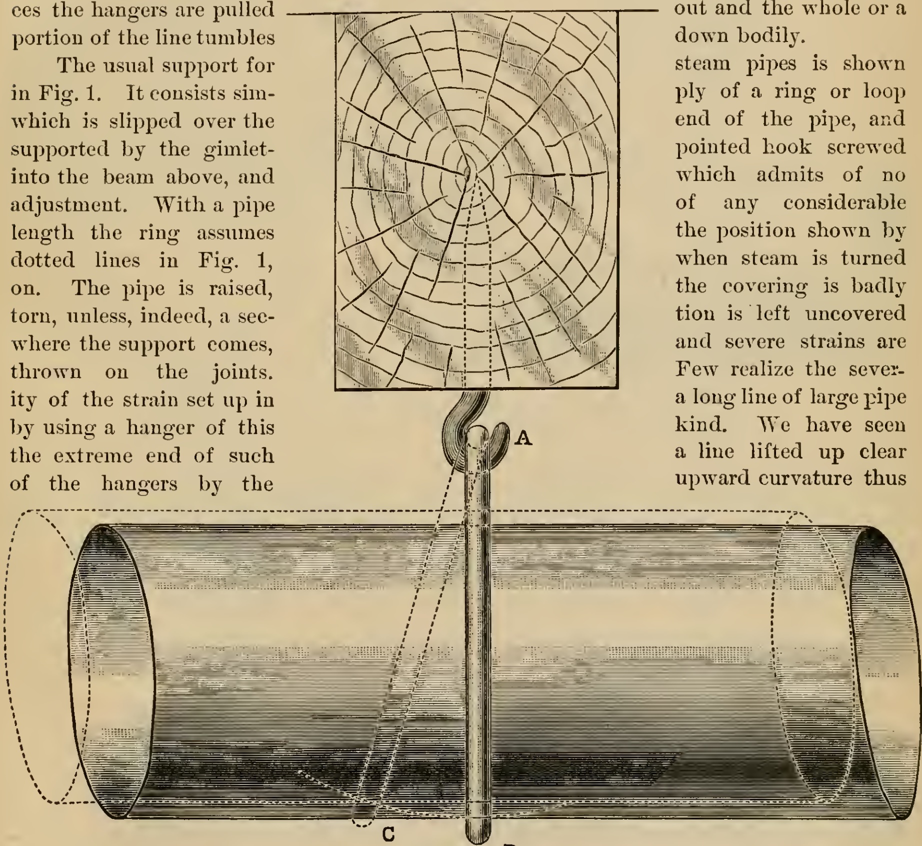

FIG. 1.

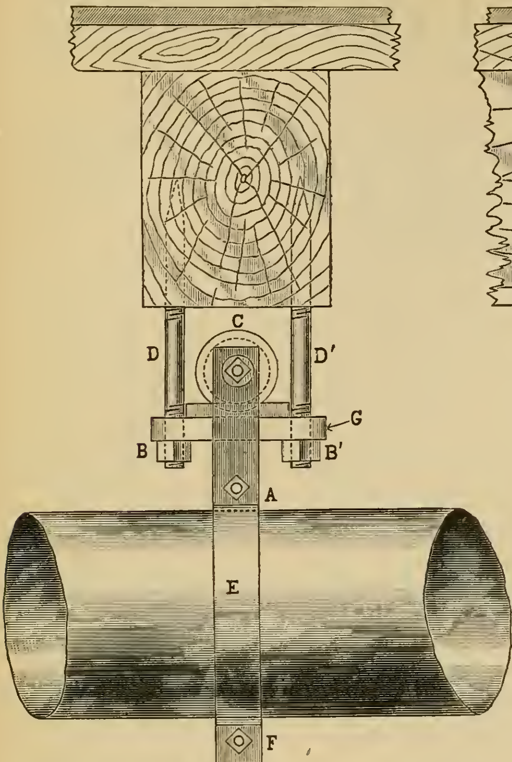

FIG. 2.

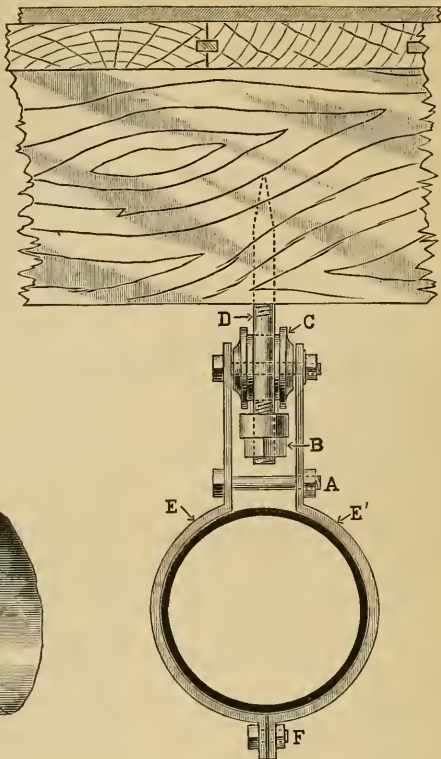

FIG. 3.

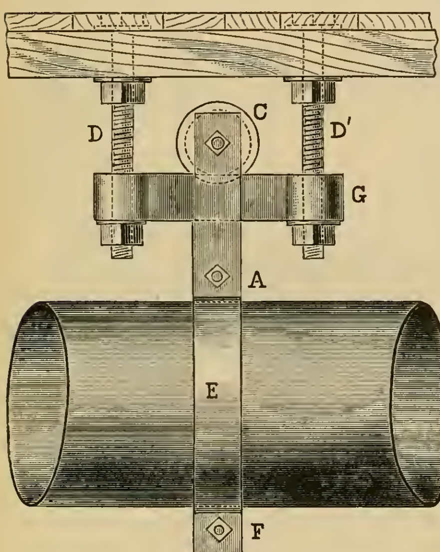

FIG. 4.

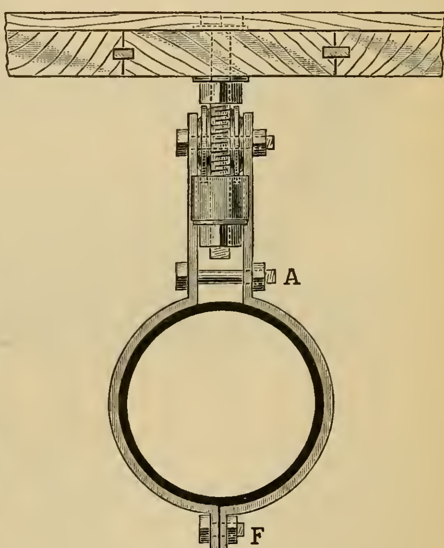

FIG. 5.

Pipe of any size should always be supported by some sort of hanger that will admit of a parallel motion when the pipe expands. We illustrate in this issue various forms of hanger which we have found to answer admirably for supporting long lines of heavy steam pipe.

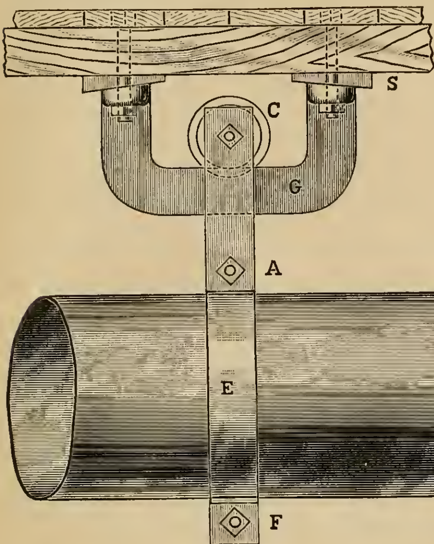

Fig. 6.

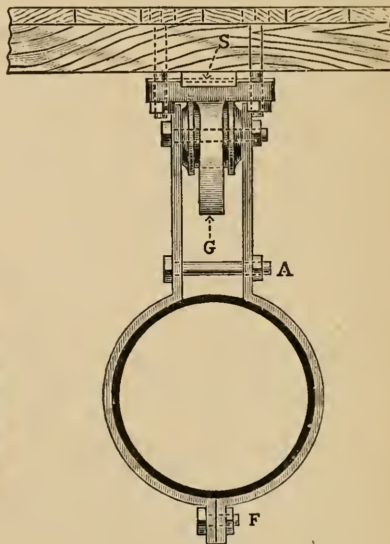

Fig. 7.

Fig. 2 is a side view and Fig. 3 an end view of one of the cheapest and best forms of hanger where the motion of the pipe is not very great. Two clips are made of $3'' \times \frac{1}{2}''$

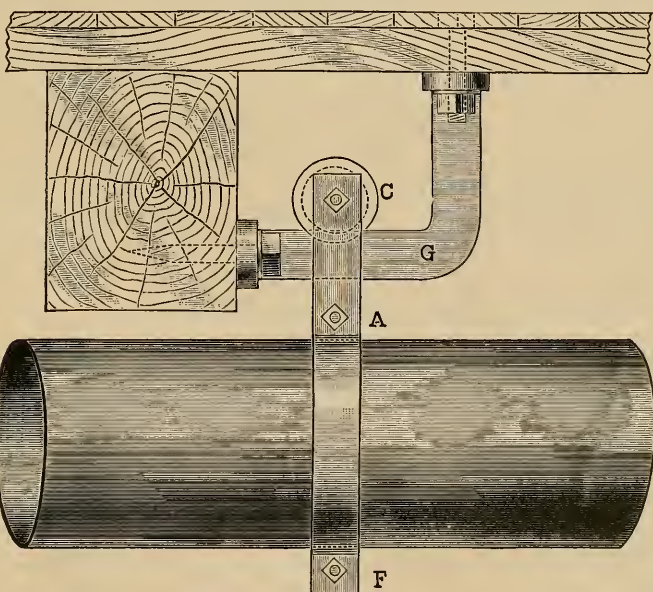

Fig. 8.

flat iron bent around to fit the pipe, so that when the nuts on the bolts at A and F are screwed up the pipe is tightly gripped. The upper ends of the clips are not brought together but are left a few inches apart and long enough to enable the roll C to be placed between them as shown. The bolt passing through the clips and roll forms a bearing for the roll. This roll is grooved on its periphery, and runs on the bar G, which is supported by the lag bolts which are screwed into the beam as shown. The pipe may be raised or lowered by simply turning the nuts on the bolts, and set at any desired height.

Figs. 4 and 5 show a hanger exactly similar in principle to the one just described, but available in a case where it would be necessary to carry a pipe as close as possible to the timbers. In this case the weight of pipe would be carried by the floor planks instead of the beams. With mill floors as constructed at the present time, this would form a good support, especially if it were placed close beside a beam. Two bolts are let through the floor, the heads being flush with its upper surface so as to offer no obstruction. The bolts should be a "driving fit" through the planking, and have their threads cut of such a length that a nut and washer may be screwed up to the under side of the plank. The pipe is suspended from these bolts by means of bar, roll, and clips exactly like those described in Figs. 2 and 3, and the same facility of adjustment in a vertical direction is obtained as in the first described case.

Figs. 6 and 7 show another form where the adjustment vertically may be obtained by "shimming" with the wedges shown at S, S, the remainder of the hanger being the same as those previously described. The objection to this form is, the floor would be apt to shrink and loosen the wedges, and so make frequent adjustment necessary. This form might be used in some places with satisfaction, where there would be little danger of the floors springing, but we would not advise it in preference to the first described ones.

Fig. 8 shows another form where no provision is made for adjustment vertically. When a line of pipe is run close to a wall so that there is no chance for the timbers or floor to settle appreciably, and so throw the pipe out of line, this form of hanger will answer every purpose if carefully put up in the first place.

(To be continued.)

Inspector's Reports.

SEPTEMBER, 1887.

In the month of September, 1887, our inspectors made 3,945 inspection trips, visited 7,877 boilers, inspected 3,349 both internally and externally, subjected 562 to hydrostatic pressure. The whole number of defects reported reached 7,763, of which 818 were considered dangerous; 62 boilers were regarded unsafe for further use. The defects in detail were as follows:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	449	28
Cases of incrustation and scale,	614	20
Cases of internal grooving,	27	12
Cases of internal corrosion,	213	15
Cases of external corrosion,	338	32
Broken and loose braces and stays,	235	36
Settings defective,	183	20
Furnaces out of shape,	210	13
Fractured plates,	142	36
Burned plates,	92	22
Blistered plates,	251	12
Cases of defective riveting,	2,945	145
Defective heads,	46	14

Nature of Defects.	Whole Number.	Dangerous.
Serious leakage around tube ends,	948	282
Serious leakage at seams,	563	28
Defective water-gauges,	100	23
Defective blow-offs,	53	11
Cases of deficiency of water,	15	11
Safety-valves overloaded,	18	10
Safety-valves defective in construction,	37	9
Pressure-gauges defective,	267	33
Boilers without pressure-gauges,	5	0
Defective hangers,	10	0
Defective man-hole plate,	1	1
Defective fusible plug,	1	0
Total,	7,763	818

Defective water-gauges are often found by our inspectors, and in many cases they cause a great deal of trouble. Where the defect is of such a nature that a false water level is shown, it is always absolutely dangerous, and the boiler should never be run until the defect is remedied.

It would seem that men who have been piping boilers for years would always know how to put up water-gauges, but sometimes they don't. They will as often put up a gauge, especially if it be one of the combination or water column style, so that it is impossible to know where the water is in the boiler, as they will so that the true level is indicated, and it costs more to put it up wrong, than it does to put it up right, too. But perhaps therein may be found an explanation of why it is done so.

Instead of going straight through the extension front of a boiler with the pipes connecting the column with the boiler, in which case all the pipe and fittings necessary are two nipples and an elbow, for each end of the column, the average steam fitter will use five nipples and four elbows, for each end, and if he is not molested, he will put a siphon arrangement in the steam connection that will keep the water in the gauge-glass dancing so that it is utterly impossible to tell where the water is in the boiler. We are continually running across such examples of piping, and recommending changes, but the next man that comes along will do the same thing again, in the same place. They seem to be unable or unwilling to learn a simple thing through anybody's experience but their own.

Boiler Explosions.

September, 1887.

Rendering Establishment (120). — A boiler repairer, John Kelly, went to the premises of Alois Wohlrof, in Rochester, N. Y., September 2d, to examine a boiler. It was peculiarly constructed, being really two boilers, one used for power and the other for trying out fat. Kelly told the engineer to increase the steam pressure to sixty pounds and entered the boiler used for trying fat. He had hardly entered the inner boiler when the outer exploded, demolishing the building around it and forcing the crown of the second boiler upon Kelly, who was crushed into shapeless matter. One leg only was untouched. The body was not taken out for several hours, as nearly every rivet had to be cut before the weight could be moved from it.

Electric Light Plant (121). — At 8 o'clock p. m., September 2d, a tube burst in battery No. 2, in the multiple tube safety boiler of the Edison Light Company, Cincinnati, Ohio. The effect was to blow the entire burning charge of coal in the furnace forward, and start a fire among the oil cans, loose paper, and rags, and in the wood floor. At the same time the cellar-room was full of steam, which came up the stairway, and filled the rooms on the street level. Sylvester Price, the engineer, was knocked down with a lump of coal, blown from the furnace, and Eddie Crogan, the fireman, was knocked down. Both got up quickly, and, with assistance from the street, extinguished the fire.

THRESHING MACHINE (122). — About 7 o'clock A. M., September 6th, the engine of a threshing machine belonging to William Bumpus exploded at Mount Vernon, Ill., and fatally injured the following persons: J. H. Mitchell, both legs torn off near the knees, and has since died. Robert Boynard, left arm broken. Thomas J. Williams, head cut and skull fractured; badly crushed and expected to die. Cooney Bumpus, son of the owner of the engine, badly scalded. William Bumpus, arm broken and bowels protruding; died during the day. He was also a son of the owner of the machine. The cause of the explosion is not known positively, but it is supposed that the water was low. The engine and everything near it was entirely demolished. Pieces of the engine were thrown several hundred yards. One piece weighing 300 pounds was found 200 yards away, and some smaller pieces were found as far as a mile from the place of the explosion.

LOCOMOTIVE (123). — A horrible accident occurred on the Houston & Texas Central Railroad about 9 o'clock A. M. September 6th, which was the explosion of the boiler of the south-bound accommodation train, which resulted in the death of Chas. Pinkston, the engineer, and E. L. Scales, the fireman, received injuries from which he is expected to die. The south-bound accommodation train from Denison is due at Sherman at 7.45 A. M., and after switching off one or two cars it left for the south with eight cars and a number of passengers in the coaches. On reaching a point beyond Choctaw Creek, about six miles from Sherman, the boiler exploded, pieces of it flying in different directions, from forty to fifty yards away, and tearing the tender to pieces. A box-car next to the tender was ditched, but no further damage was done and the train stopped on the track. Engineer Pinkston fell only about ten feet from the track. He breathed only a few times after he was taken up, when it was discovered that he was dead. Fireman Scales was found about thirty feet from the track on the opposite side from the engineer. He was terribly scalded from his abdomen to his extremities and about the arms and shoulders.

SAW-MILL (124). — Mrs. Sawyer's saw and grist mill, Nixonton, N. C., was damaged by a boiler explosion, September ——.

DOMESTIC BOILER (125). — By the explosion of a water-back in a laundry-range at the residence of A. D. Worthington, Hartford, Conn., September 15th, considerable damage to property was done. Fortunately no one was injured. The cause of the explosion was a dangerous arrangement of stop-cocks upon the hot and cold water pipes, so that wheu closed, as they were at the time of the explosion, afforded no outlet for the hot water and steam, which would accumulate until the pressure was sufficient to force an outlet by explosion.

WORK-HOUSE (126). — By the explosion of one of the boilers at the work-house, in Cincinnati, Ohio, September 17th, the engineer, Thomas Hall, received wounds that will scar him for life. But a few minutes before the boiler burst a fire had been started in the furnace, and the kindling had not all been consumed when the boiler gave way with a terrific report, which was heard for squares. For a short time there was a genuine panic about the building, and when one of the guards reached the ladder which descends from the basement to the engine-room, he was horrified at seeing engineer Hall emerge from the smoke and steam, covered with dust, while blood streamed down his face from two ugly wounds, one on the forehead, and the other beneath his right eye, while the right arm dangled uselessly at his side. In a few moments he recovered his presence of mind, and informed the large crowd that had assembled that the two firemen were still below, and that one of them was probably dead, as he was standing on the boiler when it exploded. A search was made at once, but both men were found comparatively uninjured. John Ritter, a colored fellow, who is serving time at the works, was standing in front of the boiler, shoveling coal into the furnace when the explosion occurred. He was knocked back several feet and slightly scalded by the steam. Jake Malsan, the other fireman, was standing on top of the boiler adjusting one of the valves so that the steam could communicate with the laundry, when he was suddenly lifted from his feet and hurled a distance of some fifteen feet, and landed prone on his back on an adjoining boiler, uninjured. An examination of the boiler showed that the iron was very rotten, and it was the surprise of many that the accident had not occurred before.

Steam Launch (127). — The boiler of a steam launch, with nine men on board, exploded in the Sound, off East Chester, N. Y., at about 10 o'clock, September 18th. All the men were more or less scalded with escaping steam, but none were seriously injured. William Talbot and John Cleary received scalds that required surgical attention.

Saw-Mill (128). — Landecker's saw-mill, eight miles from Camden, Ark., was wrecked by an explosion, September ——.

Saw-Mill (129). — J. W. Price's saw-mill, Poulan, Ga., was recently wrecked by a boiler explosion.

Saw-Mill (130). — The explosion of a boiler, September ——, in David Young's saw-mill, three miles northwest of Amanda, Ohio, killed George Lape, Perry Lape, Simon Young, and Amos Young. Mrs. Simon Young, who was at the time 200 yards from the mill, was seriously injured.

Saw-Mill (131). — The Dunham Lumber Company's saw-mill, Dunham, Ala., was recently damaged by an explosion to the amount of $800.

Grist Mill (132). — A terrible boiler explosion occurred September 28th, at Isham McKinney's steam grist mill and ginnery, a distance of about twelve miles from Selma, Ala. A white fireman named James Carter was literally cooked with the hot steam. Another white man named Walter Hoffman, who was feeding the gin at the time of the explosion, was blown to pieces. Fragments of his body were picked up more than 200 feet from the gin. He was blown through the top of the building, and his head has never been found. A negro named Yancey McKance was also broken to pieces, and will die. Yancey Gibney, another negro, who was filling a basket of cotton when the boiler burst, was hurled head foremost through the roof, and for sometime remained senseless. He will recover. The gin and mill caught fire, but were saved from burning. The loss is about $300, with no insurance. Carelessness was the cause of the disaster.

Iron Foundry (133). — The workmen at the Penn Foundry, Hooker street, Millvale borough, near Pittsburg, Pa., were busily engaged "pouring off," about 5 o'clock, September 28th, when they were startled by a deafening noise and the crash of timbers. All work was immediately suspended and the workmen ran out for safety. After the dust had cleared away it was found that the boiler had exploded. It was a horizontal boiler, 16 feet long and 28 inches in diameter. The third plate had broken and the brick work around the boiler was scattered around. The boiler front was wrecked, and the building badly shattered. About 25 men were within 20 feet of the place of the explosion, but none were injured.

The Locomotive.

HARTFORD, NOVEMBER, 1887.

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

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

A WELL-PROPORTIONED chimney, of neat design, from 200 to 300 feet high, is always an imposing structure and an ornament to a large manufacturing establishment, but it may well be questioned if it is ever worth while to build them over 150 feet high. Where cost is no consideration there is no objection to building them as high as one pleases; and sometimes the location, or the nature of the business carried on, or both combined, may make an extremely high chimney a necessity; but for the purely utilitarian purpose of steam-making we have yet to find a case where it was necessary to build a chimney more than 150 feet high; and in many cases where this height has been reached equally good results might have been attained with a shorter chimney at not much more than one-half the cost.

We do not wish anyone to understand from the above that we are making au argument in favor of very short chimneys, for we believe that many, in fact, more than one-half, the chimneys in use at the present time are too short. The point we would call attention to, is the fact that, after a certain height has been attained — enough to ensure sufficient intensity of draught, if the chimney is of proper sectional area — to burn any sort of fuel, the economical limit of height has been reached, and any additional amount of chimney power is obtained at a much less cost by keeping the height at this point and using a large chimney, than it can be by increasing the height.

For example, a chimney is needed for a large battery of boilers. After much consultation and guessing it is decided that a chimney with a flue ten feet in diameter and 250 feet high will be about right, and it is built. This is perfectly satisfactory, but it should be borne in mind that exactly the same results would have been attained at not over two-thirds the cost by making the flue just sixteen inches larger, or eleven feet four inches diameter, and 100 feet shorter, or 150 feet high. Ordinarily, this would represent a clear saving of about 5,000 dollars. This saving in first cost results from the saving of bricks and labor where the height is kept down within reasonable limits.

We are aware that many engineers like to make the height of the chimney about twenty-five times the diameter of the flue. This makes a neatly-proportioned stack; but, with all due respect to looks, we would suggest that "looks" are not what chimneys are built for; their primary object is to furnish draught to burn coal or other fuel as it should be burned. If a ratio of height to diameter of twenty-five to one is adhered to, then the smaller sizes of chimneys, for one or two boilers, will not be high enough to produce sufficient draught force, and chimneys for a large battery of boilers will be higher than will be at all necessary; and, as we stated above, their cost will be from thirty to fifty per cent. greater than it should be.

After a sufficient height has been reached to produce draught of sufficient intensity to burn fine, hard coal, provided the area of the chimney is large enough, there seems no good mechanical reason for adding further to the height, whatever the size of the chimney required. Sufficient draught will be furnished to burn any fuel to be obtained if the area of the chimney is equal to the combined area of the tubes — where tubular boilers are used — and the height is 100 feet. With this height the area of the chimney may also be made equal to one-eighth of the grate surface, that being about the ratio existing between tube area and grate area when boilers are well proportioned. A much less height than 100 feet cannot be recommended for a boiler chimney for the reasons above given; the lower grades of fuel cannot be burned as they should be with a shorter chimney.

Thus we see, if the rule of making the height twenty-five times the diameter were followed with a twenty-four-inch flue, our chimney would be but fifty feet high. This is not high enough to properly burn anything but the very softest fuel. And if the same rule is adhered to where a ten or twelve-foot flue is required, the height will be from 250 to 300 feet, much greater than is at all necessary for proper combustion of the fuel.

The idea obtains to a considerable extent among those unacquainted with the principles upon which chimney draught depends, that the draught power of chimneys increases directly as their height; so that, if we have two chimneys of the same size, but one being twice as high as the other, the higher chimney will have twice the power of the shorter one, or, in other words, will give sufficient draught, under the same conditions, for twice as many boilers as the other. This is an error. The increase of power would be, theoretically, but forty-one per cent. more, and in practice, owing to the fact that the frictional resistance of the sides of the flue to the passage of the gases *would* be doubled, it would be less than forty-one per cent. Given two chimneys having flues of the same size, but different heights, their power to burn coal under similar batteries of boilers would be in proportion to the square roots of their heights; so if one was to have double the power of the other it would have to be *four times* as high.

Isn't it a curious fact that 2,000 pounds of Lehigh coal fills a space equal to 36 cubic feet if you are selling it, but only 33 cubic feet if you are buying it — that is, if you can take the dealer's word for it?

Isn't it curious that a pound of coal which contains barely enough combustible matter to evaporate, if perfectly utilized, eight pounds of water, will, if burned under a boiler set with Cheatem's Patent Setting, easily evaporate twelve or thirteen pounds of water, and generally "would have done better if the boiler had been clean"? The mystery surrounding this surprising fact may be more easily penetrated if it be borne in mind that the figures obtained with Cheatem's setting are the result of Cheatem's test.

Isn't it curious that after a manufacturer has put in a boiler which evaporates twenty-five per cent. more than any other boiler can, has it set with a setting which saves him twenty-five per cent. of the fuel which would be necessary with any other setting, feeds his boiler with some sort of an apparatus which will put the water into it for about one-tenth the cost of putting it in with a power pump, and has half an acre, more or less, of ground covered over with various fuel-saving devices, of one kind or another, he finds himself burning more coal than his neighbor, who has less apparatus but may have more common-sense?

Peculiar ideas are afloat among those who ought to know better regarding the object or function of the fusible plug. Not long since application was made for insurance on a boiler of the portable locomotive type. When our inspector made his examination he found that the crown-sheet had been so badly overheated and bagged down that the stays were all started, and that the boiler could not be safely run until a new crown-sheet had been put in. The fusible plug, properly located, was found unmelted.

The owner's attention was called to the state of affairs, and after expressing his regret at being obliged to get a new crown-sheet, he expressed his gratification that the fusible plug was intact. "Why," said he, "I was bothered awfully with that plug. It melted out three or four times, and I had to put in new ones until I got Mr. Blank to fix it. He said he would fix it so it wouldn't bother me any more." And so it seemed. The plug was filled with hard Babbit metal, and a bill of about a hundred dollars for a new crown-sheet was the result. But the proprietor was happy because he wasn't "bothered" by the plug melting out.

Another recent case was as follows. One of our inspectors in going into the furnace of a horizontal tubular boiler "bumped" his head against something projecting down from the furnace plates directly over the fire. Investigation revealed the fact that it was the fusible plug, and it was put into the lowest point of the boiler-shell over the fire. Inquiry developed the fact that it had been put there by direction of a traveling salesman of various steam appliances, who assured them that "it was the proper place for it; he had put hundreds in there and never had any melt out yet," which latter statement was quite easy to believe.

It is quite a common thing where they have been "bothered" by the melting of fusible plugs to find solid cast-iron plugs screwed in. This effectually stops the trouble (?). Another favorite device is to take out the plug and drive in a boiler-maker's drift-pin. Neither of these latter forms of "fusible" plugs have ever been known to "bother" the engineer by melting out.

Useful Notes on Water.

WEIGHT OF WATER PER CUBIC FOOT AT DIFFERENT TEMPERATURES.

At 32°	Fahr.	1	cubic	foot	weighs	62.417	pounds.
40°	"	"	"	"	"	62.423	"
50°	"	"	"	"	"	62.409	"
60°	"	"	"	"	"	62.367	"
70°	"	"	"	"	"	62.302	"
80°	"	"	"	"	"	62.218	"
90°	"	"	"	"	"	62.119	"
212°	"	"	"	"	"	59.7	"

From the above it will be seen that in heating water from 60° to 212° F., its bulk is increased about $\frac{1}{22}$ part, or nearly 4½ per cent.

The weight of a cubic foot of water at 39.1° F., the temperature of maximum density, is 62.425 pounds. The weight of the same volume at 32° F., is 62.418 pounds, showing that water expands about $\frac{1}{8000}$ part in cooling from 39.1° to 32° F.

The rate of expansion upward from 39.1° is about the same within the same limits as it is when cooled. Thus the volume and density at a temperature of 46° F., seven degrees above the point of maximum density, are the same as they are at 32°, seven degrees below that point.

The size of the ordinary commercial measures may be obtained from the weight of water as follows, at a temperature of from 70° to 75° Fahr.:

LIQUID MEASURES.

1	U. S.	Gill	=	.26	lb.	of	water.
1	"	Pint	=	1.04	"	"	"
1	"	Quart	=	2.08	"	"	"
1	"	Gallon	=	8.32	"	"	"
1	"	Wine Barrel	=	262.13	"	"	"

DRY MEASURES.

1 U. S.	Pint	=	1.21	lb. of water.
1 "	Quart	=	2.42	" " "
1 "	Gallon	=	9.68	" " "
1 "	Peck	=	19.37	" " "
1 "	Bushel, Struck,	=	77.47	" " "

When water contains much lime it is difficult to make a lather with soap, and it is then said to be *hard*. Such water is not suitable for use in steam boilers, as it will cause a very bad scale.

A piece of ice floating on water has about $\frac{11}{12}$ of its bulk below the surface, and only about $\frac{1}{12}$ above the surface. A cubic foot of ice weighs about $57\frac{1}{4}$ pounds.

A cubic foot of sea water at 60° F. weighs about 64 pounds, about $\frac{1}{30}$ part of its weight being due to various salts held in solution.

To calculate roughly the quantity of water in any given pipe or other cylindrical vessel, it is only necessary to remember that a pipe one yard, or 3 feet, long will hold about as many pounds of water as the square of its diameter in inches. Thus:

If we have a pipe 20 inches in diameter and 16 feet long, we have simply to square twenty ($20^2 = 400$), and multiply the result by the number of times 3 feet is contained in 16 feet $= 5\frac{1}{3}$ times;

$$\text{hence, } 400 \times 5\tfrac{1}{3} = 2{,}133 \text{ pounds.}$$

The exact weight may be found by increasing the result by 2 per cent., or $\frac{1}{50}$.

Or, — Square the diameter of the pipe (in inches), multiply by the length (in feet), and divide the product by 2.94; the quotient will be the weight in pounds.

The capacity of any given vessel of irregular shape may be found when no measure is at hand by simply weighing the vessel empty, then filling it with water and weighing. The difference will be the weight of the water, and this weight divided by the weight of a cubic foot of water at that temperature, will give the cubic contents of the vessel, from which its capacity in quarts, gallons, or any other measure may be easily calculated.

Edison's New Phonograph.

A reporter of the *Evening Post* lately interviewed Mr. Edison, and obtained the following interesting particulars:

When found in the laboratory of his lamp factory in Newark, from which 4,000 lamps a day are now sent out, Edison said that the commercial phonograph is now the most interesting thing in the world to him, although it is perfectly finished, and tools are being made for its manufacture upon a large scale. The stories which Edison tells of what his perfected phonograph will do are so extraordinary that he scarcely expects people to believe him, and yet he says that the apparatus is so simple, so effective, and so immediately useful that he is certain of its rapid introduction into business — far more certain than he was of the universal adoption of the telephone as a business instrument. Edison said of his newly finished phonograph: "You know that I finished the first phonograph more than ten years ago. It remained more or less of a toy. The germ of something wonderful was perfectly distinct, but I tried the impossible with it, and when the electric light business assumed commercial importance, I threw everything overboard for that.

"Nevertheless, the phonograph has been more or less constantly in my mind ever since. When resting from prolonged work upon the light, my brain would revert almost automatically to the old idea. Since the light has been finished, I have taken up the phonograph, and, after eight months of steady work, have made it a commercial invention. My phonograph I expect to see in every business office. The first five hundred will, I hope, be ready for distribution about the end of January. Their operation is simplicity itself, and cannot fail. The merchant or clerk who wishes to send a letter has only to set the machine in motion, and to talk in his natural voice and at the usual rate of speed into the receiver. When he has finished, the sheet, or 'phonogram,' as I call it, is ready for putting into a little box made on purpose for the mails. We are making the sheets in three size — one for letters of from 800 to 1,000 words, another size for 2,000 words, another size for 4,000 words. I expect that an arrangement may be made with the post-office authorities enabling the phonogram boxes to be sent at the same rate as a letter.

"The receiver of a phonogram will put it into his apparatus, and the message will be given out more clearly, more distinctly, than the best telephone message ever sent. The tones of the voice in the two phonographs which I have finished are so perfectly rendered that one can distinguish between twenty different persons, each one of whom has said a few words. One tremendous advantage is that the letter may be repeated a thousand times if necessary. The phonogram does not wear out by use. Moreover, it may be filed away for a hundred years and be ready the instant it is needed. If a man dictates his will to the phonograph, there will be no disputing the authenticity of the document with those who knew the tones of his voice in life. The cost of making the phonogram will be scarcely more than the cost of ordinary letter paper. The machine will read out the letter or message at the same speed with which it was dictated.

"I have experimented with a device for enabling printers to set type directly from the dictation of the phonograph, and think it will work to a charm. It is arranged that the printer by touching a lever with his foot allows five or ten words of the phonogram to be sounded. If he is not satisfied with the first hearing, he can make it repeat the same words over and over again until he has them in type. For busy men who dictate a great deal for the press, I am sure that the phonograph will be a necessity after a very little experience.

"For musicians the phonograph is going to do wonders, owing to the extreme cheapness with which I can duplicate phonogram and the delicacy with which the apparatus gives out all musical sounds. In the early phonograph of ten years ago, which was a very imperfect and crude affair compared to that of to-day, it was always noticed that musical sounds came out peculiarly well. The machine would whistle or sing far better than it would talk. This peculiarity of the phonograph remains. I have taken down the music of an orchestra, and the result is marvelous. Each instrument can be perfectly distinguished, the strings are perfectly distinct, the violins from the cellos, the wind instruments and the wood are perfectly heard, and even in the notes of a violin the overtones are distinct to a delicate ear. It is going to work wonders for the benefit of music lovers. A piece for any instrument, for the piano, or for an orchestra, or an act, or the whole of an opera, musical instruments and voices, can be given out by the phonograph with a beauty of tone and a distinctness past belief, and the duplicating apparatus for phonograms is so cheap an affair that the price of music for the phonograph will be scarcely worth considering. As the phonogram will be practically indestructible by ordinary use, such music can be played over and over again.

"My first phonograph, as you remember, consisted simply of a roller carrying the foil, and provided with a diaphragm point properly arranged to scrape or indent the foil. The roller was turned by hand. In the new instrument there is far more complication, but altogether different results. My propelling machinery consists of a small electric motor run by a very few cells. Strange to say, I have found more difficulty in getting a motor to suit me than any other part of the apparatus. I tried various kinds of clockwork and spring motors, but found them untrustworthy and noisy. The motors I am now making are absolutely steady and noiseless. There is no part of the apparatus, the tools for which I am now making upon a large scale here, which is likely to get out of order or to work in an uncertain manner. The two finished phonographs are practically exactly what I intend to offer for sale within a few months."

Among the things at which Mr. Edison is hard at work, taking them up in turns, are the cotton picker, the heat generator of electricity, and a new device for propelling street cars by electricity. As already mentioned, the heat generator has been brought to a stand-still by the lack of nickel in this country. Edison found that the rapid heating and cooling of iron plates in his generator, which was described at length in the *Evening Post* at the time of the September meeting of the American Association for the Advancement of Science, caused them to disintegrate very rapidly. Nickel does not attain so high a degree of magnetization as iron, but it loses it more rapidly under the action of heat, and Edison expects better results from it than from iron. The cotton picker upon which he is at work is the result of an idea which came to him down in Florida last winter. He is not quite sure that it will result in a practical cotton picker, but he has faith enough in it to make the experiments. He will not yet say in what consists the essential feature of his proposed machine. The last work which he proposes to undertake very soon is to run the Orange street cars upon an electric system which he says will not need any overhead wires or underground conduits, both expensive and troublesome necessities of all existing electric railways. He is confident that he can do this, and is now busy upon the first working models.

A Perilous Ride.

The following graphic account of a ride in a flume used to transport lumber down the Sierra Nevada mountains for use in the mines around Virginia City, Nevada, was written by Mr. H. J. Ramsdell of the *New York Tribune*. We clip it from *The Pacific Tourist*:

"The flume . . . is built wholly upon trestle work and stringers; there is not a cut in the whole distance, and the grade is so heavy there is little danger of a jam.

"The trestle work is very substantial, and is undoubtedly strong enough to support a narrow gauge railway. . . .

"In one place it is seventy feet high. The highest point of the flume from the plain is 3,700 feet, and on an air line, from beginning to end, the distance is eight miles, the course taking up seven miles in twists and turns, it being fifteen miles long from beginning to end. The total fall from top to bottom end is between 1,600 and 2,000 feet, or an average of 120 feet to the mile. The sharpest fall is three feet in six. There are two reservoirs from which the flume is fed.

"The flume was built in ten weeks. It required 2,000,000 feet of lumber in its construction.

"*The ride.*—Upon my return I found that Mr. Flood and Mr. Fair had arranged for a ride in the flume, and I was challenged to go with them. Indeed, the proposition was put in the form of a challenge—they dared me to go. I thought that if men worth $25,000,000 or $30,000,000 apiece could afford to risk their lives I could afford to risk mine, which was not worth half as much. So I accepted the challenge and two *boats* were ordered. These were nothing more than pig-troughs with one end knocked out. The *boat* is built, like the flume, V shaped, and it fits into the flume. It is composed of three pieces of wood—two two-inch planks sixteen feet long, and an end-board which is nailed about two and one-half feet across the top. The forward end of the boat was left open, the rear end closed with a board—against which was to come the current of water to propel us. Two narrow boards were placed in the boat for seats, and everything was made ready. Mr. Fair and myself were to go in the first boat, and Mr. Flood and Mr. Hereford in the other.

"Mr. Fair thought that we had better take a third man with us who knew something about the flume. There were probably fifty men from the mill standing in the vicinity waiting to see us off, and when it was proposed to take a third man, the question was asked of them if anybody was willing to go. Only one man, a red-faced carpenter, who takes more kindly to whisky than to his bench, volunteered to go. Finally, everything was arranged. Two or three stout men held the boat over the flume, and told us to jump into it the minute it touched the water, and to '*hang on to our hats.*'

"The signal of '*all ready*' was given, the boat was launched and we jumped into it as best we could, which was not very well, and away we went like the wind.

"One man who helped to launch the boat, fell into it just as the water struck it, but he scampered out on to the trestle, and whether he was hurt or not we could not wait to see.

"The grade of the flume at the mill is very heavy, and the water rushes through it at railroad speed. The terrors of that ride can never be blotted from the memory of one of that party. To ride upon the cow-catcher of a locomotive down a steep grade is simply exhilarating, for you know there is a wide track, regularly laid upon a firm foundation, that there are wheels grooved and fitted to the track, that there are trusty men at the brakes, and better than all, you know that the power that impels the train can be rendered powerless in an instant by the driver's light touch upon his lever. But a flume has no element of safety. In the first place the grade cannot be regulated as it is upon a railroad; you cannot go fast or slow at pleasure, you are wholly at the mercy of the water. You cannot stop, you cannot lessen your speed, you have nothing to hold to; you have only to sit still, shut your eyes, say your prayers, take all the water that comes —filling your boat, wetting your feet, drenching you like a plunge through the surf,— and wait for eternity. It is all there is to hope for after you are launched in a flume-boat. I can not give the reader a better idea of a flume ride than to compare it to riding down an old-fashioned eave-trough at an angle of 45°, hanging in mid air without support of roof or house, and thus shot a distance of fifteen miles.

"At the start we went at the rate of about twenty miles an hour, which is a little less than the average speed of a railroad train. The reader can have no idea of the speed we made until he compares it to a railroad. The average time we made was thirty miles per hour — a mile in two minutes for the entire distance. This is greater than the average time of railroads.

"The red-faced carpenter sat in front of our boat on the bottom, as best he could. Mr. Fair sat on a seat behind him, and I sat behind Mr. Fair in the stern, and was of great service to him in keeping the water, which broke over the end-board, from his back. There was a great deal of water also shipped in the bows of the hog-trough, and I know Mr. Fair's broad shoulders kept me from many a wetting in that memorable trip. At the heaviest grade the water came in so furiously in front that it was impossible to see where we were going, or what was ahead of us, but when the grade was light, and we were going at a three or four minute pace, the vision was very delightful, although it was terrible.

"In this ride, which fails me to describe, I was perched up in a boat no wider than a chair, sometimes twenty feet high in the air, and with the ever varying altitude of the flume, often seventy feet high. When the water would enable me to look ahead, I would see this trestle here and there for miles, so small and narrow, and apparently so fragile, that I could only compare it to a chalk mark, upon which, high in the air, I was running at a rate unknown on railroads.

"One circumstance during the trip did more to show me the terrible rapidity with which we dashed through the flume than anything else. We had been rushing down at a pretty lively rate of speed, when the bow of the boat suddenly struck something — a nail or lodged stick of wood which ought not to have been there. What was the result? The red-faced carpenter was sent whirling into the flume ten feet ahead. Mr. Fair was precipitated on his face, and I found a soft lodgment on his back. It seemed to me that in a second's time Mr. Fair, a powerful man, had the carpenter by the scruff of the neck, and had pulled him into the boat. I did not know that at this time Fair had his fingers crushed between the boat and the flume.

"But we sped along; minutes seemed hours. It seemed an hour before we reached the worst place in the flume, and yet Hereford tells me it was less than ten minutes. The flume at this point must have been very near 45° inclination. In looking out before we reached it, I thought the only way to get to the bottom was to fall. How our boat kept in the track is more than I know. The wind, the steamboat, the railroad train never went so fast. I have been where the wind blew at the rate of eighty miles an hour, and yet my breath was not taken away. In the flume in the bad places, it seemed as if I would suffocate. In this particularly bad place I allude to, my desire was to form some judgment of the speed we were making. If the truth must be spoken, I was really scared almost out of reason; but if I was on the way to eternity, I wanted to know exactly how fast I went, so I huddled close to Fair and turned my eyes toward the hills. Every object I placed my eyes on was gone before I could see clearly what it was. . . I felt that I did not weigh an hundred pounds, although I knew in the sharpness of intellect which one has at such a moment, that the scales turned at *two hundred.*

"Mr. Flood and Mr. Hereford, although they started several minutes later than we, were close upon us. They were not so heavily loaded, and they had the full sweep of the water, while we had it rather at second hand. Their boat finally struck ours with a terrible crash. Mr. Flood was thrown upon his face, and the water flowed over him, leaving not a dry thread upon him. What became of Hereford I do not know, except that when we reached the terminus he was as wet as any of us.

"This only remains to be said. We made the entire distance in less time than a railroad train would ordinarily make it, and a portion of the time we went faster than any railroad train ever did. Fair said we went at least a mile a minute. Flood said we went at the rate of 100 miles an hour, and *my* deliberate belief is that we went at a rate that annihilated time and space. We were a wet lot when we reached the terminus of the flume. Flood said he would not make the trip again for the whole *Consolidated Virginia Mine.*

"Fair said he should never again place himself on an equality with timber and wood, and Hereford said he was sorry he ever built the flume. As for myself, I told the millionaire that I had accepted my last challenge. When we left our boats we were more dead than alive. . . . The next day neither Flood nor Fair were able to leave their beds, while I had only strength enough left to say, '*I have had enough of flumes.*'"

The Locomotive.

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Pipe Hangers.

(*Continued from page* 164.)

Figures 9 and 10 show a different form of clip from those previously described. This is simply a bar of round iron with threads cut on the ends and bent around to fit the pipe. The upper ends of this yoke pass through holes in the plate S and are provided with nuts which enable adjustment to be made in a vertical direction. The plate S rests on two cast iron balls B B, which roll with scarcely any friction as the pipe expands.

Figs. 11 and 12 show a hanger made on a different principle. In this the pipe is supported on a concave roller which rolls with little friction on the plate P, which is

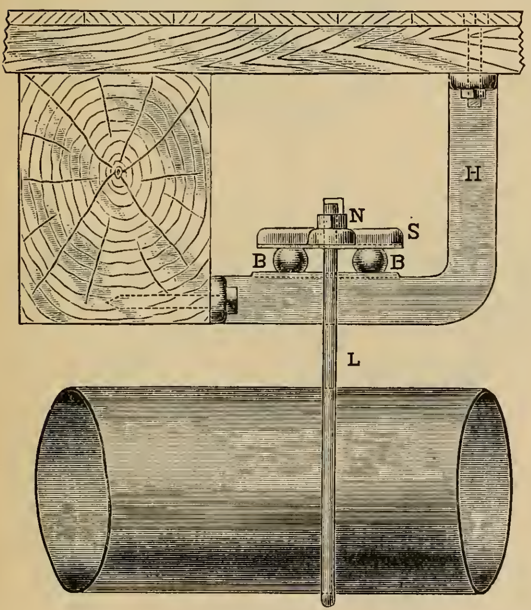

FIG. 9.

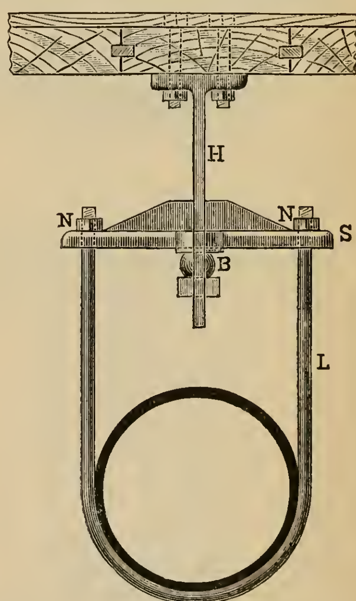

FIG. 10.

adjustable vertically by means of the four set screws *s s s s*, the whole being carried by the casting H, which is bolted securely to the beam as shown.

Figs. 13 and 14 show a form similar to that last described, but modified so that it does not interfere with covering the entire length of the pipe. A cast-iron saddle, P, carries the pipe. This saddle rests on a cylindrical roller R which is carried on set screws in the same manner as that in Figs. 11 and 12.

In either of the two last-described hangers the vertical adjustment may be omitted if there is reason to believe that the beams or other means of support to which they are attached will never settle appreciably.

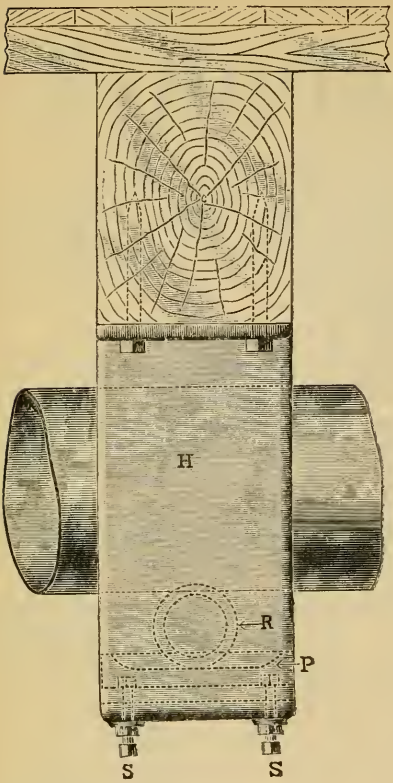

FIG. 11.

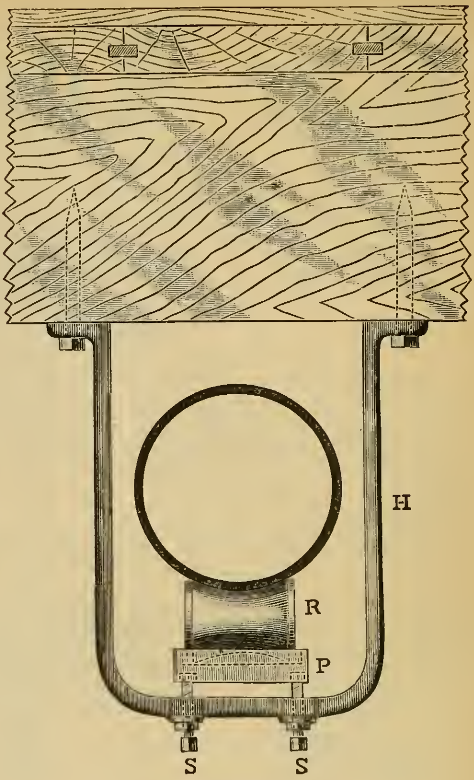

FIG. 12.

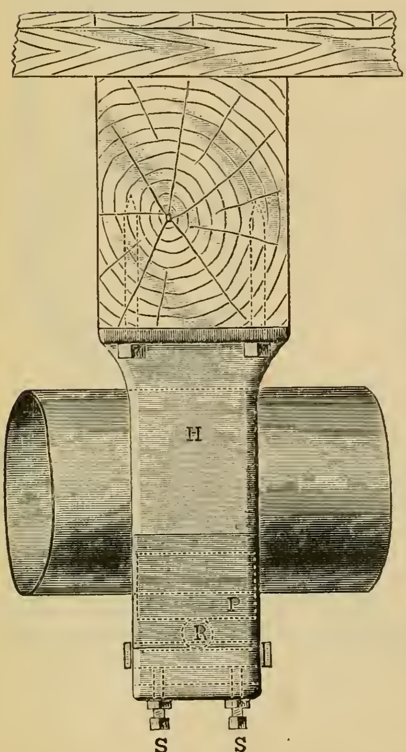

FIG. 13.

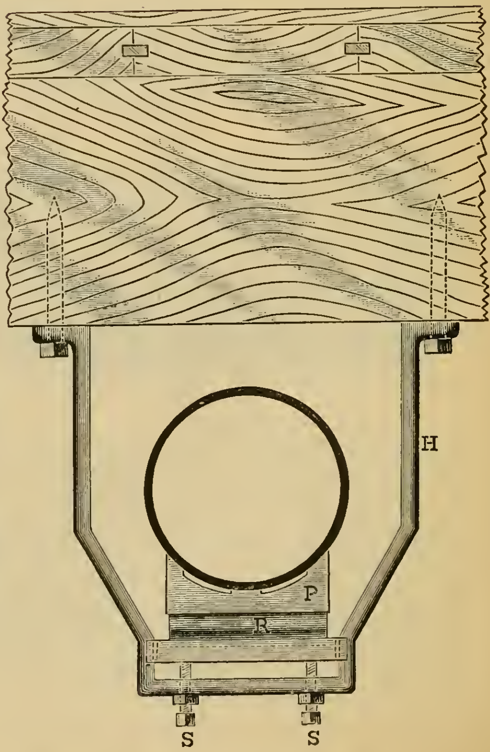

FIG. 14.

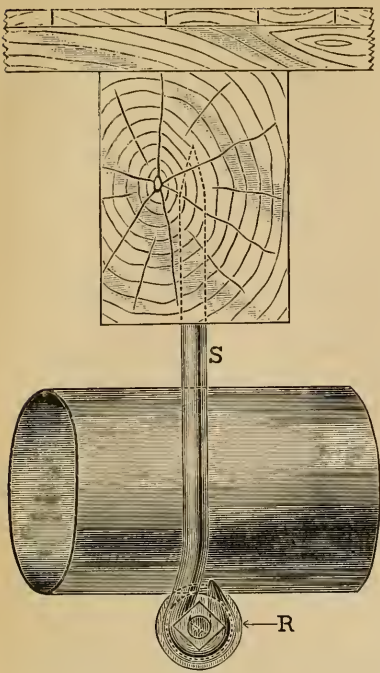

Fig. 15.

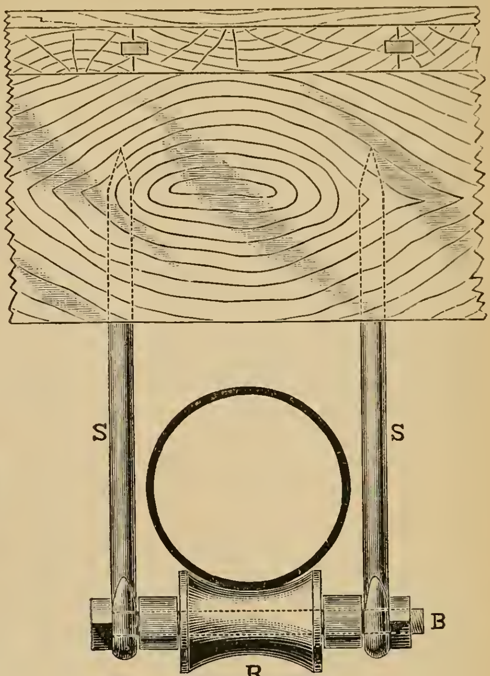

Fig. 16.

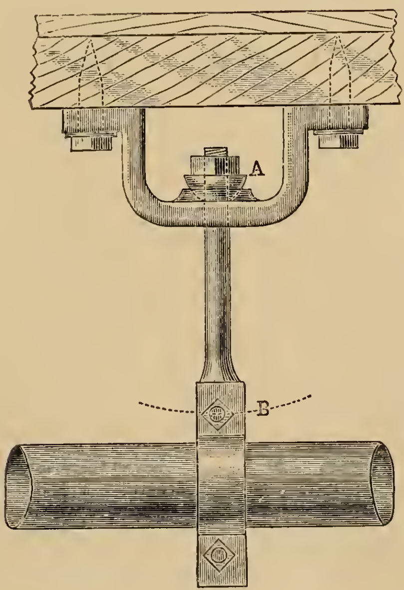

Fig. 17.

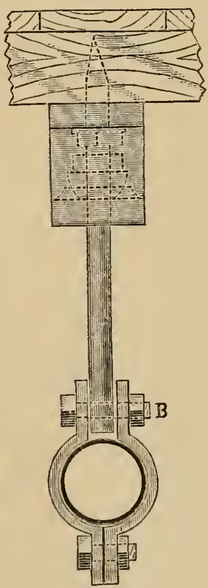

Fig. 18.

Figs. 15 and 16 show a form of hanger sometimes used and which answers its purpose very well if care is used in putting it up. Two lag screws S, S, are screwed into the timbers overhead. These screws are bent into the form of a hook at their lower ends, and an ordinary bolt passing through forms a bearing for the roller R, and carries the pipe as shown. A section of the pipe must be left uncovered where the bearing comes. This hanger is adjustable for height, but the minimum change which can be given it is equal to one-half the pitch of the thread on the lag screws. The adjustment is easily made by removing the bolt, B, and giving the screws half a turn or more as may be necessary, in either direction.

Figs. 17 and 18 show a hanger which may be used with advantage on a short line of small pipe. The cast-iron hanger is bolted to the floor or any convenient support. It may be varied in its form to suit the requirements of different cases. It is concave on the upper side, and the nut on the rod is convex to fit it. The clips around the pipe are of the same form as those described in Figs. 1 to 8, although but one bolt will be needed above the pipe. This passes through a hole in the end of the rod and the whole form a very neat adjustable hanger for short lengths of pipe. The longer the vertical rod can be made, the more easily will it work, and the longer the line of pipe it can be used on.

Inspector's Reports.

OCTOBER, 1887.

The inspectors of the Hartford Company made during the month of October last, 4,185 visits of inspection, examined 8,976 boilers, of which number 3,516 were thoroughly inspected both internally and externally, and 651 were subjected to hydrostatic pressure. The whole number of defects which were considered of sufficient importance to put on record was 8,584, of which 1,182 were considered dangerous, and led to the condemnation of 52 boilers. Our usual tabular statement is appended.

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	537	60
Cases of incrustation and scale,	780	45
Cases of internal grooving,	26	4
Cases of internal corrosion,	203	17
Cases of external corrosion,	355	33
Broken and loose braces and stays,	381	47
Settings defective,	158	18
Furnaces out of shape,	168	9
Fractured plates,	282	82
Burned plates,	191	50
Blistered plates,	338	15
Cases of defective riveting,	3,023	473
Defective heads,	44	16
Serious leakage around tube ends,	808	136
Serious leakage at seams,	690	61
Defective water-gauges,	113	25
Defective blow-offs,	40	6
Cases of deficiency of water,	23	8
Safety-valves overloaded,	40	13
Safety-valves defective in construction,	56	19
Pressure-gauges defective,	305	36
Boilers without pressure-gauges,	11	1
Defective hangers,	7	3
Defective man-hole mouth-pieces,	5	5
Total,	8,584	1182

Internal corrosion, always a dangerous foe to steam boilers, arises from a variety of causes, chief among which is, of course, bad feed water. Whatever the cause it should always be removed if possible, as soon as the corrosive action is discovered; if neglected it may go on to such an extent before danger is thought of that the boiler may be ruined, or even an explosion may result.

Different waters may act apparently in very different ways in steam boilers yet lead to the same result in the end. It is only by intelligently studying the action, and ascertaining its true cause, that proper measures of relief may be prescribed in particular cases.

What are considered to be very pure natural waters may cause severe corrosion in boilers. The action seems to be caused by the carbonic acid and oxygen held in solution by the water, and which is liberated by the high temperature in the boiler. The presence of chlorides of sodium, magnesium, ammonium, and calcium, in such waters also appears to greatly intensify the corrosive action. The addition of a suitable alkali will generally stop the corrosive action.

The presence of grease will with most waters cause corrosion of the plates. If salts of lime and magnesia are present, even in small quantities, they form with grease at the temperatures to which they are subjected in boilers a sort of lime soap, which at a higher temperature, partly decomposes into free fatty acid and an organic substance. This adheres to the boiler plates, while the acid attacks the iron. A mixture of lime-water and caustic soda judiciously applied will generally correct the action in such cases, and sometimes less heroic measures may answer the purpose, according to circumstances.

Water contaminated by sewage, the refuse from dye-works and similar establishments, always acts injuriously upon boilers. The best remedy in such cases, where possible, is a change of water, which is not always, however, convenient or practicable. Such waters sometimes form a hard scale, which adheres firmly to the plates, and beneath which the corrosive action may be surprisingly active. In such cases, where the water cannot be changed, the boilers must be kept scrupulously clean, and the addition of a suitable alkali will be found generally of great benefit.

Boiler Explosions.

October, 1887.

Flouring Mill (134).—Four persons were killed and several seriously wounded by the explosion of a boiler at George P. Plants' flour mill, St. Louis, Mo., October 3d. Mrs. Thomas S. Rivers, wife of the fireman, was blown from the boiler-room across the alley into a room sixty feet from where she was standing. She was killed as was her husband who was buried under the debris. Fritz Kuhlman was also buried in the ruins and was taken out dead. Henry Tenne was instantly killed by the steam and force of the explosion. Engineer Benjamin J. Eyers was seriously injured. Minnie Richman, a child of five years, had both legs broken, and is so injured that recovery is not probable. A piece of the boiler flew 200 feet and crushed down upon the roof of H. C. Mayer's two-story house, crushing through to the cellar, demolishing the whole house. Another piece of the boiler smashed into an adjoining livery stable and pulled down a wall and part of the roof. Mike Donnelly, a flagman of the Iron Mountain Railway, on duty two blocks from the scene of the explosion, was knocked down, badly bruised, and possibly internally injured. Pat Hogan, a coal heaver, was unloading coal near the boiler-house, and was buried beneath the debris. He was taken out half an hour after the catastrophe, and was badly bruised and cut about the head and had three ribs broken. The mud-drum, weighing 1,000 pounds, crashed through the roof to the cellar of John Burby's house. Every house in the neighborhood was more or less damaged. The engineer can assign no cause for the disaster. He says the boilers were only two years old, and were recently thoroughly repaired. They were supposed to be non-explosive.

SAW-MILL (135).—By the explosion of a boiler in David Young's saw-mill, three miles northeast of Amanda, Ohio, October 5th, George Lape, Terry Lape, Simon Young, and Amos Young, were instantly killed, and Mrs. Simon Young, who was at the time 200 yards from the mill, was seriously injured. The cause is unknown, as everyone at the mill was killed. Simons' head was blown a hundred feet in the air. Amos' skull was crushed to atoms and the others were blown to fragments.

STEAMER (136).—The boiler of the small steamer *Paducah*, used in pumping water out of the coffer-dam at the new bridge, three miles from Nashville, Tenn., near the Hyde's ferry turnpike, exploded with terrific force October 8th. The boat was torn to fragments, some being blown a very long distance. Thomas J. Treppard, the engineer, was instantly killed, the front of his skull being crushed in, his face and body scalded and a terrible wound in his side. His body was found near the gunwale of the half-sunken wreck. William Morgan, the carpenter of the works, was struck with a heavy piece of wood and had his left leg broken. The boiler was carrying about 140 pounds of steam at the time the accident occurred.

SAW-MILL (137).—The boiler of a saw-mill near Manchester, Ky., exploded October 12th, killing two persons and badly injuring two others.

SAW-MILL (138).—The boiler at George Goodwin & Co.'s saw and planing mills, Cygnet, O., exploded at two o'clock on the morning of October 14th, tearing up everything, and making a wreck of the property, which afterwards burned, and killing three men. A man named Erwine was torn to pieces, Kent Evans was killed, and a man named Tompkins died soon after being taken from behind a lumber pile, terribly maimed. Others fell victims to the fire. Four men were asleep in the third story of the mill, and two, who jumped from the windows, escaped without serious injury. J. G. McCall of Fostoria, O., and William Flaughner of Sugar Grove, Pa., lost their lives, their bodies being burned to a crisp. The mill was valued at $8,000, and was insured for $2,000.

SAW-MILL (139).—One of the most appalling boiler explosions ever known in the county, occurred at the saw-works of J. C. Painter & Bro., near Thornton, W. Va., October 14th. Out of a crew of five men there is but one left to tell the story, and he is so distracted by the disaster that scarcely anything intelligible can be gleaned from him. The mill crew was composed of John L. Warthem, sawyer; his son, Chauncey D. Warthem, fireman; Lloyd McCarty and James Jones, off-bearers, and Henry Artis, tail-setter. While the sawyer, John L. Warthem, was engaged in the yard he was startled by a terrific explosion, and was paralyzed with horror at seeing the mill literally blown to atoms. When the smoke cleared not a vestige of the mill was found standing, and not a man was to be seen. A short search, however, revealed the fireman, Chauncey Warthem, upon a hillside over 200 feet away, where he had been blown through the tree tops, dead. About the same distance away on the other side of the mill James Jones was found dead and frightfully disfigured. His head had struck a fence with such force as to break one of the rails. At other places equally distant were found Lloyd McCarty and Henry Artis, both with heads crushed and other injuries that are fatal. All the bodies were terribly scalded from head to feet, and their clothing and shoes were torn off by the force of the explosion. The machinery was scattered far and wide, a part of the boiler, weighing 4,000 pounds, being blown over 300 feet through the trees and brush. The mill was completely annihilated. The theory as to the cause of the accident is that the water had run down too low, letting the boilers get too hot, and when the fireman turned on fresh water, and as he was in the act of doing it, the explosion took place.

Iron Works (140).— A boiler explosion caused a general stampede among several hundred employees in one department at the Western Steel Works, Carondelet, Mo., October 16th, and it is marvelous how a great loss of life was avoided, as the fragments flew in every direction.

Soapstone Factory (141).—While Cornelius Mulraney was engaged in making some repairs upon a steam boiler in the soapstone factory of P. H. Butler, 8 Beverly street, Boston, Mass., October 16th, the safety valve was blown off, and struck him with such force as to fracture his skull, causing instant death.

Saw-Mill (142).— A saw-mill boiler exploded at Van Buren, Ark., October 18th, killing two men and injuring another.

Steamer (143).—The Canadian propeller *Ontario* was blown to pieces by the explosion of her boiler in the North Channel, near Bruce Mines, October 22d, and thirty-five people killed. No particulars can be obtained, it being isolated from any port or telegraph station.

Saw-Mill (144).— On Saturday, October 22d, at noon, the workmen employed in Parker & Elwood's steam saw-mill, in the lower part of West Brownsville, Pa., went away to their dinner. No one was left in the mill. Between 12 and 1 o'clock, as the men were on their way back to the mill, the boiler in the establishment exploded. When the cloud of steam cleared away, not a vestige of the mill was visible, except the circular saw, which was in its place and uninjured. Windows were broken by the shock two miles away. A portion of the boiler, twelve feet long, and weighing two tons, was found 300 feet distant. It had struck a large tree with such force that the trunk was broken off close to the ground. The furnace box was thrown 1,800 feet through the air in one direction, and other parts of the boiler as far in the opposite direction. The mill itself seemed utterly annihilated. While the workmen were rejoicing that no one was in the mill at the time, the terribly mangled body of a man was found nearly 100 yards from where the mill had stood. His face and part of his head were missing, and he could not be identified. A man who lives near the scene of the explosion said that he had seen William Kelley, his brother John, and another man land a small raft in front of the mill just after the workmen had gone to dinner, and that the men had walked towards the mill. The body of the dead man was then identified by his clothing as that of William Kelley. Two hours later the body of John Kelley, also terribly mutilated, was found in the river, 300 feet distant from the mill. The body of the third man has not been found.

Iron Works (145).— A battery of six boilers at the Lawrence Iron Works, Ironton, Ohio, exploded, October 21st, killing four men. Their names were, Michael Dyer, James F. Dyer, Thomas A. Davis, and Peter Clay. John Maine, Robert Jones, Mack Grubb, Charles Sloan, Edward Dyer, John Pritchard, and Ben Golden, colored, were badly injured, but will all probably recover. Thirty other people were also injured. The boilers were inspected and pronounced all right on the 19th of June by Inspector W. H. Budd for the Cleveland Fidelity and Casualty Company. The engines were working as usual when the engineer, Floyd Barker, noticed that the water was going down rapidly. He stopped the engine and the explosion at once followed. The boilers and other debris were blown several hundred yards. Telegraph poles were uprooted and blown on houses. The railroad tracks near by were loosened and one rail was broken squarely off two feet from the end. The loss to property is $10,000. The boilers were insured for $3,000, machinery for $2,500, and the building and stock for $200.

PORTABLE BOILER (146).—A boiler used in drilling a well near Omaha, Neb., exploded, October 22d, killing one man and severely injuring another. The boiler had been considered unsafe for some time, and several workmen had left, on that account, refusing to work in its vicinity.

STEAM LAUNCH (147).—The steam launch *Mary* burst her boiler, October 23d, at the foot of One Hundred and Sixteenth street, N. Y., instantly killing John and Patrick Cunningham, brothers. Carl E. Schmidt, owner of the launch, was blown into the river, but was saved. Several others were badly bruised.

SAW-MILL (148).—A saw-mill boiler exploded near Portsmouth, Ohio, October 23d, killing one man and injuring three others.

SAW-MILL (149).—The boiler in Jewett's mill at Milledgeville, N. B., exploded October 27th, seriously injuring Perley Wetmore and Charles Gibbons, and wrecking the building.

FIRE-BRICK WORKS (150).—The large double boiler at Holden's fire-brick works at Mineral Point, Ohio, exploded with terrific force, October 28th, fatally scalding four persons and seriously injuring five others. The following persons are fatally hurt; Frank Harter, James Milward, W. Lautenstagle, and a boy named Graham. Several others whose names could not be learned, were more or less injured. The head of one of the boilers was found at the quarry, two hundred yards from the engine. The explosion caused the most intense excitement in the neighborhood, and was heard for miles around.

STEAMER (151).—One of the boilers on the Iron Mountain Transfer steamer *St. Louis*, exploded at Columbus, Ky., October 29th, doing but little damage to the boat, and slightly injuring one negro deck hand. The boat continues her trip, working only one battery until she can get a substitute.

PUMPING ENGINE BOILERS (152).—A boiler explosion occurred, October 30th, a few minutes before 9 o'clock A. M., at the Terrace Baths, Alameda, Cal., causing the death almost instantaneously, of Robert Haley, proprietor of the bathing establishment, and seriously injuring Charles Becker, an employee. The boiler which wrought the terrible destruction was located in a building 18x20 feet, which stands on the southern dyke or dam of the bathing inclosure, about 200 feet from the shore. The boiler operated an engine which was used to pump the water of the bay into the inclosure.

LOCOMOTIVE (153).—A engine exploded near Mackberry, Cal., October 31st, killing Engineer Schröder, Fireman Long, and Brakeman Trapp. The bodies were found 300 from the track.

SAW-MILL (154).—James Townsley's saw-mill, twenty miles from Augusta, Ky. was damaged by a boiler explosion, October —.

THE world's production of copper for the past three years in tons, is estimated as follows:—

	1886.	1885.	1884.
Europe,	76,463	76,551	75,410
North America,	73,780	77,706	66,750
South America,	40,008	44,573	48,269
Africa,	6,125	5,700	5,260
Asia,	10,000	10,000	10,000
Australia,	9,700	11,400	14,100

The Locomotive.

HARTFORD, DECEMBER, 1887.

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

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

THE device most generally adopted to compensate for the expansion of long lines of steam pipe, where it is inconvenient or impossible to get in a right-angled turn of sufficient length to accomplish the purpose, is an expansion or slip joint. When well made, properly put in, and carefully attended to, it will fulfill its intended purpose very well; but as it is usually made and put up it is a most annoying piece of apparatus, and the right-angled turn is to be in all cases preferred where it can be so arranged.

With the smaller sizes of joint there is usually not so much trouble as there is with the larger ones, more especially if they are of the ordinary commercial make. In the case of pipes up to three or four inches in diameter no especial trouble need be experienced if it is seen that there is travel enough for the joint, it is perfectly lined up, and the body is securely anchored or bolted to some rigid support. It is common practice to put these joints into lines of pipe without any support whatever except that afforded by the pipe itself. This is very bad practice, and it is useless to expect them to work smoothly under such circumstances.

To insure a good working joint several things must be strictly attended to. In the first place, the joint itself must be properly designed and well made. It will not do to have the sleeve so short that it pulls out of the packing every time the pipe cools off. We have known of cases where this has occurred. In one extensive system in particular that we have in mind, the sleeves are so short that they frequently pull out while the pipes are under steam, it being due to the facts that the sleeves are too short, and the pipes are improperly anchored. As this system of piping is located mostly out of doors and underground, it may readily be imagined what sort of work it makes.

For an expansion joint for a 12-inch pipe to carry steam of high pressure and consequent high temperature, allowance should be made for an expansion of 2½ inches in every 100 feet of its length. In addition to this, in designing a joint for such a pipe, a margin of at least 4 inches more than this should be provided for in the length of the sleeve, 2 inches in each direction. The body of the joint should be securely anchored, as well also as the pipe at the point from which the expansion is to take place. Neither will it do to support a section of pipe of this length on the common swinging hooks that are so often used. It must be carried on some sort of parallel motion hanger, so that the joint will not be cramped.

In setting an expansion joint of this size, or any other size for that matter, it should not be considered as rough "pipe work." It should be borne in mind that the construction and operation is the same as it is in the case of the piston rod of a very large engine, and unless the same care is exercised, and the pipe and joint are lined up with the same accuracy that is deemed necessary in engine work and precautions taken to keep them in line, it will not remain tight or work satisfactorily.

But in spite of all care that can be exercised in the design, construction, and setting of a joint of this sort, we would never advise their use when it can be avoided. If the pipe can be arranged conveniently with right-angled turns so that its spring will take the expansion, it should always be done; where it cannot be so arranged we would advise the use of a U-shaped piece of copper pipe. The conditions where this could not be put in somewhere in the line are very rare. A length of 10 feet in the U will be sufficient to compensate for the expansion of 100 feet of 12-inch pipe, and for smaller sizes a less length will answer. The reason for using copper instead of making an offset in the pipe itself, is because of its very much greater flexibility a shorter turn may be used. It would cost no more than a slip joint, and once in, it would give no more trouble than a similar length of the pipe itself.

A RECENT boiler explosion is said to have been caused by a wooden plug driven from the inside of the boiler into the nozzle to which the safety-valve was attached. It was driven in by a man who was employed to clean the boiler, to keep hot water from a leaky connection to an adjacent boiler which was under steam, from dropping on him while he was at work, and when he got through he forgot to remove it. We have heard of such cases before now. A similar one will be found illustrated in THE LOCOMOTIVE, September, 1882.

Several morals may be drawn from such an occurrence. One is that it always *pays* to keep tight joints about the boiler connections; then there would be no occasion for the plug. Another is: Always have your safety-valve connected to a nozzle of its own, so it *cannot* be shut off, and don't make any other connections with this nozzle. Do not even connect the several safety-valves on a battery of boilers to a common escape pipe, or the same trouble may ensue. Make the safety-valve on every boiler a safety-valve in *fact* as well as in *name*, and keep it so.

THE consolidation of the heating apparatus for large institutions is quite the thing to do now-a-days, but we seriously question if it is always worth while to do it. Where the buildings are compactly placed, and favorably situated, it will generally pay; but when they are widely separated, and the formation of the ground is unfavorable, making it a matter of difficulty to run pipes, and return the water of condensation without a complicated system, it will not generally pay. The expense involved in running large mains underground three or four thousand feet, and doing it properly, is very great, and the unavoidable loss by condensation in such mains is very apt to more than offset any gain that may result from having the boilers located at one point. Still the particular circumstances governing each individual case will generally have to be taken into consideration, in order to determine whether a central plant is advisable or not.

ONE of the funniest things that has lately appeared, and which is rendered all the funnier by the fact that several mechanical papers, whose editors ought to know better, have devoted whole columns to it, is an alleged new theory of heat said to have been invented(?) by some one out in Ohio. If correctly reported, and it probably matters little whether it is or not, it is the sheerest rot, not worth noticing in a serious manner. Theories on scientific subjects are easily "invented," and the denser a person's ignorance is the more easily he can invent them.

STEAM BOILER EXPLOSIONS, by Prof. R. H. Thurston, just received from the press of John Wiley & Sons, 15 Astor Place, New York, is the title of a well-written and illustrated work of 170 pages, in which the causes of boiler explosions are treated in a common sense manner and practically illustrated. The tables showing the amount of energy stored in various boilers when in working order are especially interesting. All interested in the subject should read it.

We note with pleasure that Mr. M. N. Forney is publishing in the *Railroad and Engineering Journal*, his well known *Catechism of the Locomotive*, revised, re-written, and enlarged. This is the best work we know of for locomotive engineers, and every man who "presides" at the throttle of a locomotive should read it.

Messrs. E. P. Watson & Son will change the name of their paper, *The Mechanical Engineer*, to *The Engineer* on the first of January next. We commend the change,—and recommend the paper. Every issue is well filled with interesting and instructive matter.

The paragraphers who are just now so busily engaged in letting the world know that Prof. Kirchhoff is dead, seem to be totally unaware that such a person as Dr. John W. Draper ever existed.

United States Government Rules for Marine Boiler Pressures.

We reproduce here a synopsis of the principal rules governing the qualities of boiler plate, and strength of boilers and flues as approved by the United States Board of Supervising Inspectors of Steam Vessels; they will be found valuable for reference in many cases.

STRENGTH AND DUCTILITY OF PLATES.

Iron of 45,000 pounds tensile strength and under shall show a reduction of area of 15 per cent., and each additional 1,000 pounds tensile strength shall show one (1) per cent. additional contraction of area, up to and including 55,000 T. S. Iron of 55,000 T. S. and upwards, showing twenty-five (25) per cent. reduction of area, shall be deemed to have the lawful ductility.

All steel plate of one-half inch thickness and under shall show a contraction of area not less than fifty (50) per cent. Steel plate over one-half inch in thickness shall show a reduction of not less than forty-five (45) per cent. Steel plate required for repairs to boilers built previous to April 1, 1886, may be used for such repairs when showing a contraction of area of not less than forty (40) per cent.

A cut showing the Government form of test piece may be found in The Locomotive of March, 1886.

The pressure for any dimension of boiler must be ascertained by the following rule, viz.:

Multiply one-sixth ($\frac{1}{6}$) of the lowest tensile strength found stamped on any plate in the cylindrical shell by the thickness — expressed in inches, or parts of an inch — of the thinnest plate in the same cylindrical shell, and divide by the radius or half diameter — also expressed in inches — and the quotient will be the pressure allowable per square inch of surface for single-riveting, to which add twenty per centum for double-riveting.

Boilers built prior to February 28, 1872, shall be deemed to have a tensile strength of 50,000 pounds to the square inch, whether stamped or not.

Where flat surfaces exist, the inspector must satisfy himself that the bracing and all other parts of the boiler are of equal strength with the shell, and he must also, after applying the hydrostatic test, thoroughly examine every part of the boiler.

The hydrostatic pressure applied must be in the proportion of one hundred and fifty pounds to the square inch to one hundred pounds to the square inch of steam pressure allowed.

No braces or stays hereafter employed in the construction of boilers shall be allowed a greater strain than 6,000 pounds per square inch or section, and no screw-stay bolt shall be allowed to be used in the construction of marine boilers in which salt water is used to generate steam. But such screw-stay bolts may be used in staying the fire-boxes and furnaces of such boilers, and not else where, when fresh water is used for generating steam in said boilers.

RIVETED FLUES.

Flues having a diameter not										
less than	6″,	7″,	8″,	9″,	10″,	11″,	12″,	13″,	14″,	15″,
and not more than . . .	7″,	8″,	9″,	10″,	11″,	12″,	13″,	14″,	15″,	16″,
shall have a thickness not less than	.18″,	.20″,	.21″,	.21″,	.22″,	.22″,	.23″.	.24″,	.25″,	.27″;

and if in the opinion of the inspectors it is deemed safe may be allowed a steam pressure according to the thickness as follows;

6 to 7 inches in diameter.

Thickness, ...	.18,	.19,	.20,	.21, . . .	of an inch.
Pressure in pounds, . .	189,	194,	199,	204, . . .	per square inch.

7 to 8 inches in diameter.

Thickness, . . .	.20,	.21,	.22,	.23,	.24, . .	of an inch.
Pressure in pounds, .	184,	189,	194,	199,	204, . .	per square inch.

8 to 9 inches in diameter.

Thickness, ...	.21,	.22,	.23,	.24,	.25,	.26,	of an inch.
Pressure in pounds,	179,	184,	189,	194,	199,	204,	per square inch.

9 to 10 inches in diameter.

Thickness, ...	.21,	.22,	.23,	.24,	.25,	.26,	.27,	of an inch.
Pressure in pounds,	174,	179,	184,	189,	194,	199,	204,	per square inch.

10 to 11 inches in diameter.

Thickness, ...	.22,	.23,	.24,	.25,	.26,	.27,	.28,	.29,	of an inch.
Pressure in pounds,	169,	174,	179,	184,	189,	194,	199,	204,	per square inch.

11 to 12 inches in diameter.

Thickness, ...	.22,	.23,	.24,	.25.	.26,	.27,	.28,	.29,	.30.	of an inch.
Pressure in pounds,	164,	169,	174,	179,	184,	189,	194,	199,	204,	per square inch.

12 to 13 inches in diameter.

Thickness, ...	.23,	.24,	.25,	.26.	.27,	.28,	.29,	.30,	.31,	.32,	of an inch.
Pressure in pounds,	159,	164,	169,	174,	179,	184,	189,	194,	199,	204,	per sq. inch.

13 to 14 inches in diameter.

Thickness, . . .	.24,	.25,	.26,	.27,	.28,	.29,	.30,	.31,	.32,	.33,	.34,	of an inch.
Pressure in lbs.,	154,	159,	164,	169,	174,	179,	184,	189,	194,	199,	204.	per sq. inch.

14 to 15 inches in diameter.

Thickness, . . .	.25,	.26,	.27,	.28,	.29,	.30,	.31,	.32,	.33,	.34,	.35.	of an inch.
Pressure in lbs.,	147,	152,	157,	162,	167,	172,	177,	182,	187,	192,	197,	per sq. inch.

15 to 16 inches in diameter.

Thickness, . . .	.26,	.27,	.28,	.29,	.30,	.31,	.32,	.33,	.34,	.35,	.36,	of an inch.
Pressure in lbs.,	140,	145,	150,	155,	160,	165,	170,	175,	180,	185,	190,	per sq. inch.

LAP-WELDED FLUES.

Lap-welded flues, 16 inches and not less than 7 inches in diameter. To determine the pressure per square inch allowable on lap-welded flues 18 feet and less in length, multiply the thickness of material in hundredths of an inch by the constant whole number 44, 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 three pounds per square inch from the pressure allowable on a flue 18 feet in length, or add $\frac{1}{100}$ of an inch to the thickness of the material required for a flue 18 feet in length for every 3 feet or fraction thereof over 18 feet.

To determine the thickness of material for any required pressure, multiply the pressure in pounds by the radius of the flue in inches, and divide the product by the constant 44; the quotient will be the thickness required.

The thickness of lap-welded flues shall not be less than the product of the constant 2.20 multiplied by the diameter of the flue in inches, which will express the thickness in hundredths of an inch.

Lap-welded flues 7 inches and not over 16 inches in diameter, over 5 feet and not over 10 feet in length, shall be re-enforced by one wrought iron ring attached externally at the center of the flue.

Lap-welded flues over 10 feet and not over 15 feet in length shall have two wrought iron rings attached to the flue externally, equidistant between the ends of the flue, and there shall be attached one additional ring for every 5 feet or fraction thereof over 15 feet in length.

All such rings shall be good and substantially made, and properly and securely attached to the flues, and shall have a thickness of material not less than the thickness of material of the flues, and a width of not less than $2\frac{1}{2}$ inches, *provided, however*, where such flues are made in lengths of not over 5 feet, and fitted one into the other, and substantially riveted, the wrought iron rings may be dispensed with.

Lap-welded flues 7 inches in diameter and less shall be in accordance with the following table of thicknesses: *provided, however*, that all lap-welded flues 16 inches diameter, and not less than 7 inches diameter, when used under a steam pressure of 120 pounds and upwards, shall be of the same thickness as prescribed in table Rule 2, section 8, for riveted flues.

Diameter in Inches.	Thickness in Inches.	Diameter in Inches.	Thickness in Inches.	Diameter in Inches.	Thickness in Inches.	Diameter in Inches.	Thickness in Inches.
7	.165	4	.134	3	.109	2	.095
6	.165	$3\frac{3}{4}$	.120	$2\frac{3}{4}$	.109	$1\frac{3}{4}$	.095
5	.148	$3\frac{1}{2}$	.120	$2\frac{1}{2}$	.109	$1\frac{1}{2}$	.083
$4\frac{1}{2}$	.134	$3\frac{1}{4}$	.120	$2\frac{1}{4}$	.095	$1\frac{1}{4}$	.072
						1	.072

For cylindrical boiler flues over 16 and less than 40 inches in diameter, the following formulas shall be used in determining the pressure allowable.

Let D = diameter of flue in inches.

1760 = A constant.

T = thickness of flue in decimals of an inch.

P = pressure of steam allowable, in pounds.

$$\frac{1760}{D} = F, \text{ a factor.}$$

.31 = C, a constant.

$$\text{Formula: } \frac{F \times T}{C} = P.$$

EXAMPLE.

Given a flue 20 inches in diameter, and .37 of an inch in thickness; what pressure could be allowed by the inspectors?

$$F = \frac{1760}{20} = 88; \text{ then, } \frac{88 \times .37}{.31} = 105 + \text{ pounds as the allowable pressure.}$$

CORRUGATED FURNACE FLUES.

The strength of corrugated flues, when used for furnaces or steam chimneys (corrugations not less than $1\frac{1}{2}$ inches deep), and provided that the plain parts at the ends do not exceed 6 inches in length, and the plates are not less than $\frac{5}{16}$ of an inch thick, when new corrugated and practically true circles, to be calculated from the following formula:

Let T = thickness in inches.

D = mean diameter, in inches.

$$\text{Allowable pressure} = \frac{12500}{D} \times T.$$

Example: A flue 40 inches in diameter, and $\frac{1}{2}$ inch thick would be allowed a pressure of $\frac{12500}{40} \times \frac{1}{2} = 156 +$ pounds per square inch.

The formula for cylindrical lap-welded and riveted flues in boilers to be used as furnaces, which shall be used by inspectors in determining the pressure to be allowed, shall be as follows, viz:

Let D = diameter of flue, in inches.

89600 = A constant.

T = thickness of flue in decimals of an inch.

L = length of flue in feet, not to exceed 8 feet.

P = pressure allowable, in pounds per square inch.

$$\text{Then } \frac{89600 \times T^2}{L \times D} = P.$$

Example: A flue 40 inches in diameter, 7 feet long, and $\frac{1}{2}$ of an inch thick would be allowed on a steam pressure of

$$\frac{89600 \times .5 \times .5}{7 \times 40} = 80 \text{ pounds per square inch.}$$

Provided, If rings of wrought iron fitted and riveted properly on, around, and to the flues, in such manner that the tensile strain on the rivets shall not exceed 6000 pounds per square inch of section, the distance between the rings shall be taken as the length of the flue in the formula.

He Thought a Hole Through a Board.

"I can make you think a hole through a half-inch board," was the rather startling remark made to a New York reporter.

The speaker was Edward Weston of Newark, one of the leading experts in electricity of the world.

Mr. Weston has fitted up in the rear of his place in Newark a laboratory for the purpose of scientific experiment and research. It is a veritable Aladdin's palace, having been created by the "slaves of the [electric] lamp," and having as many magical appurtenances as ever the genii could boast of.

Entering the physical department, Mr. Weston produced two thermopiles: A thermopile is a device for generating electricity direct from heat. It consists of bars of dissimilar metals placed close together, alternately, so that a section cut through the thermopile would resemble a chess board, one metal representing the black and the other the white squares. These bars are insulated from each other, except at alternate ends, where electric connection is made. The application of heat at once excites an electric current in the thermopile, as was shown to the reporter by several experiments.

"Now," said Mr. Weston, "I will connect two of these thermopiles by this wire. They are connected in opposition, so that as long as the same amount of heat is applied to each they will neutralize each other, and there will be no electric current to run this electric motor, which is in the circuit. But if one is heated more than the other the greater current will overpower the lesser, to use a commonly understood way of expressing the result, and a current will pass to the motor.

"I place one thermopile in this dish, surrounded by water, which I keep exactly at the normal temperature of the blood — 98.5 degrees. Of course that would excite a current, but I neutralize that current by placing the other thermopile in contact with your temple. You see, the two thermopiles now counteract each other, since the same degree of heat is applied to each. Now, take a problem in mechanics and solve it. Are you ready?"

With a thermopile pressed against the starboard lobe of his alleged brain, and enough wires and other electrical appliances close at hand to send him to Lucifer if he refused, the reporter intimated his willingness to attack a problem, if it were only a little one.

"All right. Now suppose you drop a stone down a coal shaft and hear it strike bottom in five seconds, how deep is the shaft? Remember, $s=vt$ and $v=\frac{1}{2}gt$, and you can allow 1,142 feet per second for the velocity of sound."

It is hardly necessary to say that the reporter struggled with that problem with an energy born of despair. He quickly forgot all about the electric experiment and was bent upon reconciling the conflicting demands of the time of the stone's downward flight and the time of the upward flight of the sound made by its striking, the two intervals equaling five seconds.

Suddenly he was aware of a buzzing in the motor. It began to spin faster and faster until he lost interest in the problem, when it began to slacken speed.

"Ah!" said Mr. Weston, "stick to your mechanics or you deprive the motor of power. You must keep up your mental exertion if you want to bore that hole."

Thus adjured, the reporter struggled with the mechanical and algebraic difficulties of the case until, having got utterly muddled with v and g and t, he couldn't have told whether the shaft was 50 or 500 feet deep. He made a valiant struggle, nevertheless.

As his supposed brain wrestled with the problem the temperature of his head increased and the thermopile in contact was, of course, heated above its twin, which remained at the normal blood heat. As this difference in temperature generated an electric current, which current ran the motor, it was evident that the latter was being driven practically by the reporter's efforts to solve the problem. And as the motor, with a loaded fly wheel, carried a fine drill on its axis, the piercing of a piece of wood by the drill was easily accomplished, long before there was the least prospect of the depth of the coal shaft being discovered.

Thus Mr. Weston had literally kept his promise of making the reporter "think a hole through a half-inch board." — *The Stationary Engineer.*

An iron lighthouse for the Government has just been completed by a New York firm. It will be situated on Auclote Key, on the western coast of Florida. It is a skeleton structure, 106 feet high from the base to the top of the lantern chamber. It consists of a hollow central shaft, six feet six inches in diameter, secured by heavy posts fastened with radial struts and stiffened by wrought-iron diagonal tie-bolts. When in position, it will have a concrete foundation four feet deep and thirty-eight feet square. The lantern chamber is reached by a spiral iron staircase inside the central shaft. The doorways and windows are storm-proof. Just below the lantern chamber is the watch room whence oil is pumped to the lantern. This room is lighted by portholes in the floor, solidly glazed. The lantern chamber itself is octagonal in shape and about ten feet high. The light and the glass sides of the chamber are being made in France. The lighthouse will cost the Government $11,000. It will weigh about seventy-five tons.— *Exchange.*

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