HARTFORD STEAM BOILER

HARTFORD

CONN.

INSPECTION AND INSURANCE CO.

The Locomotive.

PUBLISHED BY THE

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

NEW SERIES.

Vol. IV.

HARTFORD, CONN.

1883

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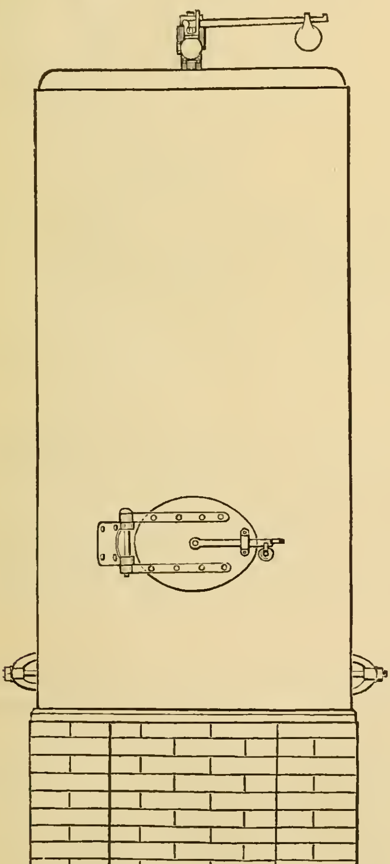
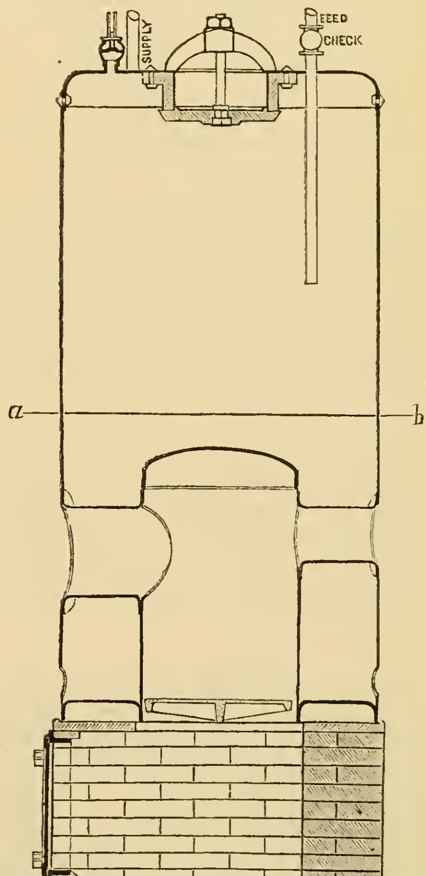
NEW SERIES—VOL. IV. HARTFORD, CONN., JANUARY, 1883. No. 1.

Upright Boiler for Heating Water.

The boiler which we illustrate below is not for generating steam, but for heating water. It was designed by Mr. J. M. Allen, for the purpose of supplying hot water to

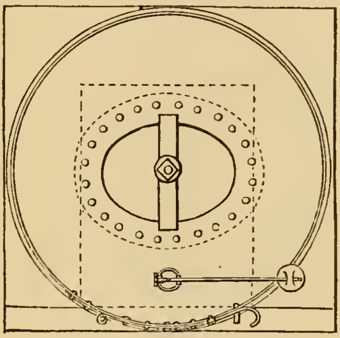


FRONT ELEVATION

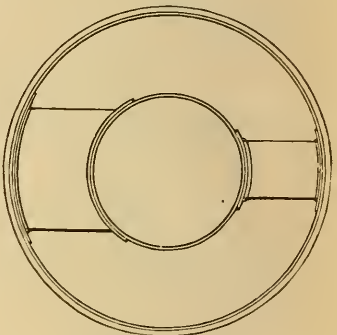


SECTION

laundry, bath-rooms, and wash-bowls, in a large public institution. It is made of $\frac{1}{4}$ inch iron, riveted up in the same manner as an ordinary vertical boiler. It sets upon a brick or cast iron base, in which is the ash pit. The grate is of the ordinary hot air furnace pattern, and can be easily shaken or "dumped." The furnace is small, as compared with the size of the boiler, being only 18 inches in diameter. The boiler is 36 inches diameter. This gives water legs, or water safes of about 9 inches. The door frame and mouth are flanged on to the boiler shell and furnace sheets. The smoke pipe or "out-take" is smaller, but attached in the same way. This hot water boiler can be set up anywhere, near a chimney. A common sheet iron stove pipe being all that is necessary to connect it with the chimney. It has three *hand-holes*, just above the bottom head for facility of cleaning. There is a man-hole on top, also a safety valve, and supply and



PLAN



SECTION ON a.b

feed pipes. The safety-valve is put on simply as a precautionary measure, in case the feed should become disarranged and steam be raised in the boiler. There is a long glass water-gauge, which is not shown in the illustration. This boiler is fed from the city pressure, which at the place where it is used is about 25 lbs. per square inch. The boiler is kept constantly full of water. Two hods (ordinary size), are usually sufficient fuel for a day's supply. The care is no more than would be required for a small cylinder stove.

As has been stated, it provides abundant hot water for laundry and bathing purposes for a public institution. We regard it as especially adapted to this purpose, and for boarding-houses, as well as private dwellings, where a larger quantity of hot water is needed than is supplied by the ordinary stove or range boiler. In places where a running supply of water, under sufficient pressure to supply rooms on different stories cannot be obtained, a tank must be used in the attic and kept full. The boiler, to be run economically, must be adapted in size to the needs of the place where it is to be used.

DYNAMITE SUPERSEDES THE AXE.—A Somerset county firm have a pulp manufactory, consuming spruce and hemlock timber. Their operations are large, and instead of practising the slow method of chopping down trees and sawing them up, in order to get the wood into the pulp-mill, they blow them to splinters with dynamite. An eye witness thus describes the process: A fine large spruce was selected, and a hole was driven in about ten inches, the chips were removed, and a dynamite cartridge was inserted. The dynamite comes in sticks like a candle and resembles moist brown sugar. A fuse was attached, and the men sought a place of safety. In a few seconds there was a mighty roar, and the great tree was lifted up in the air about ten feet, and then with a swoop and a crash it came to the earth, splintered half way up the trunk. Dynamite is not cheap; but, taking into consideration the time, labor, wear and tear of tools saved, is not as expensive as might be supposed.—*Lumberman.*

Inspectors' Reports.

November, 1882.

The one hundred and ninety-fourth monthly summary of the reports of the Company's Inspectors is given below, and will repay a careful perusal. From it we learn that 2,120 visits of inspection were made and 4,794 boilers were examined. The number of thorough annual internal inspections reaches a total of 1,875, and 376 boilers were proved by hydrostatic pressure.

The whole number of defects found which were considered sufficiently serious to be reported, was 3,334, of which number 686 were considered to be of so grave a nature as to impair the safety of the boilers in which they were found. The number of boilers condemned was 48. The usual analysis of defects is given below.

Nature of defects.	Whole number.	Dangerous.
Cases of deposition of sediment,	280	38
Cases of incrustation and scale,	428	38
Cases of internal grooving,	15	7
Cases of internal corrosion,	107	11
Cases of external corrosion,	157	36
Broken and loose braces and stays,	85	37
Settings defective,	83	16
Furnaces out of shape,	91	10
Fractured plates,	155	72
Burned plates,	97	33
Blistered plates,	185	19
Cases of defective riveting,	600	76
Defective heads,	56	21
Leakage around tubes,	393	134
Leakage at seams,	298	56
Water gauges defective,	58	16
Blow-outs defective,	38	11
Cases of deficiency of water,	13	7
Safety-valves overloaded,	27	6
Safety-valves defective in construction,	31	15
Pressure gauges defective,	135	24
Boilers without pressure gauges,	1	1
Defective feed pipe,	1	1
One dangerous defect unclassified,		1
Total,	3,334	686

The straightening up of a tall chimney somewhere in Germany, which had become dangerous through the settling of the foundation on one side, by sawing through the joints on the convex side, has given rise to numerous paragraphs in both the scientific and daily papers. If our memory serves us rightly, the first case on record where this thing was done was at the mills of the Lawrence Manufacturing Co., in Lowell, Mass., some twelve or thirteen years ago. The chimney in question was a very large one, some 225 feet high, and canted to one side through unequal settling of the foundation, or other cause. It was brought back to a perpendicular position by passing a saw through the joints on the side from which it leaned, thus removing a narrow strip of mortar and allowing it to settle back to its original position.

Man-Hole Openings in Boilers.

It will we think be generally admitted that no boiler is complete without a man-hole through which admission may be had to the interior of the boiler for the purpose of examination, cleaning, or repairs. In the smaller sizes where this is impracticable there should be a number of hand-holes judiciously placed, through which the interior may be viewed, and also to facilitate removal of scales or deposit. An important matter too often neglected in the design and construction of boilers, is the location of the man and hand-hole openings where they will do the most good.

The best location for a man-hole is on the shell of the boiler, and its strongest form is where protected by an inside frame or mouthpiece accurately fitted and securely riveted on. Where steam domes are thought to be a necessary adjunct to a boiler, a common practice is to have a cast iron dome head with the steam pipe nozzle and man-hole cast in. This is a weaker form than the one first described, for it leaves the opening in the shell beneath the dome without re-enforcement, while it is much more difficult,—sometimes impossible to get inside the boiler after it is set, owing to the steam piping being in the way.

In our larger cities where ground space is limited, boilers are often placed in vaults or sub-cellars, where the overhead room is limited, which often brings the dome close up under the vault or ceiling, where it would be impossible for even the smallest child to get inside the boiler through the man-hole, owing, as we have pointed out, to the contracted space and net work of steam-pipes and connections. We have knowledge of cases in which it was necessary to cut away a portion of the ceiling or vault covering, sufficient to gain access to the inside of the boiler, which involved considerable expense and trouble, besides to some extent weakening the structure; the cases we have in mind were planned by architects of good repute, and the work executed under their direction. Without engineering experience they did not realize the importance of setting boilers in such a manner as to make them accessible, thus illustrating the necessity of consulting the most competent advisors in planning and executing steam engineering work. In every case there would have been no trouble in gaining access to the boiler, had the man-hole been upon the shell, instead of on the top of dome. We have always favored its location upon the shell because we believed it best for all purposes of strength and accessibility.

The horizontal tubular boiler, owing to its simplicity, compactness, strength, and accessibility, is a great favorite among steam users, and increases in public favor every year. It admits of a variety of modifications and disposition of tubes by which it may be adapted to the wants of different localities, fuels, and feed waters. To facilitate the cleaning of the sheets over the fire in localities where the feed water forms a troublesome scale or a deposit of sediment from muddy water, a clear space of ten or twelve inches is left between the bottom row of tubes and boiler bottom, and a man-hole put in the front head. In our plans and specifications this man-hole opening is re-enforced by a suitable frame, same as that used on the shell. Ordinarily, manufacturers simply re-enforce it by a strengthening ring. In one case in which two new boilers were offered us for inspection and insurance there was neither strengthening ring, stays nor reinforcement of any kind. The man-hole was 10x14 inches, heads 60 inches in diameter, and the boilers were designed for a working pressure of 70 pounds per square inch.

Our inspector recommended the addition of a strengthening ring or stays, preferably the former, but the party who furnished the boilers said there was no necessity for either; he never used anything of the sort in his boilers. It may be remarked incidentally that had he deemed this alteration necessary he would have been required to do it at his own expense. The boiler in this condition of course was regarded as uninsurable.

The great advantage of properly located man and hand-hole openings are their utility. This we think is not always appreciated; sometimes they are regarded as ornamental appendages. We know of exceptional cases in which they had not been removed for a number of years; meanwhile scale or a deposit of sediment had accumulated to a dangerous extent and nearly ruined the boiler, the excuse offered by those in charge being that the joints of the plates were tight and they were afraid to take them off for fear they would leak when put back. With proper care in scraping off the old material from the face of the joint before it is remade, that is when the old gasket cannot be used over again, there should be no trouble.

Some of our friends claim that a light wash of black lead and oil applied to the face of the gasket facilitates its removal when the joint is broken again; by this means they can use the same gasket a number of times. There are various other preparations used by engineers to accomplish the same purpose. Within a few years, special attention has been given to the manufacture of rubber gaskets for man-hole joints, that would give better satisfaction and be more durable than those heretofore used. They may be had of dealers in machinery supplies in all parts of the country.

With a suitable gasket free from gritty particles which are sometimes found adhering to it, there should be no trouble in making a tight joint at the man or hand-hole plates; if there is it indicates distortion either of the plate or its seating, in hand-holes possibly a weakness due to dangerous thinning of the shell by corrosion around the opening; in either case, the pressure should be lowered and the boiler put out of service until an inspector can be summoned to determine the cause, and make a suitable recommendation. Do not try excessive screwing up to stop the leak; that is a very dangerous plan, in which many inexperienced or reckless men have lost their lives. Tightening a joint under steam pressure is attended with great danger under any circumstances. When the joint is about the boiler it is doubly so. Under proper conditions ordinary screwing up should give a tight joint; when it does not something is wrong, and what that something is must be determined by an examination. F. B. A.

Russian Railway Employees.—It is stated that the Russian railway companies find it extremely difficult to obtain native employés for anything above manual labor. At present half the engine-drivers upon Russian lines are Germans, and to remedy this state of things the companies have instituted schools with the view of training boys as engine-drivers, stokers, telegraph operators, etc. There is a preparatory course of one year for candidates who cannot read or write, and the ordinary course of instruction lasts three years, and for some departments is followed by two years of a working apprenticeship. All pupils who have passed through the school are bound to serve two years with the company whose school they have attended. There are now 33 of these schools in existence, but they cannot be said to have passed beyond an experimental stage, as the oldest, which was established in 1872, has thus far turned out only 25 employés.—*Engineering.*

A new use has been discovered for potatoes. They can be converted into a substance resembling celluloid by peeling them, and after soaking in water impregnated with sulphuric acid, drying and pressing between sheets of blotting paper. In France, pipes are made of this substance, scarcely distinguishable from meerschaum. By subjecting the mass to great pressure, billiard balls can be made of it, rivaling ivory in hardness.—*Cotton, Wool, and Iron.*

The Locomotive.

HARTFORD, JANUARY, 1883.

THE opening of a new year is always fraught with hopeful anticipations and with anxiety as well. We look upon the old year as finished and its record closed up. We say we know what we have accomplished, and how much we have gained in this or in that direction. But do we stop to think that the efforts of the past lap over on to the future, and that the successes or failures before us will be largely dependent upon the methods and means employed in the past. If we do not learn wisdom by experience, we shall make no progress. If we are simply willing to plod along in a path that is smooth and easy, because it is easy, we shall leave no mark to show that we have had a place among men. There is no easy spot for active, progressive men to-day.

The air is full of discovery and invention, surprise follows surprise as great achievements are announced, and we wonderingly say, "what will come next?" Now it must not be forgotten that these wonderful strides are not the result of the labors of one day or one year, but of the patient, painstaking toil of years, mingled with discouragements, disappointments, and setbacks many and grievous. No great enterprise is built up in one year; hence the records of any one year, as looked upon by those who are building and expanding, can only be an integral part in the work which has but partially attained its growth. Other years of toil must be added, not only to enlarge and perfect, but to undo and eliminate the mistakes and the errors of the past. So the year before us is full of hope and possibilities. But good use must be made of the real substantial things that have been done in the past. They lap over like mighty cords to bind the good of the past to the valuable things to be accomplished in the future. Bad methods, while favored for a time with apparent success, will in the end prove a failure, because the foundation is wrong, and the superstructure has no reliable support, but rocket like, it sooner or later comes down a stick. Now, with all the discouragements that the future has in it, to business men—we mean the disturbances that come from political agitations and unwise legislation, causing stagnation in business, want of confidence, and all the evils that follow in the train—there is much that is encouraging. We have a vast country, wonderful in resources, with a rapidly increasing population, that must be fed, clothed, housed, transported and taken care of, and we also have much to do for other nations, who are mightily taxed to suitably care for their own populations. Hence a legitimate business well managed, strengthened by wise methods in the past, adapting itself to the varying lines and fluctuations of trade in the future, willing to be modest, and make haste slowly, lengthening its lines gradually and cautiously, but strengthening its stakes firmly, will grow. It cannot help it. Honest work will tell in the end, and although there may be some bare spots, like the snow ball the accumulations will be larger as each year rolls round. Then let us all take courage and believe that the coming year will be a prosperous one, *and it will.*

Unclassified Data.

BY J. H. COOPER.

No. 3.

Effects of temperature on the tensile strength of boiler plate. Styffe, p. 144.—"Low Moor iron which broke under 59,081 lbs. per square inch at a 60° temperature, required 66,355 lbs. to break it at a temperature of 323°.

Another specimen which failed at 52,837 lbs. at a temperature of 60°, had its strength increased to 69,717 lbs. at 318°, but fell back in strength to 62,556 lbs. at 419, showing that the maxumum tenacity was passed somewhere between the temperatures of 300° and 400°."

See also Experiments of the Franklin Institute Committee in 1837, and those of Styffe in 1869.

Holley, Railway Practice, New York, 1867, p. 39:

"Pitch of Rivets.—For $\frac{3}{8}$ inch and $\frac{1}{2}$ inch iron plates, $\frac{3}{4}$ inch rivets at 2 inch centres were found by trials to be as strong as the plates. Steel rivets, the material being stronger, may be placed further apart, allowing less section of plate to be cut away by the holes. On the North London road $\frac{5}{8}$ inch steel rivets pitched at $1\frac{3}{4}$ inches were found to make a stronger joint than $\frac{7}{8}$ inch iron rivets similarly pitched."

P. 34. "It may thence be inferred from Mr. Brunel's experiments on riveted joints on a large scale that the maximum strength is obtained when the riveted sectional area of the rivets to resist shearing is equal to the sectional area of the plate through the line of rivet-holes."

Nystrom, "Steam Engineering," p. 102:

"Proportion of single riveted lap joints with punched holes, to the nearest $\frac{1}{16}$ of an inch, as used in practice.

Thickness of Plate.	Diameter of Rivets.	Pitch of Rivets.	Lap.	Area of Rivet.	Area of Plate.	Per cent. of Solid Plate.
$\frac{3}{16}$	$\frac{7}{16}$	$1\frac{5}{16}$	$1\frac{1}{2}$	.1503	.1640	66
$\frac{1}{4}$	$\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{3}{4}$	.1963	.2500	66
$\frac{5}{16}$	$\frac{5}{8}$	$1\frac{7}{8}$	2	.3067	.3906	66
$\frac{3}{8}$	$\frac{3}{4}$	$2\frac{1}{4}$	$2\frac{1}{4}$	.4417	.5625	66
$\frac{7}{16}$	$\frac{13}{16}$	$2\frac{3}{8}$	$2\frac{3}{8}$	.5184	.6836	65
$\frac{1}{2}$	$\frac{7}{8}$	$2\frac{1}{2}$	$2\frac{1}{2}$	.6013	.7525	64
$\frac{9}{16}$	1	$2\frac{5}{8}$	$2\frac{5}{8}$	.7854	.9140	63
$\frac{5}{8}$	$1\frac{1}{16}$	$2\frac{3}{4}$	$2\frac{7}{8}$	.8904	1.0546	62

For drilled holes make the distance between the centres of the holes $\frac{1}{8}$ inch less."

Mr. Fairbairn, in 1838, experimented on plates of iron, twenty-two hundredths of an inch thick; 3 to $3\frac{1}{2}$ inches wide, riveted in various ways and then torn asunder. He considered that the friction of the plates by the bond of the rivets and the greater number of rivets usual in the wider plates of boiler work, made a stronger joint than that shown by his experiments, from which he established the oft quoted numbers 100, 70, and 56, representing the strength of the solid plate, the double riveted joint, and the single riveted joint respectively.

On the Effects of Heat.*—Com. of the Franklin Inst., 1837.

"163 experiments at ordinary temperatures showing a mean tensile strength per square inch of 57,525 lbs. Up to a temperature of 825° Fah. the tensile strength does not fall below 50,000 lbs. to the square inch.

* These Experiments are understood to refer to iron plate.—Ed. Locomotive.

At 1,000° Fah. it falls to 37,000 lbs., nearly.
At 1,100° Fah. it falls to 27,000 lbs., nearly.
At 1,200° Fah. it falls to 22,000 lbs., nearly.
At 1,300° Fah. it falls to 19,000 lbs., nearly.

"The mean of fourteen experiments shows a ratio of elongation to breaking weight of 641 to 1, in irons breaking from 40,643 lbs. to 68,513 lbs. per square inch."

ON THE EFFECTS OF ANNEALING.—" Seventeen comparisons of the strength of specimens of boiler plate after annealing showed a tensile strength of 45,117 lbs. per square inch."

COLLAPSING OF CIRCULAR FURNACES.—" The strength of furnaces to resist collapsing pressures to be calculated from the following formula: $\frac{89,600 \times T^2}{L \times D}$ = working pressure lbs. per square inch, where 89,600 = constant.

T = Thickness of plate in inches.
D = Outside diameter of furnace in inches.
L = Length of furnaces in feet. If rings are fitted the length between rings to be taken.

The pressure in no case to exceed $\frac{8,000 \times T.}{D.}$

Thomas Cargill, London, 1873, p. 16, says:

"A tensile strain exceeding 12 tons to the square inch will injure the elasticity of wrought iron and permanently damage its utility and strength."

WORKS IN IRON.—E. Matheson, London, 1873.

"The maximum amount of strain which any piece of iron will endure without losing its capacity of returning to its original condition when the force is withdrawn is called it 'limit of elasticity,' and in wrought iron under a tensile strain this limit or commencement of permanent set occurs at about *half its breaking strain*, the exact point varying with the quality of the iron and the kind of treatment to which it has been subjected during manufacture."

It is the general practice of engineers in designing bridges, roofs, and other structures, to give such dimensions and thickness of iron as shall involve only a working strain of from 4 to 7 tons per square inch; 5 tons for railroad bridges as the utmost.

Trautwine, Philadelphia, 1872, p. 178:

"In important practice good bar iron should not be trusted permanently with more than 5 tons per square inch, which will stretch it about $\frac{1}{8}$ inch in 25 feet.

"The elastic limit under tension usually ranges between 8 and 12 tons per square inch, or nearly half the breaking strain, according to quality."

"The strongest wrought iron stretches less before breaking than weaker specimens, and is therefore more apt to snap under sudden blows or strains.

"Heating up to 600° Fah. does not weaken bar iron. Its elastic limit under pressure averages about 16 tons per square inch. It begins to shorten perceptibly under 8 to 10 tons but recovers when the weight is removed. With from 18 to 20 tons it shortens permanently about $\frac{1}{60}$ part of its length."

Trenton Iron Works "Notes for Engineers for Basis of Strength," p. 31:

"The limit of elasticity for wrought iron is about 21,000 lbs. per square inch. Experiments on the effects of repeated applications and removals of the load, accompanied with considerable vibration, appear, however, to show that where a wrought iron beam may be subjected to such repeated applications of the load an indefinitely great number of times, the maximum stress should not exceed 16,000 lbs. per square inch."

Useful Information for Engineers by Phoenix Iron Co., p. 49, says:

"In reference to tests of bars of iron for the Niagara Bridge," the recovery of each bar after the removal of the proof load, 20,000 lbs. per square inch, was perfect, no permanent set occurring at less than 25,000 lbs.

Bourne, Hand Book of the Steam Engine, London, 1865, p. 461:

Quotes Fairbairn's proportions of rivets and riveted joints, his 34,000 lbs. as the strength of a single riveted joint, and his factor of safety of 6, but believes Mr. Fairbairn's margin of safety is too small, and therefore gives a rule of his own based upon a factor of safety of $\frac{1}{7.6}$ of the bursting pressure embodied in the following formula:

$P = \frac{8.900\ t}{d}$ in which

P = Safe working pressure in lbs. per square inch.

t = Thickness of boiler plate in inches.

d = Diameter of boiler in inches.

Mr. Bourne goes even further than this towards a higher factor of safety. He says: "This rule gives the strain about one-fourth of the elastic force or 4,450 lbs. per square inch of sectional area of the iron; but 3,000 lbs. is enough when the flame impinges directly on the iron as in some of the ordinary cylindrical boilers, and the rule may be adapted for that strain by taking* 6,000 as a divisor instead of 8,900.

In this connection he quotes the Messrs. Napier's strength of Yorkshire plates at 55,433 lbs. with the grain, and the tensile strength of ordinary "Best" and "Best Best" boiler plates as manufactured by ten different makers, which were found to be 50,242 lbs. with the grain, and 45,986 lbs. across the grain, giving a mean of 48,114 lbs. per square inch of section.

In his Catechism of the Steam Engine, London, 1865, p. 189, he says:

"The iron of boilers, like the iron of machines or structures, is capable of withstanding a tensile strength of 50,000 to 60,000 lbs. upon every square inch of section; but it will only bear a third of this strain without permanent damagement of structure, and it does not appear expedient in any boiler to let the strain exceed 4,000 lbs. upon the square inch of sectional area of metal, especially if it is liable to be weakened by corrosion."

It is plain to be seen that Mr. Bourne's rules are based upon his opinion of the margin of safety, rather than upon the capabilities of the materials upon which he figures. For with Fairbairn's joint, and with iron equal to the best average English, which he gives, boilers ought to be safe with a factor of 6, whether made by Fairbairn or Bourne.

Barr on Boilers, p. 148:

"The ultimate strength of a boiler is the greatest pressure which it is capable of withstanding without danger of rupture.

"A factor of safety in steam boilers is a unit employed to show in what proportion a given pressure is less than the ultimate strength of the boiler.

"The numerical value given a factor of safety is the relation which it bears to the ultimate strength, and not that of the elastic limit. Just what that figure should be for boilers has never been agreed upon, but has been narrowed down to either 6 or 8. So that in ordinary boiler construction for land use no very great discrepancies are likely to occur by the use of either in the regular course of business.

"In this country 6 is the ordinary factor of safety employed in all kinds of boiler work; in England it varies between 6 and 8. The elastic limit of wrought iron is not far from one-half its tensile strength."

Practical Notes on the Steam Engine. W. H. King, U. S. N. New York: 1863, p. 156, says:

"The experiments of the Franklin Institute give for the strength of single-riveted seams, 56 per cent. of the sheet, assumes the tensile strength of the best English iron to be 60,000 lbs. per square inch of section, and that one-fourth of the bursting strength would be safe to subject a boiler to in practice."

* The formula as modified for a higher factor of safety would read: $P = \frac{6,000\ t}{d}$.—Editor Locomotive.

Table showing the Character and Efficiency of American Coals.

The following Table, abstracted from Shock's work on Steam Boilers, shows the comparative value and efficiency of the principal varieties of coal used in the Eastern and Middle States. It is the result of the investigations of Prof. W. R. Johnson from 1842 to 1844.

KIND OF COAL.	Location of mine.	Specific gravity.	Cubic ft. of space required to stow a ton.	Volatile combustible matter in 100 parts.	Fixed carbon in 100 parts.	Earthy matter in 100 parts.	Moisture in fuel in 100 parts.	Ratio of fixed to volatile combustible matter.	Rate of combustion in lbs. of coal per sq. ft. of grate per hr.	Percentage of waste in ashes and clinker.	Lbs. of steam from water at 212° per lb. of coal.	Steam from 212° from one lb. of combustible.
Beaver Mead., Slp. No. 3.	Pa.	1.610	40.78	2.38	88.94	7.11	1.57	37.37	6.69	11.96	9.21	10.462
" " " 5,	Pa.	1.551	39.86	2.66	91.47	5.15	0.72	34.39	6.27	6.74	9.88	10.592
Forest Improvement,..	Pa.	1.477	41.75	3.07	90.75	4.41	1.77	29.56	6.52	6.97	10.06	10.807
Peach Mountain,......	Pa.	1.464	41.64	2.96	89.02	6.13	1.89	30.09	6.69	6.97	10.11	10.871
Lehigh,...............	Pa.	1.590	40.50	5.28	89.15	5.56	0.01	16.88	6.95	7.22	8.93	9.626
Lackawanna,..........	Pa.	1.421	45.82	3.91	87.74	6.35	2.00	22.44	6.45	8.93	9.79	10.764
Lykens Valley,........	Pa.	1.389	46.13	6.88	83.84	9.25	0.03	12.19	6.92	12.24	9.46	10.788
N. Y. and Maryland Mining Company,	Md.	1.431	41.71	12.31	73.50	12.40	1.79	5.97	6.28	12.71	9.78	11.208
Neff's Cumberland,....	Md.	1.337	41.26	12.67	74.53	10.34	2.46	5.88	7.86	10.96	9.44	10.604
Dauphin and Susq'h'na,	Pa.	1.443	44.32	13.82	74.24	11.49	0.45	5.37	6.86	16.36	9.34	11.171
Blossburg,............	Pa.	1.324	42.22	14.78	73.11	10.77	1.34	4.95	7.77	11.20	9.72	10.956
Lycoming Creek,......	Pa.	1.388	40.45	13.84	71.53	13.96	0.67	5.16	6.33	16.92	8.91	10.724
Cambria County,......	Pa.	1.407	41.90	20.52	69.37	9.15	0.96	3.38	6.68	9.75	9.24	10.239
Midlothian, Average,..	Va.	1.294	41.45	29.86	53.01	14.74	2.39	1.78	6.68	14.83	8.29	9.741
Pittsburg,............	Pa.	1.252	47.85	36.76	54.93	7.07	1.24	1.49		8.25	8.20	8.942
Cannelton,............	Ind.	1.273	47.01	33.99	58.44	4.97	2.60	1.72	11.09	5.12	7.34	7.734
Dry Pine Wood,.......			106.62			0.307			15.87	0.307	4.69	4.707

OBSERVATIONS made by M. Rafford, a member of the Société d' Horticulture at Limoges, show that a castor-oil plant having been placed in a room infested with flies, they disappeared as by enchantment. Wishing to find the cause, he soon found under the castor-oil plant a number of dead flies, and a large number of bodies had remained clinging to the under side of the leaves. It would, therefore, appear that the leaves of the castor-oil plant give out an essential oil, or some toxic principle which possesses very strong insecticide qualities. Castor-oil plants are in France very much used as ornamental plants in rooms, and they resist very well variations of atmosphere and temperature. As the castor-oil plant is much grown and cultivated in all gardens, the *Journal d'Agriculture* points out that it would be worth while to try decoctions of the leaves to destroy the green flies and other insects which in summer are so destructive to plants and fruit trees.—*Knowledge.*

AN exchange says that a locomotive engine which dropped into Kiowa Creek, Kansas, through a bridge some years ago, has never been recovered or even discovered, although repeated soundings have been made for it. No indications of quicksand in that locality existed up to the date of the accident.

Laying Off Angles.

The draughtsman, machinist, pattern-maker, or other mechanic is often obliged to lay off angles consisting of a certain definite number of degrees and minutes. To do this an instrument called a protractor is generally used. The protractor consists, in its cheapest form, of a circular or semicircular piece of horn or brass with the degrees marked near the periphery. The diameter of these cheap instruments is usually about four inches. As may readily be imagined, no approach to accuracy is possible with such an instrument. Very elaborate protractors are made, however, by which a fair degree of accuracy may be attained. These higher priced instruments consist of a whole circle of German silver, with the graduation marked near the edge, and are provided with an arm turning around the centre of the circle, which arm carries a vernier scale reading to minutes. One side of this arm forms a ruler pointing toward the centre of the circle, and angles may be very accurately laid down to the nearest minute. Their price, however (from $25 to $95) renders them an exceedingly poor investment for the average mechanic or draughtsman.

The best way known to the writer to lay off any required angle to any degree of accuracy does not require the use of any other instruments than the ordinary T square and scale, and a lead-pencil. These instruments, it will be seen, are those absolutely required to make any drawing. Even the T square may be dispensed with, and an ordinary pair of dividers used in its stead. This method may be briefly described as follows:

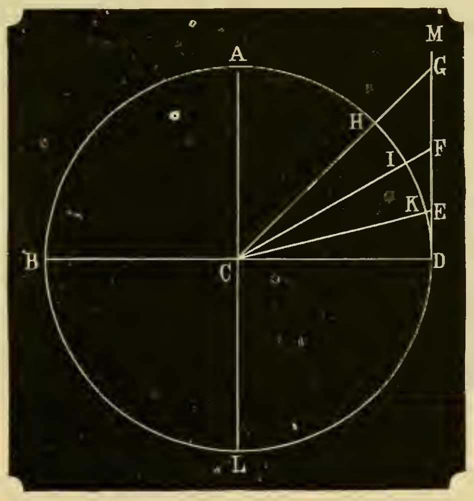


Fig. 1.

First, for the benefit of our readers who have never had an opportunity to become familiar with geometry, we will explain what the tangent of an angle is. Draw a circle as shown, Fig. 1, having a radius of one inch. Draw the diameter BD, and another diameter AL at right angles or "square" with BD. Then draw the line DM from the point D, just touching the circumference of the circle, and perpendicular to BD. Now suppose we draw a line CK from the centre of the circle to the point K in the circumference. This line will make a certain angle with the radius CD, and is measured by the part DK of the circumference lying between D and K, and may always be expressed in degrees, minutes, and seconds. A degree is measured by $\frac{1}{360}$

part of the circumference of any circle. A minute is $\frac{1}{60}$ of a degree. A second, $\frac{1}{60}$ of a minute. Now prolong the line CK from K until it cuts the line DM at E. Then the distance DE is the *tangent* of the angle DCK. In the same manner DF is the tangent of the angle DCI, and DG is the tangent of the angle DCH. If the radius of the circle is 1 inch, and the angle DCE is 15 degrees, then the tangent DE will be equal to .268 of an inch. If the angle DCF is 30 degrees, its tangent DF is equal to .577 of an inch, and so on. These dimensions may be proved by measuring the above diagram.

If the radius of the circle be made equal to *two inches*, the tangents would be just *twice* as long; if the radius were *three inches*, they would be *three* times as long as they are when the radius is one inch, and so on for any radius.

A Table of Natural Tangents is a table where the tangent of every degree and minute up to 90 degrees has been calculated for a radius = 1. If we wish to know the tangent to a radius equal to 2 or 3 we have only to multiply the tangent found in the table by 2 or 3, and we have its length at once. Every engineer's pocketbook contains such a table, and no mechanic should be without one.

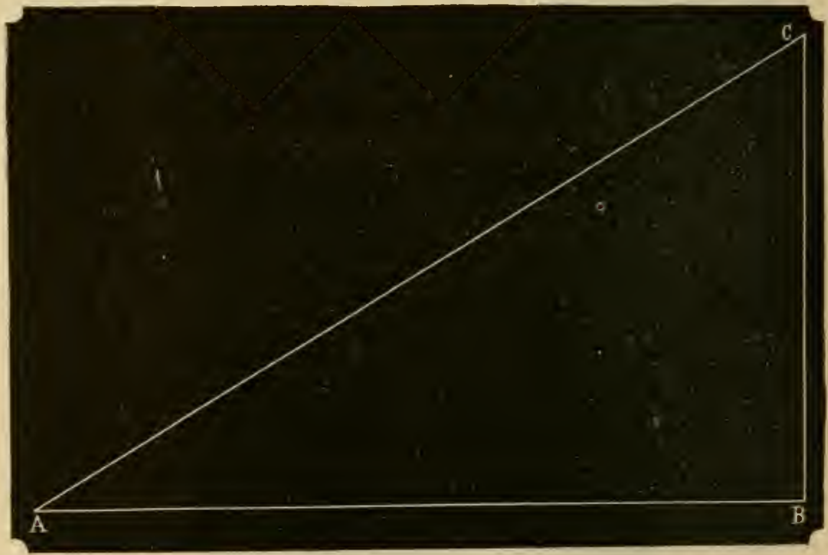


FIG. 2.

We are now ready to lay off our angle. Suppose we have given the line AB, Fig. 2, and wish to lay down another line AC which shall make an angle of 31 degrees and 17 minutes with AB. Draw BC perpendicular to AB, and say 4 inches from A to B. Look in the table for the tangent of 31° 17'. This we find to be .6076. Multiply this by 4, and we have 2.43 inches. Lay off BC = 2.43" and draw AC. Then the angle CAB = 31° 17'; proceed in the same manner for any other angle.

The most convenient length to make the line AB is 10", then the tabular tangent is to be multiplied by 10, which is performed by simply moving the decimal point one place to the right.

One of the most convenient applications of this method is the division of the pitch circles of gears having an odd or prime number of teeth. This is generally accomplished by trial stepping around the pitch circle with a pair of dividers. Any one who has had anything to do with gears knows the tediousness and uncertainty of this process. The method above described for laying off angles may be used in this case in the following manner: Let $p\ p'\ p''$ and $p'''\ p'\ p''''$, Fig. 3, represent portions of the pitch circles of two gears which are to have 59 and 60 teeth respectively, as shown. Suppose we wish to lay off the pitch on the pitch circle of the 59-toothed gear. Divide 360, the number of degrees in a circle, by 59, the number of teeth in the gear $p'''\ p'\ p''''$. This gives us 6° 6′ 6.1″ as the angle subtended by the pitch. Now draw AA′ through p', at right angles to CC′. Lay off from p', $p'd$ = to the tangent of 6° 6′ 6.1″ × the radius of the gear. Then

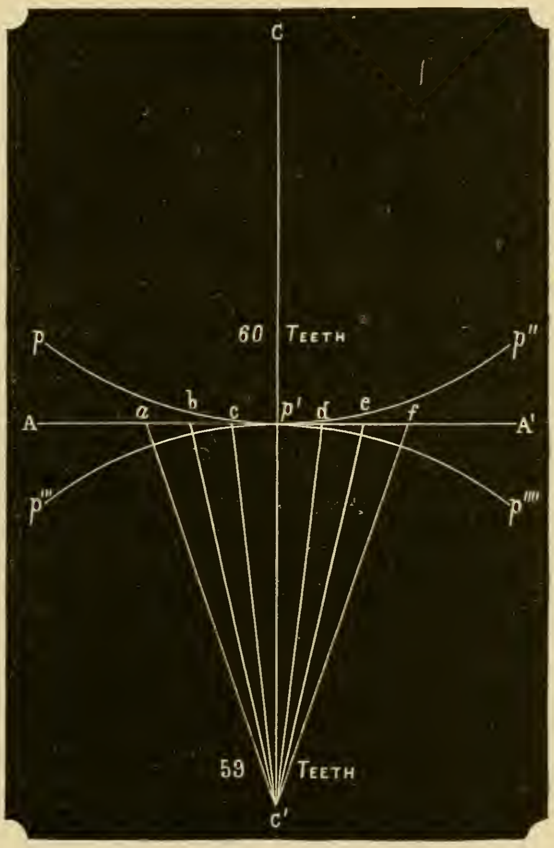


Fig. 8.

double 6° 6′ 6.1″; this gives 12° 12′ 12.2″. Lay oft the tangent of this angle $p'e$ in the same manner. Treble 6° 6′ 6.1″. This gives 18° 18′ 18.3″. Lay off its tangent $p'f$ as before, and so proceed until the tangents of the angles subtended by the required number of teeth have been determined. Then draw lines from the points *a*, *b*, *c*, *d*, *e*, *f*, etc., to the centre of the circle. The points where these radial lines cut the pitch circle will be the required pitch points.

The writer has used the above method of laying off angles and dividing the pitch circles of gears for a long time, and has always found it to give perfect satisfaction. It certainly admits of a degree of accuracy which cannot be obtained in any other way, and that, too, without the use of expensive special instruments. H. F. S.

Luminous Paint.

The color of the light is generally white, or, at first, bluish. Hyposulphite of strontium, or equal parts of carbonates of strontium and sulphur, when ignited for twenty or twenty-five minutes, at first over an ordinary Bunsen burner and then over the blast lamp, give a green light, while carbonate of barium and carbon give an orange-yellow light. The pure sulphides do not give any light at all. Hence the chemical composition of luminous paint alone does not condition its power of giving out light, since of two substances having the same composition, one may be luminous while the other is not. It seems rather as if the power of giving light depends not only on the correct chemical composition, but also upon a definite molecule condition. Hence it happens that the luminous substance obtained from burnt mother-of-pearl is better than that from burnt oyster shells; also that when slacked lime is the material employed the result differs from that obtained from aragonite, although in all four cases the resulting substances have the same chemical composition. The luminous material is scarcely at all attacked by common atmospheric influences.

The action of light upon luminous substances may be compared to striking a bell. A momentary impulse excites it and causes the bell to vibrate and give forth a tone, which tone lasts for a certain length of time, continually growing feebler, until finally it ceases entirely. So, too, the phosphorescent body. Excited by a momentary illumination, it gives out a bright light at first, which grows weaker and weaker, until at last it can only be perceived by a perfectly quiet eye in the deepest darkness, and at last comes to rest. The after illumination lasts much longer than the after sound of a bell, since the waves of light are much finer than the metallic vibrations of a ringing bell.

Most sources of light will excite phosphorescence in these substances, *e. g.*, a petroleum lamp, gas-light, and even a match. In these cases, of course the substance must be brought close to the source of light. It is excited especially by burning magnesium wire and by the electric light, but daylight is the best. Since water does not affect this substance, and since its luminosity is not due to oxidation, and hence does not need the presence of atmospheric air, it will give light under water.

An alcohol lamp flame colored yellow by common salt will not excite it. but if the alcohol flame is colored blue by copper it will. In the sun's rays, those which lie in the violet and ultra-violet are the most energetic, and they decrease in power toward the yellow. It is remarkable how the yellow and red rays destroy the effect of the opposing violet rays by extinguishing or considerably weakening the luminosity caused by these latter. Similar relations prevail when the substance is covered with colored glass. Dark blue glass, although it seems to considerably weaken the light, permits all the active rays to pass through, and at times, when daylight contains many of the red and yellow rays, a substance that has been covered with blue glass is more strongly excited than if exposed to pure daylight, because the blue glass prevents the extinguishing action of the red and yellow rays. If a surface that has been covered with phosphorescent paint is first excited, and then one-half covered with pasteboard and the other with yellow glass, the extinguishing effect of the latter will be very noticeable. The portion covered with pasteboard will continue luminous after that covered with glass is almost dark.

Heat has a peculiar effect upon the phosphorescent body after it has been isolated. It causes it to give a more intense light for a short time, but the luminosity is then of shorter duration than it otherwise would be. Heat acts here somewhat as it does on a magnet, driving out the active power, so that it requires to be recharged to set the power again in action.

It seems as if light bears the same relation to the phosphorescence of these bodies that electricity does to magnetism; hence the name of light-magnet would not be inappropriate.

The color of the light thrown out is independent of the color of the exciting rays, *i. e.*, a certain substance always glows with the same colored light whether it has been excited by a violet, blue, or colorless light. Neither does the color depend on the addition of certain metals, but seems to be the result of a definite molecular condition of the substance. The light emitted retains its color but a short time. No matter how prepared, they all get to be one color after a while—that is, white (?).

The duration of luminosity is differently stated by different authors. According to Gaedick's observation the best ones made at present time last nineteen hours, but it requires perfect darkness and an eye entirely at rest, like on waking in the morning, to detect the faint glimmer. Its luminosity is instantly destroyed by chlorine gas, also by hydrochloric and nitric acid; more slowly by sulphuric acid. It is further destroyed by substances which darken its color, hence it cannot be mixed with varnishes that contain lead and blacken; iron is also injurious, because it rusts. When used as a paint it is mixed with some adhesive substance like glue, and can then be mixed with oil, water, or a light-colored varnish, and applied repeatedly to the object that is to rendered luminous. It is well to prepare a white ground for it with chalk or zinc white mixed with a little copal, which may be dissolved in oil of turpentine.—*Oil and Paint Review.*

Rattlesnake Versus Black Snake.

On the other side of the Santa Fé water tanks yesterday, a fight occurred between a rattlesnake and a black snake. The rattlesnake was apparently on a journey, and the meeting was quite accidental. At first the rattlesnake sought to avoid a difficulty, but when the black snake pressed the matter he halted and folded his length into a coil. The black snake glided around in increasingly swift circles; the rattlesnake never changed its position—only, his head went round, following the swift movements of his foe. But the circle still diminished its size, and as the black snake drew close the rattlesnake appeared to grow confused. His rattles ceased to give out the sharp sound, and his head drooped as if vertigo was seizing him. The black snake seized, by a lightning movement, the rattler by the throat, and, winding him up in folds, the two rolled over and over together, and in a few moments the rattlesnake ceased to breathe. An examination of the dead body of the rattlesnake revealed a fracture in the spine as complete as if done by a blow with a club. The rattlesnake measured, dead, five feet and three inches.—*Fort Worth Democrat.*

A Million Years.—Here is one way of conveying to the mind some idea of what a million of years really is. Take a narrow strip of paper, an inch broad or more, and 83 ft. 4 in. in length, and stretch it along the wall of a large hall, or around the walls of an apartment somewhat over 20 feet square. Recall to memory the days of your boyhood, so as to get some adequate conception of what a period of a hundred years is. Then mark off from one of the ends of the strip one tenth of an inch. The one tenth of the inch will then represent one hundred years, and the entire length of the strip a million of years. It is well worth making the experiment, just in order to feel the striking impression that it produces on the mind. Could we stand upon the edge of a gorge, a mile and a half in depth, that had been cut out of the solid rock by a tiny stream, scarcely visible at the bottom of this fearful abyss, and were we informed that this little streamlet was able to wear off annually only one-tenth of an inch from its rocky bed, what would our conception be of the prodigious length of time that this stream must have taken to excavate the gorge? We should certainly feel startled when, on making the necessary calculations, we found that the stream had performed this enormous amount of work in something less than a million of years.—*Croll on "Climate and Time."*

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY

New Series—Vol. IV. HARTFORD, CONN., FEBRUARY, 1883. No. 2.

Some of the Dangers in Using Long Cylinder Boilers, with Remedies Suggested.

Perhaps some of our readers may take exception to our heading, for we recollect in our early experience connected with the introduction in this country of boiler inspection as a safeguard against explosion, how confidently we were informed by many of our steam users, "Your system is excellent, we wish you every success, but we do not need it. You haven't seen our boilers, have you? We use plain cylinder boilers." Sometimes this was said regretfully at the thought of our having lost so much valuable time, or possibly because they could not find even an excuse in their own estimation for the employment of a system of supervision they commended so highly, such was their confidence in plain cylinder boilers. Some of these friends have since learned by sad experience their mistake, and that plain cylinder boilers to be safe need the most careful attention, even more than some other types.

We are not insensible to the many advantages in accessibility for cleaning or repairs offered by the plain cylinder boiler, in certain localities, particularly when the feed water is muddy or deposits a troublesome scale; also, its advantages for utilizing the waste heat of furnaces, nor to its construction being a form of strength within certain limitations, and subject to the practical conditions of setting and use, we have from time to time pointed out. The experience of this company causes it to regard with some anxiety the use of long boilers; in the plain cylinder type, where the diameter is practically limited to about forty-two inches, and rarely exceeds forty-eight inches, its length must be increased to obtain the necessary heating surface. Lengths of from forty to sixty feet are common, and one case is reported where the length exceeds one hundred feet, and therein lies the danger.

It is not our purpose to excite needless alarm among users of this type of boiler, but we submit in all candor that in boilers of such great length the question of setting is one of the gravest importance. We have devoted some years of study to the solution of this problem under conditions of every-day practice among the thousands of boilers under our supervision. Limited space forbids the further consideration of this branch of our subject at this time; our readers will find it, however, exhaustively considered in The Locomotive, new series, vol. 2, No. 3, March, 1881. The exploded boiler illustrated and described in the following sketch will explain many of the dangers and difficulties we have referred to; even under good care and management such as is commonly found in our rolling mills and blast furnaces throughout the country.

The boiler, Fig. 2, was of the plain cylinder construction, 40 inches in diameter, and 30 feet long. The shell was composed of eight courses of iron, single riveted, varying in thickness from .290 to .312 of an inch. Upon one of the plates appeared the brand of a well-known manufacturer; this was the only brand found. It was erected in a brick setting suspended at three points in its length by substantial straps riveted on the boiler, and attached to hook bolts and plates at each of the points of suspension by two cross-bars of railroad iron, which extended transversely across the setting and rested on pier walls built up from the side walls, as will appear by reference to Fig. 2.

This boiler was one of thirteen in use; it was built in 1872 by a firm having a good local reputation, but it had not been used continuously since that time, the works having lain idle for three years; during the last year its working pressure was about 60 pounds; it had a safety valve of three inches diameter in working order set to blow off at 70 pounds; frequent repairs had been made, two patches and a new half sheet, all on the bottom of the shell, were put on at the time of last repair one year ago; it was last examined and washed out by one of the engineers two days before the explosion; as he reported no defects, it is believed he regarded the boiler as being in good working order. The feed supply was pumped from a pond on the premises into a large tank, thence through part of an old boiler—fitted up as an open heater—into the boilers

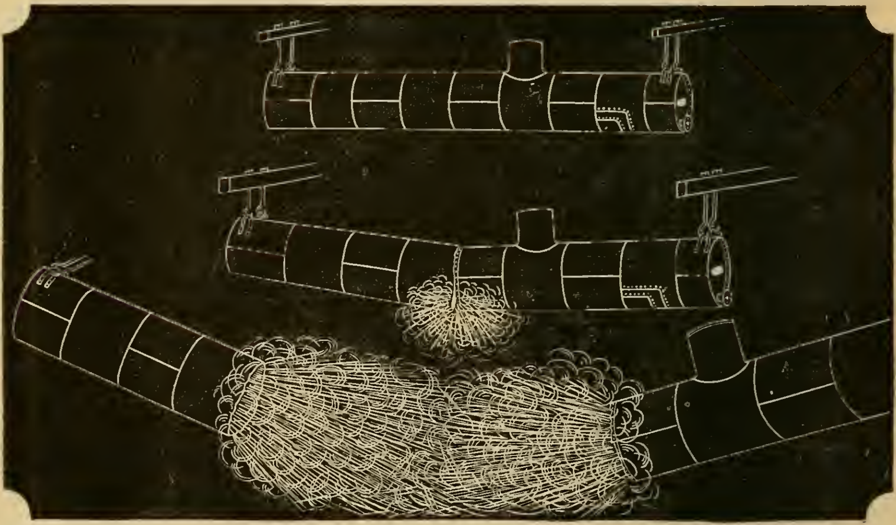


FIG. 1.

through a two-inch feed pipe on top of boiler as shown, by an independent pump. The main engine exhausted into the heater, possibly raising the temperature of the feed to 80° or 90° when the engine was in operation; when it was not its temperature would only be slightly above that of the pond which at that season of the year was 50°; it was quite muddy at the time of our visit, and it appeared from an examination of the exploded boiler to form a deposit of sediment and a troublesome lining scale.

It had been noticed some thirty minutes before the explosion occurred that this boiler was leaking on the bottom girth seam between the third and fourth courses from the front end; the attendant stated to one of the men near him that the pump was on and it lost over a gauge of water in less than fifteen minutes. After watching the leak for a few minutes he became alarmed and reported it to the chief engineer, who reached the boiler but a moment before the explosion, and was killed; possibly he was shutting the stop valve between that and the other boilers at the time, for it was found closed afterwards.

The rupture was through the line of rivet holes of the inside lap seam, where it had been observed to be leaking, C D, Fig. 2. The boiler broke into two parts as is usual in such cases, which were projected by the explosion a distance of 500 feet and 300 feet respectively in opposite directions; one of the parts in its flight struck some sharp object, possibly some broken part of the housings of the rolls, and cut out a strip of iron 20 inches long by ⅝-inch wide across the grain of the sheet *a*, Fig. 2. This strip was afterwards found curled up like a shaving, and showed that part of the iron was of fair quality; the iron generally presented a fibrous appearance, though there was some crystalization observable along ruptured edges of the lap seam. With the preceding data before us we think it will not be difficult to determine the probable cause of the explosion.

It seems probable from a study of the circumstances that the intermediate fire walls had settled, assuming that they were properly set at first, or that some of the attachments forming the middle support had yielded, leaving that part of the boiler without other support than the resistance afforded by the strength of its material. The temperature of the furnace, to the heat of which the boiler is exposed, varies considerably at different times, as for instance between the time when it is maintaining a heat and afterwards when that heat is withdrawn. It will be readily seen that these variations of temperature, with their attendant expansion and contraction, cause a movement of the boiler, the effect of which is more disastrous to the riveted lap seams owing to their greater rigidity, than to the solid plate. To this strain the boiler was gradually yielding at its weakest point—the girth seam—and gave warning of its distress by leaking. We do not know how long it had been leaking, but simply that it had become serious enough on the day of explosion to attract the engineer's attention by a sudden loss of water. This occurred after the engine had been shut down, in the interval of an hour which elapsed between the day and night shifts.

As soon as the engine stopped, the engineer, as was his habit, checked the draft by opening the various doors in the setting, and prevented the further rise of steam pressure by feeding the boilers; putting a feed on this boiler first, he pumped it up to three full gauges of water. As we have pointed out the temperature of this feed was close to 50°. What must be the effect of such a quantity of water at a low lemperature discharged within a few inches of the bottom of the boiler, and augmented by the injury from the currents of cold air admitted through the open doors in the setting, upon a boiler expanded to the temperature of its enclosing furnace? Would not the contraction which must inevitably ensue be especially destructive to the lap joints along the boiler bottom? and in this particular boiler with its overloaded and distressed girth seam, using a homely phrase, was not this the feather that broke the camel's back?

At the time of the last repair of this boiler, nearly a year previous, a new bottom half sheet *b*, Fig. 2, had been put in; the boiler maker in selecting a suitable sheet may have measured the one he put in for $\frac{5}{16}$ iron. Careful measurement by the micrometer gauge shows that it was .022 of an inch thicker than the inside sheet. We do not know how carefully the work of backing out the old rivets was done, nor what amount of *drawing* was required to bring the holes of the old and new sheet fair; there are large possibilities here. The strength of a riveted lap joint is determined by the perfection in workmanship and material of its several parts, and the injury they suffered, we can only conjecture. We do know, however, as a matter of experience, the effect of riveting together a new sheet of greater thickness and rigidity to an older sheet that is lighter, lighter in material we mean. It is true the difference in thickness between the two sheets in this case was not a great deal, but sufficient we think to merit consideration as a factor in the case, and probably explains why a rupture occurred at the third girth seam, because it was weaker and more susceptible to the adverse influences we have described, than the fourth, which was nearer the middle of the boiler.

Long boilers, assuming they are properly adjusted at first, which is not always the case, are exposed to the danger of settling of the piers or supports at the point of suspension, and whatever weaknesses may be developed in the boiler are aggravated by

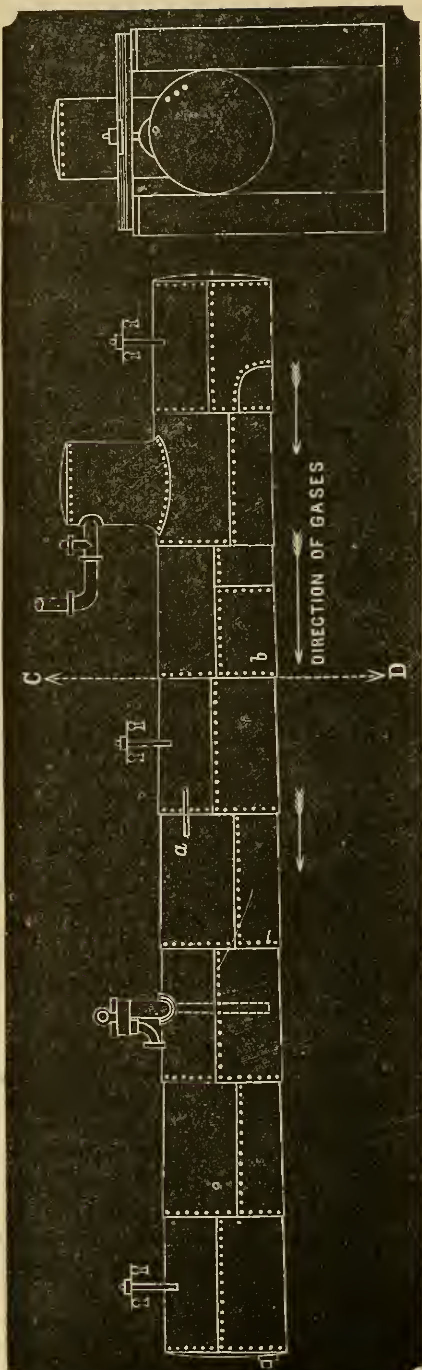


FIG. 2.

just such treatment as we have described. The feed water may be heated a few degrees higher, but the plan of filling up the boilers at the time of shift is that generally pursued; as a consequence accidents such as we have described are not of unusual occurrence at iron works at the time of shift or immediately afterwards. We have recommended for some years that plain cylinder boilers should have two fore and-aft braces of suitable proportions from head to head of the boilers; this we believe to be an excellent precaution in the event of rupture at a girth seam, for they will hold the halves of the boiler together and prevent explosion during the time the boiler is being put out of service, for it will be apparent that the head braces are ineffectual in such a case, hence when rupture occurs there is nothing to hold the boiler together, and it breaks into two parts which, by the ensuing explosion, are projected in opposite directions with great destruction to everything in their path. The reader will have a clear understanding of the manner of operation from a study of Fig. 1, which though prepared and used to illustrate another explosion varying slightly in details, was alike in principle. That the fore-and-aft braces are a valuable reënforcement to boilers of this description has been demonstrated to our satisfaction. and that of our patrons.

We would urge again, emphasized by the experience of this and other explosions under somewhat similar circumstances, *that when a boiler gives signs of distress by unusual leaking at its seams or by other well-known indications, it must at once and with the least possible disturbance be put out of service until it can be thoroughly examined by a competent inspector and the nature of the defect determined.* The average water tender puts a heavy feed on the boiler and gets a ladder with which he may climb up and watch the spread of the leak. In opening the flue doors in the setting to afford him the necessary view, unwittingly no doubt, he permits a stream of cold air to sweep the boiler bottom, which adds another important element to its destruction. and perhaps his own. We would as soon think of entering a powder magazine with a lighted cigar as to do either of these things at the time, or under the circumstances we have described. F. B. A.

Inspectors' Reports.

DECEMBER, 1882.

Below is given the summary of the work of the Inspectors for the month of December last, and immediately following, the summary for the year, and the grand total of inspections made, and defects reported since the organization of the Company.

The number of visits of inspection made during the closing month of the year foots up 2,191. 4,790 boilers were examined, of which number 2,133 we thoroughly inspected, both externally and internally. 272 boilers we subjected to the hydrostatic test, and 38 were condemned, being considered unfit for further use.

The usual analysis of defects is appended.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	289	33
Cases of incrustation and scale,	524	54
Cases of internal grooving,	26	4
Cases of internal corrosion,	135	25
Cases of external corrosion,	203	36
Broken and loose braces and stays,	38	18
Defective settings,	68	12
Furnaces out of shape,	75	7
Fractured plates,	140	63
Burned plates,	139	89
Blistered plates,	251	26
Cases of defective riveting,	660	103
Defective heads,	43	17
Leakage around tubes,	521	144
Leakage at seams,	252	27
Defective water gauges,	67	15
Defective blow-out apparatus,	26	15
Cases of deficiency of water,	23	20
Safety-valves overloaded,	40	14
Safety-valves defective in construction,	41	8
Pressure gauges defective,	153	24
Boilers without pressure gauges,	1	0
Total,	3,715	754

SUMMARY OF INSPECTORS' REPORTS FOR THE YEAR 1882.

During the year 1882 there were made 25,742 visits of inspection, an increase of 3,330, or nearly 13 per cent. over the number made in 1881. The total number of boilers examined was 55,679, an increase of 8,434, or slightly more than 15 per cent. more than were examined in 1881. The number of complete internal inspections foots up 21,428, being an increase of 3,838, or almost 18 per cent. more than were made in the previous year. This indicates a very gratifying increase of business. The hydrostatic test was applied in 4,564 cases. The number of boilers condemned was 478.

The number of defects reported was 33,690, of which number 6,867 were considered dangerous. Appended is a detailed statement of the defects found.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	3,138	467
Cases of incrustation and scale,	4,913	450
Cases of internal grooving,	237	112
Cases of internal corrosion,	1,210	232
Cases of external corrosion,	1,803	437
Broken and loose braces and stays,	613	293
Defective settings,	935	158
Furnaces out of shape,	1,030	204
Fractured plates,	1,801	902
Burned plates,	1,084	412
Blistered plates,	2,853	385
Cases of defective riveting,	4,807	535
Defective heads,	386	149
Serious leakage around tubes,	3,414	845
Serious leakage at seams,	1,957	342
Defective water gauges,	640	146
Defective blow-out apparatus,	290	118
Cases of low water,	131	84
Safety-valves overloaded,	358	136
Safety-valves defective in construction,	238	99
Defective pressure gauges,	1,808	344
Boilers without pressure gauges,	43	14
Defective feed pipe,	1	1
Dangerous defect unclassified by inspectors,		2
Total,	33,690	6,867

GRAND TOTAL OF THE INSPECTORS' WORK SINCE THE COMPANY BEGAN BUSINESS.

Visits of inspection made,	211,851
Whole number of boilers inspected,	434,142
Complete internal inspections,	147,178
Boilers tested by hydrostatic pressure,	33,703
Total number of defects discovered,	217,865
Total number of dangerous defects,	49,295
Boilers condemned,	2,678

DR. W. G. K. FRITZGAERTNER, geologist and mineralogist to the government of the Republic of Honduras, has supplied some very interesting information as to the mineral resources of the country. Among other things he says: "Whole mountains of fine magnetic iron ore exist both near the coast and in the interior. The natives use clean and fine ore directly in their forges. The iron produced is of a very superior quality, and greatly resembles steel in all its characteristics. Coal is very abundant on the Atlantic coast, near the river Uloa, the quality being a semi-bituminous kind. As the quantity seems to be quite considerable, this mineral will in the near future become a valuable article of commerce along the Caribbean coast. Mining property is not taxed, and there is no duty on the exportation of ores or bullion; while the government is so anxious to encourage the industry that it will render all assistance in its power for the transportation of machinery, and will free it of import duties."—*Industrial World.*

The Locomotive.

HARTFORD, FEBRUARY, 1883.

By tables of statistics on another page it will be seen that there were one hundred and seventy-five boiler explosions during the year 1882, attended with more or less loss and damage. The list of explosions kept in this office does not include every accident that happens to a boiler, but only those that find their way into the papers. The number of these accidents is much larger than it should be, though when compared with the number of boilers in use in the country the percentage is small, being only about eleven one-hundredths of one per cent. of the whole. When careful and intelligent investigation is made into the cause of many of these explosions it is found that the boilers have been worn out, over-worked, or there has been some carelessness in construction, setting, or management. The tendency among steam-users to hold on to old boilers and get a little more work out of them is altogether too strong; and a further tendency to add a little more pressure, when work is brisk, to already overworked boilers, has no doubt been the direct cause of many accidents. There is a demand for *more steam, more steam*, while the boiler capacity is not increased. Incompetent men are often employed to take care of boilers—men who are habitual drunkards, and utterly incompetent to have such responsible duties in charge. The desire to reduce expense leads to the employment of very inefficient and cheap help, and so long as this is done boilers will explode. Explosions are not confined to any special type of boiler. Wrought-iron, cast-iron, horizontal, upright, and sectional boilers alike have their troubles. No boiler can be regarded as safe under poor and inefficient management; while any well-constructed boiler of proper type, well set and under good management, may be regarded as safe. The best of men will sometimes be careless, or from thoughtlessness neglect some important duty; hence perfection cannot be expected in every one of the seventy-five or one hundred thousand, more or less, of engineers and firemen in the country. The record of defects discovered by this Company during the year tells its own story. It goes to show that boilers are often found in much worse condition than their owners have any conception of, and these timely examinations have saved many establishments from wreck and ruin. This Company has examined during the year between sixteen thousand and seventeen thousand boilers. They are used in all kinds of manufacturing establishments. Of this number six have exploded, four of which were in iron-works. In two cases leaks were discovered, but before the fires could be drawn and the boilers put out of use, they parted at the girth seams and the different portions were projected in opposite directions. The hard firing which many boilers in iron-works receive, and the carelessness in allowing currents of cold air to flow into the furnace and along the boiler bottom when the iron is being run off, also the feeding of cold water, are fruitful causes of disaster. The remedy against these accidents is apparent. Have your boilers honestly made, of good material. Don't buy this or that iron or steel because it is cheap; satisfy yourself that it is all that is claimed for it, and it is properly branded and stamped as to quality. Buy your boilers of a maker whom you know to be honest and intelligent. Have your boilers well set; don't leave the work to any cheap bricklayer, who has no idea whatever of what is required for good draft and a proper distribution of heat along the fire-surfaces of the boiler. It will pay in the end to employ competent men for this work. When the boiler or boilers are set, arrange to have them periodically inspected, which, with a sober, competent engineer in charge, will not only secure economy, but the danger of explosion will be reduced to a bare possibility.

Mr. Brehm's Way.

Mr. Charles E. Brehm, ex-assemblyman of New York, has been informing the public, through a New York paper, all about boiler inspections. He says: "Most all explosions of steam boilers are due to the imperfect inspections by steam boiler insurance companies." A representative of *The Chronicle* called upon him for some reason for his statements. He frankly stated that he was not a practical engineer; nevertheless, the only way to inspect a boiler, in his opinion, was by the "*hydrostatic test*." This man when in the assembly was a member of the insurance committee, and persistently fought the steam boiler insurance companies. Now he flourishes his "*hydrostatics*," presumably to aid in influencing legislation in the present assembly. It will not be difficult to show that he knows very little of what he is talking about. We repeat his remark: "Most all explosions of steam boilers are due to the imperfect inspections by steam boiler insurance companies,"—because they do not use the hydrostatic test. Now it happens that less than four per cent. of the boilers that exploded in 1882 were insured, so the steam boiler insurance companies had very little to do with them. The Hartford Steam Boiler Inspection and Insurance Company uses the hydrostatic test when it deems it necessary; and of nearly 17,000 boilers under its care in 1882, less than four one-hundredths of one per cent. exploded. Here is food for Mr. Brehm's active mind. The hydrostatic test, as often used, is a positive injury to boilers, as many manufacturers can testify. This company has as much interest in keeping boilers in safe condition as any one can possibly have, for it has more than $20,000,000 at risk, and any such statements as Mr. Brehm's only display his entire ignorance of the subject. It may do for the purpose of influencing legislation, but it will have little weight with intelligent men.

In a recent issue of a New York evening paper Charles E. Brehm, an ex-assemblyman from this city, made the remarkable statement that "most all explosions of steam boilers are due to the imperfect inspections by steam boiler insurance companies"! In conversation with a *Chronicle* representative, who called on him last Monday to ascertain the grounds on which he based such a sweeping charge, Mr. Brehm mentioned the inadequacy of hammer tests, upon which, he alleged, the steam boiler insurance companies invariably rely, and referred to hydrostatic pressure as the only reliable way of testing a boiler's soundness. As these hammer tests are by him set down as unreliable, Mr. Brehm endeavors to make the point that legalizing this sort of inspection prevents a better examination—hence it follows that the steam boiler insurance companies become responsible for the loss of property and life annually caused by boiler explosions! The ex-assemblyman is entitled to passing notice, as he has been a member of the insurance committee of the legislature and for a year or more has been a bitter enemy of the steam boiler insurance companies. Therefore we cheerfully call his attention to the statistics of inspections printed in the December number of the Hartford Steam Boiler inspection and insurance company's publication, The Locomotive—recommending, by the way, that he become a regular reader of this sprightly and instructive sheet. He will find a summary of the reports of this company's inspections for the last quarter of 1882, about as follows: "There were made during the month of October last 2,333 visits of inspection, by which 5,044 boilers were examined. Of this number 1,890 were thoroughly inspected, both internally and externally. The number of defects found foots up 3,718, of which 612 were considered dangerous. Four hundred and fifty-three boilers were tested by hydrostatic pressure, and 36 were condemned as unfit for further service." A perusal of these facts will show that hydrostatic tests, his hobby, are made whenever practicable. And if he cares to read further, the specific enumeration of the 3,718 defects found under twenty-two headings should convince him of the exquisite carefulness with which these inspections were made. If he will then reflect that four times per year similar examinations are made of every one of the 17,000 boilers watched over by this company, he will, perhaps, have some difficulty in understanding how any governmental inspections could possibly be their equal, even if the tests were exclusively "hydrastic," as he is pleased to term his favorite method. They could not, for instance, be equal to the Hartford Steam Boiler inspection and insurance company's—or any other reliable company's—inspections, because public servants are proverbially careless and their work is never as thoroughly done as that of the employés of private persons or corporations. Perhaps we should have said before that Mr. Brehm frankly confesses that he is *not* a practical engineer. This accounts, probably, for his limited knowledge of some things, including "hydrastics." He does not even appear to appreciate the force of the axiom that "business is business," otherwise he would know that it is to all insurance companies' interest to select good risks, and that particularly in the case of steam boiler insurance companies the least carelessness in this selection is followed by a money loss. Indeed, it is the thoroughness with which the inspections of such companies are and have been carried on that makes their certificates to-day a better guaranty than those of the best governmental inspectors.—*The Chronicle, January* 18, 1883.

BOILER EXPLOSIONS.

MONTH OF JANUARY, 1882.

Locomotive (1).—On the morning of Dec. 1st, a yard engine on the Wabash, St. Louis & Pacific blew out its dome in the yard at Council Bluffs, Ia. The upper part of the engine was almost destroyed, the fireman killed, and the engineer badly hurt.

Rubber Works (2).—About 1 o'clock in the morning of Dec. 28th, one of the boilers of the Metallic Rubber Shoe Co. at Naugatuck, Conn., ruptured a plate on the bottom of the shell. Damage slight. No one injured.

Locomotive (3).—A freight engine on the Savannah, Florida & Western Road blew up Jan. 3d, killing the engineer and scalding the fireman.

Locomotive (4).—The train leaving North Adams, Mass., at 3 p. m., Jan. 4th, on the Boston & Albany R. R., was delayed an hour by the collapsing of one of the flues of the boiler. No one injured.

Kitchen Range (5).—The residence of Hon. Joseph R. Hawley, 147 Sigourney street, Hartford, Conn., was slightly damaged by fire, Jan. 4th, by the explosion of a range in the kitchen. The premises were being put in order for the return of the family of Mr. Hawley from Washington and a fire had been started in the range. The cold snap had frozen the water in the water-back and pipes and when the fire thawed the ice the explosion occurred. A portion of the range was thrown across the room and another portion through the plastering on the ceiling, and some of the contents of the kitchen were set afire. Assistance was called from Engine 5's house, and Engineer Loomis sent out an alarm from box 62. The fire was promptly put out by No. 5's company by pails of water, and the damage was slight.

Rendering Tanks (6).—The extensive pork packing establishment of F. W. Whittaker & Son, situated near the National Stock Yards, in the northern part of East St. Louis, took fire about one o'clock, Jan. 6th. The fire caught in the lard rendering part of the establishment, a large three-story brick building, containing fourteen immense tanks. Five of these exploded and blew the house nearly to pieces. The loss is $60,000 and the insurance $42,000.

Locomotive (7).—The whole city of Bloomington, Ill., was startled at 1 p. m., Jan. 7th, by a deafening report, jarring dwellings a mile away, caused by the explosion of the boiler of locomotive No. 36 of the Chicago & Alton Railway Company. She was standing in the yard in the rear of the shops, just outside the roundhouse. The concussion and the flying metal caved the inside and roof of the coppersmith's shop, and the windows of the roundhouse were all shattered. A piece of metal weighing seven pounds came down through the roof of a butcher-shop one-fourth of a mile away. The bell-frame, weighing 100 pounds, flew 200 yards, cutting off a large branch of a tree in its course, and entering the side of a dwelling, jarring the building so that a piano was turned around. Old locomotive-builders say they never saw a wreck more complete. The rear head of the boiler was uninjured, but the remainder of the boiler and engine were blown into thousands of pieces. The most remarkable circumstance was that the coaler, named Eperly, in the cab, was not killed, being bruised, but not crippled. The cause of the accident was a mystery. It was one of the oldest engines on the road, but had had new flues put in and other repairs made, and was standing with 100 pounds of steam, waiting to go out on a short trial trip.

Locomotive (8).—The suburban train leaving Kensington, on the Illinois Central Railroad at 4 in the afternoon, Jan. 9th, and due at Chicago at 4.20, came in somewhat later than usual. The train, drawn by engine 167, was about ten minutes late at Forty-third street, and when at a point a few feet north of Forty-third street the boiler of the engine exploded. The front of the engine was attached to the baggage-car and a train of four coaches. "It was running along smoothly, when," as Prof. Leslie Lewis said to a reporter, "we heard a dull thud; hot water and steam and several pieces of iron came flying into the car. The occupants made a rush for the door, and crushed each other until it seemed as though they would crowd each other off the platform." The train ran along as though nothing had happened, and stopped at Thirty-ninth street. The whole boiler was blown off of the running gear, which remained unhurt. Pieces of flues and other parts of the boiler were thrown great distances. Some dropped through the carpenter shop connected with the new building of Mr. John Bordens, others landed in the yard of Mr. Goodwin, and the smoke-stack was thrown in the lake. The cab remained untouched. The engineer, John Glover, was scalded slightly and his foot cut. His face was cut a little by glass, but not severely. The fireman, Edward Scanlan, was also slightly scalded. The door of the car was torn out and the passengers were wet and a few were somewhat scalded. The brakeman jumped off and struck his head against the brick wall, injuring him slightly. Isaac Perkins, pop-corn peddler, was scalded quite badly, but not fatally. Every one in the baggage car was pretty well blackened by soot. The probable cost of repairs to the engine will be $10,000, and it will take $500 to fix up the car.

Saw-Mill (9).—A boiler explosion occurred at the saw-mill of W. A. Jackson, about ten miles from Norfolk, Va., Jan. 16th, which totally destroyed the property and injured a number of parties, one of them, John Lamb, a negro fireman, fatally.

Locomotive (10).—On the morning of January 20th, the end blew out of the boiler of a locomotive on the St. Joseph & Des Moines Railroad. The engineer, John Reed, was lodged on the top of the cab; the fireman, John Gahagen, was thrown through the window of the cab and some twenty or thirty feet away, lighting in a sitting position; and Henry Dorsey, switchman, was sent out of the doorway fully 100 yards, lighting on his face. Reed and Dorsey were both injured somewhat, and Gahagen was very severely scalded about the face, arms, and neck, and otherwise bruised up. The engine was attached to a passenger train, and had just pulled out for Albany, Gentry County, and had not run over 200 yards when the explosion occurred.

Saw-Mill (11).—A distressing calamity occurred at the village of East Liberty, O., at 11 o'clock, Jan. 20th, in which one man was instantly killed and a great number of others injured, two perhaps fatally. New machinery and a band saw had just been put in a mill owned by Josiah Morrison. A band saw being a curiosity to many of the people of that section, a large number gathered to witness the trial of the new machinery. Shortly after the mill was put in motion, and without warning, the boiler, which was old, exploded, tearing both legs off a man named Albert Crouse, instantly killing him. Job Everingham also had his right leg blown off, and it is thought cannot recover. Capt. Smith's skull was fractured by a fragment, and he lies in a precarious condition. C. T. Huff, master mechanic for J. A. Fay & Co., Cincinnati, who was superintending the new machinery, sustained a serious compound fracture of the leg, below the knee, and a number of other persons who were in the mill were more or less injured. The boiler carried but forty pounds of steam at the time of the accident, and no reason is assigned for the explosion. The building was worth about $500, and is a total wreck ; no insurance.

Cloth-Dryer (12).—Quite a serious scalding accident happened, Jan. 21st, at the Middlesex bleachery, Somerville, Mass., to four men employed there. It occurred in the printing department. After the cloth is printed, it is run by machinery over a dryer, which is in the form of a drum, of the width of the material and six feet in diameter. This is composed of sheet iron, and is charged with steam from the boiler. While a number of these dryers were in motion one burst, scalding the men in the vicinity. Isaiah Hobson, a printer, who boards at Hotel Warren, was scalded about the face and arms; Charles Hunt, a workman, was similarly seriously scalded, and Luke Mullen and John Durand were more fortunate, their burns not being quite as bad. All four were taken to their homes and medical assistance summoned.

Tannery (13).—A boiler in Shaw Brothers' tannery, at Jackson Brook, Me., exploded Jan. 21st, killing Thomas Lacy, the engineer. The exploded boiler was thrown fifty feet. Two other boilers were lifted from their beds; two smoke-stacks were thrown down ; the boiler-house and furnace were wrecked.

Steam-Tug (14).—The tug H. O. Farrington, belonging to Cornell's tow line, was blown up, Jan. 23d, while lying at Peck's dock, Haverstraw. The crew, consisting of seven men, were all on board at the time. Those lost are Albert Hennion, second engineer ; David Colton, fireman ; and Lawrence Connolly, cook.

Saw-Mill (15).—The large dome on the boiler at Chickering & Kysor's mill, Fife Lake, Mich., blew off, Jan. 24th, just after the mill was started up. It opened a hole in the roof about fifteen feet square, and fell crashing down only a few feet from where it went up. Luckily no one was injured by the explosion.

Kitchen Range (16).—An explosion which came very near resulting fatally occurred at Nathaniel Lamson's house in Shelburne Falls Tuesday morning, Jan. 24th, while breakfast was being prepared by Mrs. Lamson and her mother, Mrs. Longley. A pipe which carries water to the bath-room, passing through the back of the cooking-stove, froze up during the night and, on becoming heated, burst with a report like a cannon, demolishing the stove and cooking utensils, shattering doors, windows, and ceiling to quite an extent, and damaging every thing in the apartment. Mrs. Longley, the only person in the room, had a remarkable escape, being only slightly injured. A few minutes before the explosion Mr. Lamson, his wife, and her mother were around the stove trying to find where the water leaked. Only a vigorous effort saved the house from being burned.

The stove was broken into small pieces, 160 of which were gathered up after the accident.

KITCHEN RANGE (17).—The kitchen range in the house of E. B. Cady at North Adams, Mass., exploded January 24th, doing considerable damage.

HEATING BOILER (18).—John Warrick, colored, 60 years of age, employed as night fireman in the boiler-room of the Corcoran Building, Washington, D. C., was terribly scalded at an early hour Jan. 26th, while attempting to remove some obstructions from the tubes of one of the boilers. He had placed a board in the soot-box, and was lying upon it at work on the obstructions when a sudden escape of cold water into the hot ash-box generated an enormous volume of steam, completely parboiling the unfortunate fireman. He was sent to the Freedman's Hospital. His injuries will probably result fatally.

COAL MINE (19).—A special from Canyon City to the *Republican* says: "A boiler exploded at a shaft of the Canyon City Coal Company, Jan. 25th, killing a fireman outright and injuring a blacksmith so badly that he has since died. The engineer had his leg broken and was badly scalded. The boiler was thrown a distance of 300 yards."

MACHINE WORKS (20).—A boiler at Logan's Machine Works, Oil City, Pa., undergoing repairs and being tested Jan. 27th, by James Touhill, the foreman, exploded under a pressure of sixty pounds of steam. Touhill was on top of the boiler at the time, and was thrown up into the air, killing him instantly. His arm was hurled against the front of the Opera House, across the street, bespattering the bricks with blood. Two other employes were seriously injured. Several windows in the Opera House were demolished. There were a number of miraculous escapes from death on the street.

KITCHEN RANGE (21).—Soon after 9 o'clock, Jan. —th, there was a violent explosion in a large range at the "Home" on Church street, Hartford, Conn., The matron, Miss Woodbury, and the cook were standing close to the range, but both escaped, though large pieces of iron were thrown about the room, the ceiling cut by flying pieces, the windows blown out and demolished and the door forced open by tearing loose a portion of the woodwork of the casing. The range has not been used for a number of years, the cooking being done by a large stove. From this stove a hot-water pipe passed through the range and some time ago was cut off and stopped up. It seems that water was then left in the pipe. Monday a light fire of shavings was made in the range to drive out rats which resorted to it in large numbers. This morning the experiment was repeated and charcoal used, which apparently developed heat enough to generate steam in the pipe resulting in the explosion. The damage is not serious, though some portions of the range will have to be replaced and the windows of the room filled with entire new sashes.

SAW MILL (22).—An accident occurred Jan. 28th in the mill of the Kennebec Framing Company at Fairfield, Me., by which three men were killed, two fatally, and several others seriously injured. Shortly after the workmen had begun work, one of the boilers exploded with terrific force, spreading death and destruction on every side. The following is a list of the killed and wounded: Killed—Noah Rice, son of ex-Warden Rice; J. Tomar, a fireman; and Isaac Forhey, also a fireman. Fatally injured—George McComb, engineer; John Smith, a workman; and John Avery, the foreman. Several others were seriously injured. Soon after the explosion of the boiler, which was patched and leaky, the under-work of the mill took fire, and added to the suffering of the unfortunate men who, buried under the ruins, were badly scalded by the escaping steam. These were young Noah Rice and the two firemen, Tomar and Torhey. When their remains were taken from the ruins they were scalded and mangled almost beyond recognition. It is not possible at present to place the blame for the explosion, but on account of the leaky condition of the boiler it was impossible to keep therein a sufficient quantity of water, to which cause the accident was due.

Kitchen Range (23).—On Monday morning, Jan. 23d, there was an explosion at the residence of Jas. P. Argersinger, on William street, Gloversville, N. Y., which was quite destructive in its results. From what we have been able to learn, it appears that the night previous the domestic allowed the fire to go out in the kitchen range, to which is connected a large boiler for the purpose of heating water to be distributed through the various rooms of the house, and as a consequence the connecting pipe running between the stove and boiler froze up. After building the fire that morning, the domestic proceeded with getting the breakfast ready, and while thus engaged there was an explosion, which scattered the stove, breakfast fixings, and domestic into a confused mass, entirely destroying the former and somewhat seriously injuring the latter. The explosion was caused by the stoppage of the pipe, which prevented the steam generated by reservoirs on the stove from entering the boiler; hence it was compelled to find vent in another direction, and with the result above stated.

Kitchen Range (24).—A water-back range in the residence of Mr. Russell, No. 330 Kosciusco street, Brooklyn, exploded on Tuesday, Jan. —th, injuring Mrs. Russell and her three children. One of the children, Willie, aged two years, was so badly scalded about the head and face that he has since died.

Coal Mine (25).—The boiler in Redhead's coal mine, south of Des Moines, Ia., exploded with terrific force Jan. 28th, demolishing the building, but injuring no one, although a dozen miners were within a few yards of the boiler. Loss $3,000.

Nail Mill (26).—The boiler in the Belleville, Ill., nail mill exploded, Jan. 30th, almost totally destroying the building. Several persons were severely injured. Damage, $20,000; 200 men and a number of boys are thrown out of employment.

FEBRUARY, 1882.

Saw-Mill (27).—A very disastrous and fatal boiler explosion occurred Wednesday evening, Feb. 1st, at the saw-mills of C. & J. Tyler, at Bardstown, Ky., about fifteen miles from Louisville, and about one and a half miles back from the Bardstown turnpike road. Newby Johnson, aged 14, was killed, and four others badly injured. The mill was wrecked.

—— Mill (28).—A boiler in Kirkham mill at Doctortown, exploded Feb. 9th, killing David Mitchell and scalding six others.

Saw-Mill (29).—A boiler exploded Thursday afternoon, Feb. 16th, in John & Wm. Tomlinson's saw-mill near Zoar Bridge, doing considerable domage. The building and engine were completely demolished. One of the Tomlinsons, who was in the act of loading wood on a wagon, was struck with a piece of timber and hurled about twenty feet. He remained unconscious two hours. Other men were working around the building, but happened to be out of the way at the time of the explosion.

Saw-Mill (30).—William Dempster, an engineer, and George Gillette, an employee, were killed by an explosion of a boiler at Cole's saw-mill, near Elk Mound, Wis., Feb. 16th. The mill was blown to atoms.

Flour-Mill (31).—An explosion occurred shortly before noon, Feb. 16th, in the flour mills of Jewell Brothers, situated at the foot of Fulton street, near Fulton ferry, New York city, and a shower of bricks, timber, and iron was hurled in every direction.

Two of the boilers, which were located in the extension at the end of the mills, burst with terrific force, and the crown head or some other portion of one of the boilers went completely through the end of the mills, a distance of thirty feet from the ground. Several men who were at work in this mill at the time had narrow escapes.

CAR-WORKS (32).—The boiler of the Georgia Car-works at Cartersville, Ga., exploded Feb. 17th, killing instantly five negroes and injuring a number of others, two of whom have since died. An engineer named Wood was injured, probably fatally. Superintendent Lucas, of the Lucas sleeping-cars, was also hurt. Damage to the building was very great. The dead men are Leonard Choice, Matt Bomar, Hardy Hammond, David Richards, R. L. Patterson, and Sam Davis. Only six were killed. M. L. Wood, engineer, will probably die. Henry Hickson and Ellis Lane are badly hurt. E. C. Lucas's injuries were not dangerous. Damage to property, $6,000.

DISTILLERY (33).—The boiler in the Marion distillery at Portland, Ky., exploded Feb. 17th. John Blake, the engineer, was near the boiler when it let go, and when the men reached the place they supposed that Blake was killed, but he was found alive though seriously scalded by steam about the face, head, and limbs. The roof was torn from the building in which the machinery was located, and a scene of terrible destruction was presented. The main building in which the distilling apparatus was located was not badly injured, but the loss was $2,000 or $3,000.

LOCOMOTIVE (34).—About 7 o'clock on the morning of Feb. 20th, an engine of the Toledo, Peoria, and Wabash railroad exploded in the round-house at Lafayette, Ind. The concussion lifted the roof and blew out the walls, and the roof crashed down in shapeless ruins. The round-house and the engine were demolished. Fifteen locomotives were buried in the ruins. The explosion was a most singular one and has created intense excitement. Had it occurred ten minutes later twenty men would have been buried in the ruins. As it was, seven were buried, of whom one, Michael Kuniff, was dangerously injured, three were slightly injured, and three escaped unhurt.

SAW-MILL (35).—At New Carlisle, O., Feb. 22d, the boiler of a portable saw-mill exploded, killing George Hutzman, Michael Immel, Mr. Herschberger, and two men named Beechy. Michael Streetman was injured so that amputation of one leg was necessary. These were the only men about the mill at the time. The boiler had been known to be in a bad condition for some time.

SAW-MILL (36).—About 8 o'clock in the morning of Feb. 23d, the boiler of the engine furnishing the motive power to the machinery at James Campbell & Son's lumber yard and planing mills, Canton, Ill., exploded with terrific force. Luckily the weak point was so situated that the force of the escaping steam was spent on the earth and the foundations of the boiler walls, and $200 will probably cover the loss sustained. The engineer was struck with several bricks, but not seriously injured. The burning coals in the boiler furnace were scattered about and ignited shavings and waste timber near by, causing an alarm of fire. The blaze was put out, however, by workmen with buckets without the aid of the fire department.

IRON-WORKS (37).—About 6:30 A. M., Feb. 23, one of a battery of three boilers in the rolling mill of A. M. Byers & Co., on the South Side, Pittsburg, Pa., exploded with a loud report, scattering its debris in all directions, injuring three men and completely demolishing the boiler-shed. F. Myers and John Levelle, two of the men injured, escaped with slight wounds on the head. The other, name unascertained, was seriously, and it was thought fatally, hurt. The explosion is ascribed to a broken flange connecting the boilers with the mud drum.

Iron-Works (38).—One of the boilers in the blooming mill of the Vulcan Steel-Works, in South St. Louis, exploded with terrific force at 11 o'clock, Feb. 23d. About one hundred men were working in the mill, of whom Michael Coakley, John and Frank Chambers, and Oliver Ande were fatally injured, being terribly scalded, besides having limbs broken. Robert Colter had three ribs broken, and was severely burned; Mike Cronin suffered compound fracture of the leg, and several scalds; Frank Loftus and Thomas Brennan were also badly scalded, and three other men seriously hurt. The smoke-stack was blown down, and the mill otherwise considerably damaged. The accident is said to have occurred from the breaking of a check-valve in a water pipe, which caused the water to flow from the boiler, and before the fires could be reduced an explosion took place.

Brewery (39).—A boiler in McGrath's brewery, in West Troy, exploded about 1 o'clock, Feb. 23d, destroying the two-story frame engine-house. The engineer was entering the door of the engine-house. and was hurled fifteen feet and rendered unconscious.

Saw-Mill (40).—The boiler of Sibert & Crill's saw-mill, near New-Harrisburg, Ind., exploded Thursday, Feb. 23d, instantly killing Jacob Myers, aged twenty, and seriously injuring three others, whose names could not be obtained. Myers was not employed, but lived near, had been out hunting, and called at the mill to warm. His body was blown one hundred and sixty feet through a tree-top. The engineer was on top of the boiler when the explosion occurred, but miraculously escaped unhurt. The boiler had been used but five days. Just before the explosion there was 110 pounds pressure. Lack of water was the cause of the explosion.

Warehouse (41).—A new portable boiler in the warehouse of Krabst, Holmes & Co., St. Louis, exploded Feb. 28th. No one was injured, but the boiler was badly wrecked.

MARCH, 1882.

Iron-Works (42).—Shumway, Burgess & Co's iron works in Chicago, were demolished on the morning of March 1st by the explosion of a boiler. Loss, $6,000. Only one person was injured.

Car-Shop (43).—A fire occurred in the engine-room of the Minnesota and St. Louis car-shops at Minneapolis, March 2, accompanied by a boiler explosion. The boiler was blown thirty feet, and the storehouse adjoining burned, with contents. Only one man injured, he not seriously. Two locomotives were ruined. Loss, $10,000; insured.

Saw-Mill (44).—Five men were instantly killed, and two others badly hurt, by the explosion of a boiler in a saw-mill belonging to Wesler & Barnes, at Stone's Station, four miles north of Winchester, Ind., between 7 and 8 o'clock a. m., March 3. The mill had been running day and night all winter, but was shut down at 6 o'clock the evening before, because they could not get men enough to make up the relief gang. There was a heavy head of steam at the time the fires were banked, so that the water was kept boiling all night; in the morning the doors were opened and the furnaces filled up with shavings and refuse from the lathes and saws, so that the pressure was increased to one hundred and ninety pounds. If the story told by one of the wounded men is correct, the pump had been out of repair, and Geo. W. Wesler, one of the proprietors, was working with it at the time the explosion occurred. The building, a large, rambling frame structure, which stood on a clearing in the woods, half a mile from the depot, was lifted up, and fell back in a confused mass of broken and splintered timber; the boiler divided into a dozen pieces, and was thrown in every direction, the largest piece being hurled across the road to a field adjoining Wesler's house, three hundred feet away, and the flues taking an opposite course and dropping in the woods six or seven hundred feet distant. Wesler's body was found partly wrapped around a post, with all the large bones broken, his head split, and a great bar sunken in his face. Robert Randall's head was mashed flat, and one eye and the temple gone. Hodson Clark had his throat cut with a piece of iron or a splinter, and the back part of his head was pinched off. William Yankee's head was in the same condition, and his brains ran out on the ground. A piece of casting from the engine penetrated Louis Mann's side, and cut his entrails so that he died. John White and Trumbull Yankee were wounded on the head, and Granville Barnes had a cut on the hip. The boiler was an old one that had been used in a furniture factory, but it would have stood any ordinary usage. White thought that the safety valve was tied down and that there was nearly two hundred pounds of steam in the boiler. The theory that was most generally accepted, however, is that the pump suddenly began working after it had stopped drawing water for some time, and the cold water came in contact with the red-hot plates and was instantly converted into gas, which had so great an explosive force that it tore the boiler to pieces.

DESSICATING-WORKS (45).—At 2 o'clock in the morning of March 7th the rendering tank in the Kansas Dessicating and Refining works, just across the Kaw from the stock-yards, exploded. The exact cause of the explosion is not known. The night watchman had just passed the tank and says at the time there was only about thirty-five pounds of steam on. The tank was about twenty feet high and extended into the second story. It was blown bodily through the east wall, completely wrecking the upper story and the east and south walls. The tank was an old one, although the present works had been used less than two months. The loss is estimated at $8,000 or $10,000.

SAW-MILL (46).—A saw-mill belonging to S. W. Houston, located about eight miles above Ravenswood, W. Va., was blown to pieces March 9th, and one of the operatives, James Gandee, instantly killed.

STEAMER (47).—The Ohio river steam packet Sidney burst her steam-pipe below the town of Ravenswood March 10th, killing three persons and wounding fifteen. The steamer Graham went up the river from the scene of disaster to Ravenswood, to get physicians and coffins.

PAPER-MILL (48).—A cylinder on the bog machine in Hollingsworth & Whitney's paper-mill at Watertown, Mass., exploded March 13th, and did considerable damage to the building, but injured none of the employes. Two girls who were tending the machine at the time had a very narrow escape.

SAW-MILL (49).—A terrible explosion occurred about two miles north of Midway, Pa., March 14th, at the saw-mill of R. B. Davis. Samuel Manson and Benjamin Maffitt were terribly scalded, and Martin Stuart and David Brown mortally wounded. Stuart is from Canonsburg, Pa., Maffitt is from Wheeling, W. Va., and the others are from the vicinity.

SHOE-SHOP (50).—About twenty minutes before 7 o'clock, March 15th, the section of Lynn near the Eastern depot was startled by a terrific explosion. It was found that the boiler in Goodwin Brothers' shoe factory had exploded, leveling the building and killing several men. From the end of the building near Exchange street one poor fellow, badly mangled, was taken out. Soon after, the dead body of John Moore, the engineer, fearfully crushed, was taken out. Half an hour afterward another was found lying on his back where he had evidently been exposed to escaping steam, which was rising in clouds all the time from various parts of the ruins, and he was but just alive apparently. The building, which was of wood, 60 by 30 feet, three stories high, was blown to atoms. A portion of the boiler, weighing a ton, was thrown a quarter of a mile to Newhall street. Striking a house in that street, it glanced across and drove itself into the front doorway of the house of Councilman Burrill. Engineers think that there must have been a high pressure on at the time of the explosion, as the boiler was blown to such a great distance. Another piece of the boiler went tearing through a large covered walk across the court leading from Spring street to the scene of the catastrophe, in an opposite direction from that portion which flew to Newhall street. William Queran, Charles Goldthwait and Stephen Hanson were injured, but all will recover. Several adjoining factories were partially wrecked by the explosion and the loss will amonnt to over $10,000.

Tug-Boat (51).—The steam tow-boat Etna exploded her boilers March 15th, in the Great Kanawha, near Point Pleasant. D. Anderson, a fireman, was killed, and Captain Henderson and several others severely injured. The steamer took fire and burned to the water's edge.

Rolling-Mill (52).—A boiler in the bar mill of Swift's Rolling-Mill in Newport, Ky., collapsed March 17th, which resulted in the killing of one man and the wounding of several others. The boiler was not injured in the main part, but the explosion blew out the man-head and scattered bricks, boards, and iron metals in every conceivable direction. The boiler was set on a frame in the western part of what is called the old mill, on a support about fifteen feet above the ground. Directly facing the man-heads of the boilers is another department of the mill, wherein perhaps over one hundred men are employed. In this department the fragments of the boiler and scalding water did their damage. A large piece of iron from the boiler struck a man named Leonard Ulrich on the right side of the head and fractured his skull, and cut him in several places. The iron first fell through a sheet-iron roof. Another piece of iron struck a man named Thomas Rooney in the side and fractured three of his ribs and broke his arm. He was also badly scalded about the limbs and body. A few minutes after the accident he was removed to his home on Chestnut street, where medical aid was rendered. Casper Knecht, who lived on Brighton street, was badly scalded, but suffered no broken limbs. William Glosser was badly scalded about the face and limbs. A number of others who were near were slightly scalded. Mr. Ulrich was removed to his home on Putman street, where he died. He was a powerful looking man, weighing over two hundred and forty pounds, and left a widow and four children to mourn his loss. How a number of others escaped being injured was a mystery, as there were fully fifty men within twenty feet of the boiler when the man-head flew out. The explosion was caused by the carelessness of somebody allowing the water in the boiler to get below the flues and then pumping cold water into the boiler. Mr. Richard Doyle, who was the engineer in charge, stated that there was evidently a crack in some of the flues. The pieces from the boiler and the bricks were thrown over one hundred feet from the boiler, and large chunks of iron were forced through a sheet-iron roof in the shearing department, which is situated nearly fifty feet from the boiler. George Harris, of Covington, had one of his hands badly hurt. A young man, who was standing near the boiler, had a narrow escape from being burned to death by his clothes catching fire. He saved himself by running and jumping into a tub of cold water.

Mine (53).—A terrific boiler explosion occurred at Emaus, Pa., March 23d, at the ore mines of Charles Weiser, resulting in the instant death of the engineer, James Weaver. Nothing is known as to the cause of the accident, as the engineer was the only person about the engine-house at the time of the explosion, although a large number of workmen were in the mines, about 100 yards away. The force of the explosion was such that the boiler was thrown a great distance. The body of the engineer was not found for several hours after the explosion, when it was found in a well ninety feet deep, situated some distance from the mines. The boiler was an old one, similar to the one in use at the Texas flats, which exploded some years ago, resulting in the death of several persons.

TUG-BOAT (54).—The boiler of the tug-boat Henry C. Pratt, of Philadelphia, Pa., exploded March 23d, killing four men. George Scully, the captain, was blown over the house tops in Water street. He was taken to the hospital, where he died. The dead bodies of Bernard McCann and Patrick Flanagan, firemen, and a man named Maloney, were recovered. Two other men are reported missing. The Henry C. Pratt had arrived at the wharf to take out the canal boat of which one of the victims, Maloney, was captain. when the explosion occurred. Her boiler was thrown across Delaware avenue, knocking the front out of the building No. 134 of that thoroughfare. Both boiler and wheel-house fell on the pavement in front of this building. Immediately following the explosion flames broke out in all directions. Pier No. 8, which is occupied as the passenger and freight station of the Philadelphia and Atlantic City railway, took fire and was completely destroyed. The depot was about 200 feet in length by 60 feet in width. On the pier were a large consignment of paper from the Wymouth paper mills consigned to Russell & Armstrong, a large amount of lumber ready for shipment to Atlantic City for building purposes, also household effects belonging to cottagers at the seaside, and other goods, all of which were consumed. The loss by the railway company will reach over $15,000. The tug Ella, lying at the wharf below, also took fire and sank, after being well burned. Windows were shattered in all direction for squares distant, but the force of the explosion is better illustrated by the fact that the Pratt's anchor went flying through the air to Water and Walnut streets, where it became entangled, and remained hanging among the telegraph wires. Three dead bodies were found in the street, only one of them being badly disfigured. The engineer has been found, having had a very narrow escape.

SAW-MILL (55).—The boiler of Wesseer's saw-mill at Kempton, Ind., exploded March 28th, and killed Ed. Henry and G. Smithson.

SAW-MILL (56).—The boiler of the engine of a portable saw-mill belonging to Reuben Deutro, near Corning, O., exploded March 28th, killing one man outright and fatally injuring four others. One of the victims was Deutro. The other names are not given.

BAKERY (57).—The boiler in the Manewal Bakery, in St. Louis, Mo., exploded about March 30th. Damage about $1,100. No one injured.

APRIL, 1882.

STEAMER (58).—An appalling steamboat disaster occurred on the Mississippi April 7th, near a small town called Brownsville, ten miles below La Crosse, Wis. The steamer Bella Mac was one of the best tow-boats on the river, and was on her way up for the first trip of the season. She had a crew of seventeen men all told, and not one among the entire number escaped without injury. Six were killed outright by the catastrophe, which was the complete demolishment of the upper works of the steamer by the explosion of her boilers. The water was filled with fragments and the burned and scalded victims. The scene on the boat was one of direst confusion. The upper works were entirely gone, the deck was covered with debris, and the wounded could be heard screaming for help. The injured were taken to La Crosse and cared for. After the accident all was dark, and the cries of men for help from on board and in the water were heart-rending. The Bella Mac was a comparatively new boat, this being her third year of service, and she has been considered perfectly safe. She was valued at $8,000. The cause of the disaster cannot be learned. The second engineer says the boiler had plenty of water, and at the time of the explosion he was carrying about 135 pounds of steam.

Nitro-glycerine Works (59).—The nitro-glycerine works at East Rahway, N. J., were blown up Saturday afternoon, April 8th. The business was carried on in a long frame structure, and between twenty and thirty men were engaged there. The engineer at the works discovered, by consulting his gauge, that an explosion was inevitable, and he gave warning to the men employed in the establishment, and they fled precipitately to a patch of woodland about 500 yards distant. A few seconds after they had got beyond the point of danger, the expected explosion occurred. The boiler was hurled high in the air, and of the building not a stick larger than a piece of kindling-wood could be found. A deep hole in the meadows marked the place where the factory had stood. The shock of the explosion was felt for many miles. Fifty-four window-lights in a dwelling-house 500 yards away from the factory were shattered to fragments, and all the houses in East Rahway suffered more or less. Elizabeth, Linden, and Rahway proper were considerably shaken. The loss will probably not exceed $5,000.

Saw-Mill (60).—The boiler of H. Bowman's saw-mills at Bowman's Switch, Ark., exploded April 10th, instantly killing J. W. Price and Frank Winkler, and fatally injuring Warren Wells. Arthur Carey was somewhat cut and bruised up, but not seriously hurt.

Steamer (61).—The steamer Planter of Charleston, S. C., exploded her boiler April 13th, just after leaving the dock. Jake Washington, a colored deck hand, was scalded to death. L. F. Bosang and W. T. Ham, mate and engineer, both white, were seriously scalded. Two colored men were slightly injured. The Planter had a cargo of merchandise and about twelve cabin passengers, but none of the latter are injured.

Wood-working Mill (62).—A large boiler in the building on Pratt street, next to the corner of Fremont, Baltimore, Md., exploded April 13th, with a terrible loss of life. The immediate part of the building where the explosion occurred was occupied by A. H. Sibley & Co. as a chop and feed mill, and the floor above and the first floor adjoining on King street by Miller & Coleman as a sash and door factory. The machinery had been idle for some time for repairs, and fire had just been started to resume work when the explosion occurred. A portion of the boiler was propelled northward, entirely demolishing two two-story brick dwelling houses on King street, and throwing down the side wall of a rear building adjoining. At the time of the explosion John Addison, engineer, Harrison Waters (colored), fireman, Andrew Cooper, machinist, and Frank Kraning, a boy of fifteen, were in the engine room. All were killed. In the house 173 King street, Georgie Pentz, aged nineteen, was killed, and Ida Rosenburg had one of her legs broken. Ellen Rawlings, a colored servant woman, was severely hurt by the walls falling upon her. In No. 171 King street, Grace Gray, aged twenty, was killed. In the yard adjoining the factory, Abraham Hepbron (colored) was struck by a flying missile and his skull fractured. James Roden, aged fifteen, had his skull fractured. Edward Callahan had a leg broken. Mrs. Margaret Kauf, living at 454 Pratt street, adjoining the factory, was standing at her wash-tub in her kitchen, when she was struck by the flying bricks and killed. C. W. Gates, at work in a granite yard a square distant, was struck in the face by a brick, and severely hurt. Edward Kelley, one of the employes in the building, had a leg broken, and several others were less seriously hurt. The building and machinery and dwelling houses are owned by Richard Cromwell, Jr. The damage to property and machinery is estimated at about $8,000. There was a similar explosion in the same building twelve years ago, when five persons lost their lives.

Rolling Mill (63).—Another flue cap collapsed April 17th, at Swift's rolling-mill, Newport, Ky., similar to the one that caused such a frightful accident at the mill several weeks ago, but this time very fortunately no one was hurt. The explosion caused a big excitement among the employees, and a number of them quit work for the balance of the day.

Steam-Drill (64).—An explosion about midnight, April 17th, was caused by the malicious blowing up of the steam drill and boiler on Mahoney's contract, on the West Shore road, near West Park, N. Y. The shock was felt ten miles. No one was hurt. The damage was about $1,500.

Saw-Mill (65).—John Shoab, a farmer, was killed by the explosion of the boiler of a steam saw-mill near Catawba, Ohio, April 21st.

Paper-Mill (66).—An explosion of one of the rotary bleach boilers, weighing five tons, occurred in the Sugar River paper-mills at Claremont, N. H., April 21. The cause is a mystery. The boiler was thrown through a heavy, thick brick wall, landing down the river, 300 feet from the mill. The machinery was considerably damaged by the falling timbers, while the mill was badly shattered. Warren E. Whitney was fatally injured. Allen Jones was severely scalded. The damage is estimated at $30,000.

Saw-Mill (67).—The boiler of W. S. Robinson's saw-mill, near Longview, Texas, burst Saturday morning, April 22d, killing C. A. Willis, and making a complete wreck of the mill.

Wood-working Mill (68).—The boiler of the Dalton Pail company at Dalton, N. Y., exploded Thursday, April 27th, killing Newell Onley and Frank Baker, the proprietors, and injuring several others.

Saw-Mill (69).—The boiler of Hyman's saw-mill at Goldsboro, N. C., exploded April 28th, tearing the building to pieces, killing Fireman Mayboy, fatally injuring three, and badly scalding two employes.

Steamer (70).—A special from Kingville, S. C., says: The steamer Marion on the Wateree river exploded one of her boilers April 28th. She had on board a picnic party, thirty-five or forty in number. Miss Minnie Henry was instantly killed. Misses Mattie and Nannie Henry are missing, and supposed to have been drowned. Miss Lizzie Henry was badly hurt, and is not expected to live. J. C. Eason was badly hurt, not expected to recover. William Trumble was badly scalded, and Miss Minnie Bates had an arm broken, and sustained other serious injuries. Arvel Stiles is missing, and supposed to have been drowned. Tom Richardson (colored) one of the crew, was drowned. John Williams, another of the crew, was badly hurt. The Marion is a government steamer. She is a wreck.

MAY, 1882.

Saw-Mill (71).—A boiler explosion occurred above Newburg, Warrick County, Ind., May 3. The boiler was part of a portable saw-mill belonging to Councilman Philip Klein, of Evansville, Ind., and was at work on the farm of Luke Gardner, two miles from Newburg. The accident occurred at 9 o'clock, killing Engineer Henry Lockhart, a man named Frank Nason, and seriously wounding Jennings Wethers, an "off bearer." The boiler had been in use four months, was sixteen-horse power, and considered safe. The cause of the accident was not ascertained.

Saw-Mill (72).—William and John Williamson, twins, aged 24, were killed May 5th, by a boiler explosion in a saw-mill, where they were employed, in Upshin County, Texas.

Grist-Mill (73).—A boiler in the grist-mill of Stewart & Johnson, Sterling, Pa., exploded May 9th, blowing off the roof of the building and shaking the structure badly. No one was injured. Damage about $200.

Oil-Well (74).—A fifty-horse power boiler exploded at Red Rock, six miles east of Bradford, Pa., May 11th, injuring M. D. Thompson so severely that it was thought he could not recover, and doing much damage to oil property in its vicinity.

Saw-Mill (75).—The stave-mill owned by Syme Bros. & Mauer was completely demolished about 9 o'clock in the morning, May 15th, by the bursting of the boiler. A named Bert Weeks was killed instantly, and two men named James Owen, of Hartford, Wis., and Losenger, of Marshfield, were badly scalded. Neither is expected to live. Total loss, about $3,500. The cause of the explosion is unknown.

Saw-Mill (76).—The boiler in J. W. Grubb's saw-mill, ten miles west of Greencastle, Ind., exploded May 17th, about 10 o'clock, instantly killing the fireman, George Bowers. He was blown into the air about fifty feet, and his body was horribly mangled and presented a sickening sight. The other laborers in the mill were in the log-yard at the time of the disaster, else the fatality would have been much larger. The cause of the explosion is unknown.

Saw-Mill (77).—Mr. John Smith and a Mr. Greek, day-laborers at the Greek saw-mill, three miles southwest of Sherwood, O., were seriously injured by the explosion of a boiler, at 11 o'clock, A. M., May 10th. Mr. Greek was fatally injured.

Saw-Mill (78).—The boiler of a saw-mill at Fairview, W. Va., forty miles from Wheeling, burst May 17th, and fatally scalded one of the workmen named Chambers. Two or three other of the men about the mill were more or less scalded, but none but Chambers fatally.

Steamer (79).—A boiler of the passenger steamer American Eagle burst May 18th, about a mile and a half from Kelley's Island, near Sandusky, O., killing Lorenz Neilson, deckhand, Put-in-Bay; Frank Bittel, fireman, and Frank Walter, deck-hand, both of Sandusky. J. W. Johnson, engineer, Put-in-Bay, was fatally scalded. Hugo Steiert, mate, Put-in-Bay, head cut by a piece of boiler; Charles Kramer, cook, Put-in-Bay, badly scalded about face and arms. Six passengers were scalded; William Dillger, Sandusky, face and hands; James Fulton, Ballast Island, face, arms, and legs; J. W. Gilbert, Sandusky, face and hands; Mrs. J. W. Lutes, Middle Bass, face, hands, and abdomen, dangerously; Julia Lutes, her daughter, face and hands; J. W. Lutes, fatally.

Flour-Mill (80).—About 7 o'clock A. M., May 23d, the flouring mill of Hanes & Porch, at Williamsport, Warren County, Ind., was almost demolished by the explosion of a boiler. The engine-house was blown to atoms; debris being scattered over the entire town. The main portion of the large boiler was thrown about 200 yards, knocking off the corner of the dwelling of John Thomas. Zed Stinespring, engineer, was instantly killed, and an employee named Musselman had an arm broken. The building was a three-story frame, forty by sixty, and the entire structure was moved several inches off its foundation stones. Stinespring was a new man put on that day. The regular engineer had not been absent ten minutes when the explosion occurred. Damage, $4,000.

Mine (81).—A very destructive boiler explosion occurred about 6 o'clock A. M., May 29th, at the Middlebury shaft of Payne, Newton & Co., southeast of the city limits, Akron, O. The steam broke through one of the boilers with a tremendous noise, sending fragments of iron, timber, and machinery in all directions. One section was hurled into a field several rods away, another struck the office, about sixty feet distant, tearing that building badly. Of the two remaining boilers, one was completely, and the other badly wrecked. The large fly-wheel was demolished, and other portions of the machinery damaged. The engine-house was literally blown to pieces. Owen Hearty, who was standing near the door of the engine-house, escaped without injury, except being slightly scalded. Three or four miners had been in the engine house only five minutes before the explosion. Loss, several thousand dollars, and work suspended for some time.

Saw-Mill (82).—A boiler exploded in a mill on Big run, at Brady, Pa., May 31, without injuring anybody.

SEWER PIPE WORKS (83).—A boiler in Columbus Sewer-pipe Company's works at Clinton, Ohio, collapsed a flue on Wednesday, May 31st. The glass water gauge became stopped up, deceiving the engineer, who thereby allowed the water to get too low.

STEAMER (84).—Hub Putney, second engineer of the tow-boat John Hanna, was badly scalded about the face and breast May —, by the explosion of the pipe leading to the mud-drum. Putney went to blow out the mud-drum at about 4 o'clock, when the pipe exploded and the steam burst out, covering the upper portion of his body. His condition was reported serious, but the physicians hoped for his recovery.

JUNE, 1882.

SAW-MILL (85).—A boiler in Edward Dickerson's mill, at Ruckersville, Va., exploded June 1, instantly killing Davis, the engineer, and a colored man, named James Carpenter. The explosion was mean enough to break the remaining arm of John Garvell, he having previously lost the other. Several of the other employees were injured.

HOISTING ENGINE (86).—The boiler of a hoisting engine on the wharf of the Bradley Fertilizer Company, Boston, Mass., exploded June 2. The boiler was blown 300 feet through the roof of the boiler room in the main building, causing this boiler to explode and blowing out the front of the building, entailing damage of $3,000. Thomas Connolly, 18 years old, had his skull fractured and was fatally injured.

LOCOMOTIVE (87).—The boiler of a tramway locomotive, belonging to the Traffic Company's mill at Norrie, Wis., exploded on June 3. Several men were sitting around it eating lunch. Two men were killed, the body of one being blown to atoms. The name of one was Hopkins. Four others were injured, two probably fatally. The locomotive was built at Norrie, and had just been sent out to haul logs.

STEAMER (88).—Steamer Evansville, from Evansville to Bowling Green, exploded her boiler June 6, near Calhoun, Ky., fatally injuring her mate, Owen Gilmore, and a fireman, and slightly scalding nine or ten others. No passengers were injured.

SAW-MILL (89).—Boree Brothers' mill at Abrams, Wis., was burned June 10, together with some lumber and shingles. During the fire one of the boilers burst and the other was warped out of shape, while the machinery was utterly ruined. The filer and engineer were in the mill at the time of the fire and had a narrow escape, the former getting his face badly burned, and his whiskers and eyebrows singed off. The loss is some $10,000, and the insurance $4,000.

SAW-MILL (90).—The boiler in the steam saw-mill of Robert Patton, six miles south-east of Marion, O., exploded June 20, throwing the parts of the machinery from fifty to one hundred yards, demolishing the mill and killing Thomas Barger, the block setter, and Albert Hines, the fireman. Barger had his head carried away. Hines had his head crushed beyond recognition. David Young, off-bearer, was badly burned with steam and cinders. Colonel Owens, who was looking on, was burned in the face with cinders and steam. The safety valve was weighted down.

STEAMER (91).—The United States snag-boat Woodruff, while lying at the dry docks in the upper part of Cincinnati, June 20, burst its nigger boiler. The explosion tore the boiler deck and the cabin above the boiler to splinters. Clay Jones, a fireman, was blown into the air and terribly scalded. He was mortally hurt. He resided. at Middle-port, O. Mr. Jeffreys, the first mate, was struck in the stomach by debris and injured, but not seriously. A chambermaid was scalded slightly. The damage to the boat was $6,000.

——-Works (92).—A boiler exploded at the works of the Rawson Manufacturing Co., Hornellsville, N. Y., June 21. No one injured, but considerable damage was done to property.

Saw-Mill (93).—A terrible boiler explosion occurred June 21, at about 1.30 P. M., at East Williamsfield, O., in the saw-mill owned by Fowler & Martin, and leased by Mr. F. D. Moran. Four men were killed, two instantly, and two more were injured so that death soon came to their relief. One man, Mr. Denham, the fireman, was blown several feet in the air and through the branches of a cherry tree standing by the mill. The names of the killed are Thomas Thompson, married; Almon D. Brooks, married; Frank Chamberlin, married, and Charles Durham, single. The remains of Thompson and Durham were removed by friends, and the others were removed as soon as the friends were notified. The cause of the accident could not be fully determined, as the facts could not be brought out, all the men being killed. The scene presented a total wreck, the mill being torn to atoms, machinery and all. The boiler was blown several yards from the mill and portions of it torn in shreds like brown paper. The saw was torn into quarters.

Gold Mine (94).—A boiler at the St. Catharine gold mine, near Charlotte, N. C., exploded June 24, fatally injuring three men.

Brick-Yard (95).—The steam boiler in Cannable's brick and tile works in the northern part of Jackson, Mich., blew up with a loud report June 26, shaking the buildings in the entire neighborhood, and resulting in the instant death of one man, and injuring three or four more or less seriously, while a large amount of property was destroyed. The man killed was Michael Nugent, a brick molder, who was at work in an adjoining building. When he was struck by the boiler the force was so great as to hurl him against the wall and cut open his head, breaking one leg in two places, and bruising his body severely. David Smith, the engineer, who was standing in front of the boiler, was only slightly injured. Four others were considerably hurt.

JULY, 1882.

Paper-Mill (96).—A rotary bleach in Adams & Co's paper-mill at Chagrin Falls, O., exploded July 15th, wrecking a large part of the mill, instantly killing Albert Schwartzentroupe, who was scalded and burned almost beyond recognition, and severely if not fatally injuring a workman named St. John.

Dwelling House (97).—Miss Rosa Jones, daughter of Officer Harry Jones, of Allegheny, Pa., met with a painful accident at her home, No. 193 Fulton street, Alleghеney, July 15th. A sealed vessel filled with water had been placed on the stove, and when Miss Jones attempted to remove it it exploded, dashing the hot water and steam into her face and so scalding it that the flesh dropped from her cheek. Her eyes were injured also, but not in such a way as to affect her sight.

Fertilizer Works (98).—A terrific boiler explosion occurred July 20th in the Excelsior Fertilizer Works, Alliance, O., demolishing the engine house and wrecking two loaded cars standing on the railway, but fortunately injuring no one.

Oil Well (99).—A boiler explosion occurred July 21st on the oil tract known as Patched Run, two miles from Franklin, Pa. A driller named Moses Funk was blown down a steep bank, a distance of about ninety feet. His right arm was broken and body badly lacerated, and he had a miraculous escape from a horrible death. A man named McCarthy also narrowly escaped death. The boiler was blown to atoms and the engine-house and derrick destroyed.

THRESHING MACHINE (100).—The boiler of a threshing machine exploded near Dorchester, a small town on the Macoupin County line, July 25th. J. W. Wein, who was at work on the separator, seeing that an explosion was about to occur, rushed to the engine and pushed the engineer aside. Just then the explosion occurred, and Wein was instantly killed. Two horses and mules were also killed, and the entire wheat stock destroyed by fire.

SAW-MILL (101).—D. J. McCloud's shingle mill, in Saginaw City, Mich., took fire about 5.30 P. M., July 21st, and during the fire two boilers exploded with terrific force, scattering the brick boiler-house in fragments and the boilers in every direction. Wm. Crawford, aged 19, an employe of the mill, was struck by a fragment of the boilers and instantly killed, his skull being crushed. Ferd Scheum, a boy about 9 years old, was also killed by being struck with a flying fragment. Both persons were about 250 feet away from the mill when struck. Jas. White, the night watch, was badly injured in the head and leg; Peter White had his right leg broken; Jas. Hearns sustained a compound fracture of the right arm; Chief Engineer Wylie, of the fire department, Charles Grasson, Harry Barnes, and Oscar Hacardy were all cut and severely bruised. Loss by fire and explosion about $5,000.

LOCOMOTIVE (102).—A terriblea ccident occurred on the Millwood narrow gauge railway July 26th. The engine blew partly to pieces, fatally scalding Miss Madison. Engineer Wilson Campbell and his son were badly scalded, as was also Conductor Frank Reed.

STEAMER (103).—The steamboat Fanchion, for the Atchafalaya river, when opposite Louisiana avenue, New Orleans, July 26th, soon after leaving the wharf, blew out the head of her forward flue. E. Quatreveaux, first clerk, was slightly scalded and blown overboard, but rescued. Dave Hawkins, the second clerk, was fatally scalded. Mike Faley, the first mate, was scalded and blown overboard, but rescued. The second mate was also scalded. One colored fireman was instantly killed and fifteen colored deck hands more or less injured. Many of them jumped into the river. Some were picked up by skiffs, but it was believed that five or six were drowned. None of the passengers were injured. Fanchion is owned by same parties who owned the John Wilson, recently lost on the Atchafalaya, and was in charge of the same officers. After the excitement had subsided the Fanchion was towed back to the city.

HOISTING ENGINE (104).—A crowd of laborers on the foreign steamship wharf of Watson's stores, Brooklyn, were startled about 4.45 o'clock P. M., July 26th, by the explosion of the boiler of a floating hoisting engine that was hoisting coal out of a canal-boat into the steamship Surrey. The main portion of the boiler fell on the deck of the schooner Marcus L. Ward of Newark, which was lying at the end of the Watson's stores wharf, loading with pig iron. On the schooner's decks were half a dozen of the crew, but although the boiler crashed through the top-mast rigging to the deck, not a man lost his life. Only one man was hurt, and he only by a piece of the broken top-mast. Alongside the inner wharf lay the Old Dominion Steamship Company's barge Victoria, and on the forward deck of this vessel, near where two men were sitting, a piece of the boiler, weighing over a hundred pounds, fell without injuring any one. The engineer of the floating boiler had a narrow escape from death. He had by chance stepped on the canal-boat G. M. Cole, lying close to the float, only a moment before the boiler exploded. He had allowed the water to get out of the boiler, and he did not discover his omission until it was too late.

AUGUST, 1882.

COAL MINE (105).—The boiler at Oberlin's coal mine, four miles north of Canton, O., exploded Thursday morning, Aug. 3. There was no one hurt and the damage was only slight.

TANNERY (106).—A most distressing accident occurred Aug. 4th, in Wharton township, twelve miles from Uniontown, Pa., in the mountains. John Seiler, who runs the tannery of Downer Bros. at that place, had in his employ a man named Samuel Dillon. Seiler left the tannery about five minutes to go to the house, and while absent the boiler of the steam engine exploded. Dillon was standing near and was instantly killed. His body was terribly shattered. The buildings about were also demolished. Seiler's boy, who was standing at some distance away, was struck on the leg by a flying fragment and seriously although not dangerously hurt. Dillon leaves a wife and child.

Threshing Machine (107).—The boiler of a steam thresher belonging to Thomas Lyons exploded Aug. 7th, at Kemptville, Ontario. Mr. Lyons's son Fred was killed and considerable damage was done to property.

Machine Shop (108).—About 10 o'clock A. M., Aug. 10th, the boiler in the engine room of the Morden Frog and Crossing Works, 68 Pacific avenue, N. Y., burst with considerable violence. The engineer was severely injured.

Saw-Mill (109).—There was trouble enough for one day in a Newaukum mill, W. T. One man was badly cut with a broadax; two boys and a man got into the water among the logs and were nearly drowned, and the boiler of the mill blew up, injuring two men slightly. There must have been a jug somewhere in the mill that day.—*North-western Lumberman, Aug. 12th*, 1882.

Steamer (110).—The steamer Gold Dust blew up Aug. 7th, burned to the water's edge and sunk 200 yards north of Hickman, Ky. Seventeen people were killed and forty-seven wounded. Capt. John F. McCord was slightly hurt, and the third clerk scalded to death. The boat was landed in the eddy just above the town, and through the exertions of the citizens, the cabin passengers, officers, and part of the crew and deck passengers were taken ashore and removed to hotels and residences; twenty-four of the injured were lying in Holcomb's dry goods store at one time, where they received every attention, before being removed to more comfortable places. The citizens of Hickman are doing all they can for the sufferers. The following is a list of the injured: Capt. John T. McCord. Slightly scalded—F. S. Gray, pilot; Sol Price, first mate; John Langlois, second .clerk; William Ingram, third clerk; William Travis, barkeeper; Pat Daniels, cabin watchman; John O'Neil, deck hand; Tom Beck, deck sweeper; Dick Philips, porter; Jim Second, porter; two pantrymen, two roustabouts, three firemen and second barber. Ten deck passengers, and Mrs. Thompson a cabin passenger, are severely scalded. D. Dunham, second mate; P. Deitreid, freight clerk; James Monahan, sailor; James Nichols, baker; the third cook, Mr. Bridges, Mr. Thornton, Mr. Blank and Mrs. Blank, slightly scalded. One cabin passenger and one deck passenger, one fireman, two coal passers, eight roustabouts, four cabin boys and James Lawson, the first cook, are missing. William Ingraham, William Travis, the cabin watchman, P. P. Coleman, a deck passenger, John Jay and a roustabout have died. [Twenty-four men were killed or died from their injuries.—Ed. Loco.]

Saw-Mill (111).—At Eldersville, Pa., Aug. 9th, a boiler in Weaver's mill exploded, wrecking the building and killing Thomas Bevington and James Phillips. Bevington was killed instantly. Phillips lingered for some time. The latter was a resident of Steubenville, O., and unmarried.

Distillery (112).—The mud drum of one of the boilers in Hoffman & Co's distillery at Cincinnati, O., exploded Aug. 9th.

Manufactory (113).—The boiler at Donoline Bros.' shear factory, at Middletown, Ct., exploded Aug. 11th. The disaster occurred from some unknown cause. The boiler, which was in the basement of the building, went up through two floors and the roof, landing three rods away. John Cotter, who was working on the floor above the boiler, was thrown under a bench, about fifteen feet away, and badly injured. Thos. Brophy, a boy, was struck by a flying piece of wood and seriously cut about the head and otherwise injured by falling timbers. The injury to the building and contents is about $400.

Saw-Mill (114).—At Jackson Center, O., Aug. 12th, a small town twelve miles north-east of Sydney, the boiler in the steam saw-mill belonging to Richard Buireley, burst, completely demolishing the mill and injuring all the houses in town. The three men who were in the mill at the time were miraculously saved with but slight injuries.

Saw-Mill (115).—The boiler of Mr. W. P. Martin's saw-mill, six miles northwest of Kilgore, Texas, exploded Aug. 11th, seriously injuring Mr. Martin, his son and three colored men. One of the latter soon died, and Mr. Martin cannot live.

Water-Works (116).—The boilers of the Starr Water-Works Company, Joliet, Ill., exploded Aug. 12th, destroying the boiler-house. No one was hurt.

——-Mill (117).—A fireman was killed and two laborers severely hurt by the explosion of a boiler in Clark & Brothers' mill near Parkers, Va., Aug. —.

Threshing Machine (118).—Carrie Raefine was killed and four children hurt, two fatally, by the explosion of a threshing machine boiler at Mount Horeb, O., Tuesday night, Aug. 15.

IRON-WORKS (119).—The boiler at No. 5 furnace of the Crane Iron Company exploded Aug. 20th, and did considerable damage to the building, besides killing John McDowell, aged thirty-five years, a single man. Fire communicated to the wood-work and cars in the vicinity, and but for the prompt work of firemen much greater damage would have been occasioned. The damage to property foots up $4,000.

SAW-MILL (120).—A terrible boiler explosion occurred at 3 o'clock P. M., Aug. 21st, at Sullivan, Ind., a few miles north of Vincennes, by which three men, George Morris and Irvin Bailey, teamsters, who reside in Grayville, Sullivan County; also, George Inglehart, a resident of Buchanan, Mich., who was head sawyer at the time of the explosion, were fatally injured. The mill was owned by A. B. Perkins & Co., and the loss occasioned by the calamity reached $3,000; fully covered by insurance. Pieces of the boiler were carried hundreds of feet. The mill was a large one, and employed nearly twenty men, and had been doing an extensive business.

TILE-MILL (121).—The boiler in Miller's tile-mill near Selma, O., exploded Aug. 26th, killing Joe Wright, John Adams, and a boy named Porter.

COAL-WORKS (122).—A boiler at Wettengell & Gormley's coal-works, Chartiers township, exploded on Thursday, Aug. 31st, with a terrific report. No one was injured, but everything in the vicinity was wrecked.

SEPTEMBER, 1882.

CAR-SHOPS (123).—Shortly after 8 o'clock A. M., Sept. 5th, the boiler of the dry-house at the Erie car-shops, Erie, Pa., exploded. John Waidley, foreman, was instantly killed, and Charles Driechel, fireman, was literally blown to atoms. John White, John Sevin, Mike Weber, William Hamilton, and Joseph Engel were wounded; the last named seriously.

COKE-WORKS (124).—Shortly before noon, Sept. 6th, the boiler at the shaft of the Connellsville Gas Coal and Coke Company's works, just within the borough limits at Connellsville, Pa., exploded. The engineer, Daniel Jones, was hurled 100 feet in the air and fell in a neighboring field. He was scalded horribly, but lingered until 3 o'clock in the afternoon, when death came to his relief. Deceased was thirty-three years old and leaves a wife and two children.

IRON-WORKS (125).—The boiler in the rolling-mill of Swift & Harper at Riverside, O., exploded Sept. 4th. Five or six persons were more or less injured. None were killed outright.

SAW-MILL (126).—Tatton & Cole's mill near Luther, Lake County, Mich., was blown to pieces by the bursting of a boiler on Sept. 12th, one man being seriously and perhaps fatally injured, while several others were hurt. The mill was a perfect wreck. It was a new one, and will be rebuilt.

STEAMER (127).—About a quarter to 8 o'clock P. M., Sept. 12th, the boiler of the steamer Pinafore, a small pleasure boat on Southwick lake, Southwick, Mass., exploded. A special message to the *Courant* says that the boat was lying at the railroad wharf and upon it were a son and daughter of the owner, Henry Soule, and a young lady visiting the family. They were sitting on one of the benches and were considerably scalded. The engineer was absent from the boat. The boiler was thrown into the lake. It has not been considered safe by some who have had knowledge of the boat. It is fortunate that the explosion did not occur when the boat was crowded with excursionists, as it often is when picnic parties are at the lake.

SAW-MILL (128).—A disastrous boiler explosion occurred, Sept. 15th, in Syme & Jones' stave factory, Appleton, Wis. The boiler was blown directly over the heads of eight or ten workmen who were employed about the building, all but one of whom escaped injury. The unfortunate man was Lewis Matthies, who was crushed beneath one of the machines. A boy named Otto Fisher fell under a heavy smoke-stack, and was fatally injured, dying after a few hours of agony. The fireman received serious injuries. The boiler was located in a lean-to, and after passing through that structure it crushed into a dry-house on the opposite side of an alley. A wheelbarrow in the hands of a boy near by was smashed to splinters, leaving the scared lad uninjured and astonished. But this is not all of the story. The exploding boiler was attached to another, and the breaking of the connection resulted in a second explosion. The last boiler turned over end for end and fell among the debris of the building. The boilers were wrecked and some of the machinery was badly damaged. The boilers had been in use but one year, and contained plenty of water, and there is considerable mystery about the explosion. The damage done amounted to about $4,000.

Locomotive (129).—A locomotive on the Kansas Pacific railroad exploded its boiler Sept. 15th. The fireman was blown with great violence against a telegraph pole and instantly killed. The engineer was scalded so badly that he died soon after.

Locomotive (130).—An old locomotive in the service of the Philadelphia and Reading railroad exploded at Dunellen, N. J., Sept. 21st. The locomotive had a coal train in tow, and was run off on a siding at the Dunellen water-tank. While she stood there the boiler was rent by an explosion and split in two its entire length. The two pieces were hurled by the force of the explosion across four tracks and landed on the other side of the road-bed. The engineer, two firemen, a Central railroad pilot, and a brakeman were on or near the locomotive at the time. The pilot, who was assisting the engineer temporarily, was blown into the air and landed in a field near by without serious injury. One of the firemen, who was on the coal tender, and another, who stood near him, were badly but not fatally scalded. The engineer and the fifth man escaped with a few bruises. The conductor of the train was struck in the head by some of the flying pieces, but was not seriously hurt. The injured were all sent to their homes in Philadelphia after their wounds had been dressed. The cause of the explosion is not known.

Steamer (131).—A donkey engine, aboard the ship Queen of the North at Quebec, exploded Sept. 21st, killing Carpenter Anderson instantly, and mortally scalding three other hands of the vessel.

Steamer (132).—The boiler of the ferry steamer Richelieu at Lachine. Ont., exploded Sept. 21st, killing Duquette, the pilot, and James Richardson and Persellius Amyot, of Chateauquay, farmers. Duquette, the son of the pilot, is missing, and is supposed to have been blown overboard. Several passengers were severely scalded by steam.

Locomotive (133).—As passenger train No. 5 pulled away from the depot at Ashtabula, O., Sept. 21st, westward-bound, the engineer and one or two others were somewhat injured through some defect or bursting of a flue about the engine. The accident took place near what is called the west yard, and Mr. Haywood, an employee who happened to be on the engine at the time, was quite badly burned about the arms and side.

Steamer (134).—The steamship Lepanto, which arrived at New York Sept. 24th, from Hull, reports that on Sept. 21st, at 9 p. m., the weather became foggy. "We began to blow the steam whistle at intervals of two minutes. At 10 p. m., there was a thick fog, and our engines were running at half speed. At 10.10 p. m. we heard a whistle close to our port bow and stopped our engines. Two minutes later we heard a whistle and saw a vessel crossing our bows from S. to N. At 10.15 a. m., came into a collision with a steamer, (our head at the time being W.N.W.) which never stopped crossing, but dragged right across our port bows, at the same time swaying to the westward with her propeller going all the time. After getting clear of the steamer, we stopped our engines, and immediately sent away three boats with all our crew and officers to render assistance. At 10.30 the boats of the Edam, three in all, arrived alongside with the passengers and crew who were at once embarked. Soon after, one of our own boats returned bringing the chief officer of the Edam, a quartermaster, the steward and two passengers. The Lepanto was considerably damaged, but a careful examination showed that she was making no water, and we started the engines, running very slowly. On proceeding, we started west and shortly passed through the debris of the foundered steamer, which had, from all appearances, blown up on foundering. The passengers, twenty-one in number, and crew, numbering fifty-two, of the Edam, were made as comfortable as possible, the captain giving up his room to the women, and the cabin passengers made the most of the small accommodation. The third engineer and an assistant engineer of the Edam were lost. The Edam belonged to the Netherlands Royal Mail and sailed from Jersey City for Amsterdam Sept. 20th.

Steamer (135).—Steamer Newport, on the way from New York to Newport, blew off a patch from her boiler Sept. 24th. No commotion followed. The boat put into New London for temporary repairs, arriving at Newport only five hours late.

Portable Engine (136).—An engine attached to a pile-driver at Indianola, Texas, blew up Sept. 25th. John Casey and Frederick Montier were badly scalded. The former died. Montier is improving.

OCTOBER, 1882.

FLOURING-MILL (137).—About half-past 1 P. M., Oct. 2d, the boilers of the flouring-mill of George Stewart at Wellsburg, sixteen miles north of Wheeling, W. Va., exploded with terrible violence. The building was badly shattered, and fragments of the boiler were carried to a considerable distance. The building took fire, but the flames were soon extinguished. The loss was $1,500. No one was seriously injured, although several employees made narrow escapes, two men being engaged in packing the engine when the accident occurred.

STEAMER (138).—A fatal accident occurred on the tow-boat Fred Wilson at Vevay Island, above Ghent, Ky., about 1 o'clock, Oct. 4. The boat was coming down with a tow of coal for O'Neil & Co., and John Robson, one of the pilots, was in the wash-room shaving himself when the main steam-pipe, which runs under the wash-house, exploded, filling that part of the boat with hot steam. Robson cut himself badly with the razor as he was thrown headlong among the timbers, and was so badly scalded that he died in two hours.

SAW-MILL (139).—The boiler in Smith's saw-mill, at Longford Mills, Canada, exploded Oct. 7th, killing Ellis, the foreman, and Gray, assistant, literally blowing away their heads; and several others being badly injured. The mill was wrecked. Loss, $15,000.

BOILER WORKS (140).—A terrible boiler explosion occurred Saturday afternoon, Oct. 7th, at the boiler works of Daily & Larkin in Millerstown, Pa. Thomas Lawkins was very severely scalded, and Harry McKevin, who was standing near by, was struck by flying fragments, and severely injured, but not fatally. The boiler was lifted from its location and carried fully fifty yards through the air, when its flight was arrested by striking a tree. The wonder is that there were not more persons hurt, as a number were near at the time.

SAW-MILL (141).—The boiler in the saw-mill of Young & Smith, near Shelbyville, Ind., exploded Oct. 9th, instantly killing George Young, and fatally injuring his partner, Harry Smith. The two proprietors were the only persons within the building at the time.

SAW-MILL (142).—The saw-mill of Stevenson & Dunkan, Petersburg, Ill., was demolished by an explosion of the boiler Oct. 12th. James Stephenson and James Hochimer were killed, and George Watkins and Will Lantier fatally injured.

FLOURING-MILL (143).—The boiler in the Ontario flour-mills, at North Chatham, Ont., exploded Oct. 13th, destroying the engine-house and shattering the main building. James McDonald, the engineer, was killed.

MACHINE SHOP (144).—James Elright, an employe at the Liggett Spring and Axle Company, Beaver avenue, Allegheny, Pa., was badly injured Oct. 14th. Mr. Elright was working at the boilers when a valve blew out, and the escaping steam burned his neck and face in a horrible manner. He was removed to his home in Patterson Row, back of Beaver avenue, and at last accounts was lying in a precarious condition.

FACTORY (145).—A steam-pipe in Tuttle & Whittemore's factory, at Union City, Ct., burst Oct. 17th, and Carpenter, the night engineer, was shockingly burned, and will probably die.

TUG-BOAT (146).—The nigger boiler of the harbor tug De Soto, belonging to Messrs. Brown & Jones, exploded at Memphis, Oct. 26th, killing Jennis Bohlen, a watchman, and a negro named Joe Holman. The tug was only slightly damaged.

TUG-BOAT (147).—The tug Wetzel blew up Oct. 28th, at 7 o'clock A. M., about twelve miles north of Racine, Wis., while racing with the tug Sill for a tow. The Wetzel was completely demolished. F. F. Lovell, the captain and owner; William Kelly of Chicago, the engineer, and Pat White of Racine, fireman, were killed, and so powerful was the explosion that neither of the bodies have been found.

SAW-MILL (148).—Oct. 28th, the boiler of Lawler's portable mill, in Jenks township, Salmon Creek, Pa., exploded, playing havoc with the building and machinery. The mill was recently erected to saw hard wood. The only man in the place at the time of the accident was Owen Sweet the sawyer, who was filing a saw a few feet from the rear of the boiler, for which purpose the mill had been shut down; the boiler being well supplied with water and arranged to blow off at ninety pounds pressure. The rest of the men were in the yards building runways. The sawyer was uninjured, but one man was bruised.

Steamer (149).—John Christopher, a fireman, was scalded to death on the steamer Oceanic Oct. 29th, during her trip from Chicago to Buffalo, by the escape of steam, caused by the shifting of boilers during a heavy sea.

NOVEMBER, 1882.

Iron Works (150).—A boiler in the Forest City iron works, Cleveland, O., exploded with terrible force, Nov. 13. The boiler was eighteen feet long and forty-two inches in diameter. A large part of the roof was torn off and fragments of the boiler were hurled a long distance.

—— Mill (151).—A boiler in a mill near Washingtonville, N. Y., exploded Nov. 13, and the engineer, named Fairbanks, was seriously injured. Pieces of the boiler were thrown in all directions, and one piece struck three Italian laborers employed on the Middletown and Cornwall Branch of the New York, Ontario and Western Railroad. All were badly hurt, and two are not expected to recover. (One afterward died.)

——— (152).—A small horizontal boiler exploded at Bradford, Ont., Nov. 14, while being tested. Two lads, Charles and William Corbin, aged 13 and 15 years respectively, were fatally injured.

Cotton Gin (153).—The boiler of the steam ginning mill owned by A. G. McGehees, twelve miles from Montgomery, Ala., exploded Nov. 15, instantly killing three negro men.

Wood Working Shop (154).—The boiler in Peter Reuhl & Co.'s picture frame factory on Sycamore street, Cincinnati, O., burst Nov. 16, causing a panic among the occupants of the upper stories. The building was set on fire, besides having the floor above the engine blown to pieces and a portion of the wall blown out.

Plantation (155).—Saturday morning, Nov. 18, one of four boilers at Fairwood plantation, parish of Pointe Coupe, La., exploded, and instantly killed Engineer Camille Burgeois, and fatally injured two negro laborers.

Locomotive (156).—A freight train from Augusta ran into an up-passenger train near Union Point, Ga., early Thursday morning, Nov. 30. A moment afterward another up freight train ran into the sleeper of the passenger train. The collisions occurred in a deep cut, and two engines and several freight cars were wrecked. One engine exploded. All the passengers escaped injury. A fireman was the only one hurt.

DECEMBER, 1882.

Paper-Mill (157).—A boiler exploded in Sutphin & Wrenn's paper-mill, Dec. 1, killing instantly Adam Forester, and seriously injuring John Zeller. Two others, John Ross and Con Dillon, received slight injuries.

Steamer (158) —The boiler of the steamer Volusia exploded while lying at the wharf at Jacksonville, Fla., on Saturday, Dec. 2. The vessel was loaded with freight for up the river. The steamer and freight are a total loss. A few persons were slightly injured.

Steamer (159).—The boiler of the propeller Morning Star, plying between New Orleans and Magnolia plantation, exploded Dec. 6, at about 6 in the morning, at Bellair plantation. Of twenty-one persons on board, three were killed, eight drowned, and six badly, if not fatally, scalded. The steamer Sunbeam, near by when the accident occurred, carried the wounded to New Orleans. They were sent to the Hospital. Jack Johnson (white), fireman, and seven colored roustabouts were drowned. The following were killed: Henry Kaiser, Nancy Gardiner (colored), and a child named Joseph Simederin. The badly scalded were: Eugene Pennywith, engineer; James Ryan, boiler-maker; Mary Miller, colored passenger; Frank Holl, William Frantz, employees of the boat.

Later.—Frank Holls of Chattanooga, William Freitus, aged 16 years, and Sarah Young (colored), who were badly scalded by the explosion in the Morning Star and sent to the charity hospital, have since died. Of 21 persons on board at the time of the accident, but five are now living.

Flour-Mill (160).—The boiler of Fox's large flouring mill at Fountain City, Wayne County, Ind., exploded on the 10th of December, demolishing the boiler-house and part of the mill. One man was very badly injured. The damage was about $800.

Distillery (161).—Phelan, foreman of the Bay View distillery, Buffalo, N. Y., examined the condition of the boiler, Dec. 10, which was leaky, and was telling the engineer that he could patch it up, when it exploded. Phelan was so badly injured that he died. Woods, the engineer, and John Cassidy, who was seeking employment, were dangerously hurt. Thibault, the bookkeeper, Henry Niche and Thomas Gosling, distillers, and Mr. Hauter, the teamster, were less seriously injured. The building and machinery were wrecked.

Saw-Mill (162).—A terrible saw-mill explosion occurred at Shawneetown, Ill., on Dec. 11. A boiler in one of A. J. Vincent & Co.'s mills, on the Ohio river, just outside the corporate limits, blew up, killing eight men instantly, and scalding and mangling another so that it was thought he would not recover. The killed were: William Montgomery, sawyer; Henry Hughes (colored), Charles Glass, George Price, William Price, Charles Baker, William Hollder, and Andrew Kanady. The man fatally injured was Wayne Key, the engineer. William Emmerson was also seriously but not dangerously hurt. These names indicate every person on the spot at the time of the accident, and all but one were employees. The mill had been just shut down, and the men were seated about the boiler, eating their luncheon. The boiler was scattered for nearly a mile about. The larger piece took a northerly course, cut through the trees, and struck the earth at a distance of 200 yards, made a bound, struck again 50 yards away, going 70 feet farther before stopping. The dead bodies were picked up in different directions, 200 and 300 yards from the scene. M. B. Hair, of Hair & Ridgeway, this city, had been in the mill but a few minutes before the explosion, but fortunately left in time to escape death. The mill was new, the boiler being valued at $1,000. There was no insurance.

—— Mill (163).—The boiler in Kidwell & Good's mill at Elwood, Ind., exploded on 13th of December, and fatally scalded the engineer, John Thorp. He was the only man in the mill at the time.

Saw-Mill (164).—A boiler in Johnson's saw-mill, three miles from Osage Mission, Kan., blew up, Dec. 13. The proprietor, W. L. Johnson, and Andy Beckwood, were killed; three others seriously wounded.

Locomotive (165).—An engine on the Cumberland and Pennsylvania Railroad blew out the crown-sheet, Dec. 16, terribly scalding the engineer, George Reilly, Frank Carafine, and Henry Miller. The latter two are not expected to recover.

Coal Mine (166).—A terrific explosion of six boilers occurred Dec. 16, at the head house of No. 9 plane, Pennsylvania Coal Company's railroad, and caused much consternation and entailed great damage. Flying debris from the wreck filled the air and fell upon the adjoining buildings, riddling many roofs with large holes. Lewis Marsh, fireman, was in the boiler room attending the fires when the explosion took place, and was deluged with hot water and horribly burned. He was carried to his home near by, where he died in great agony. The force of the explosion was terrible, utterly destroying the boiler house and a portion of the engine room. Half of one boiler was thrown 1,200 feet, and large beams and pieces of masonry hurled great distances. The wire cable used in drawing the heavy trips of loaded coal cars was cut in two, and many window panes broken. The cause of the explosion is not known. The boilers were quite new and made at the company's shops. The accident will cause an entire suspension of all the company's collieries for at least four days.

Agricultural Tool Works (167).—At Canton, Ill.. Dec. 16, two boilers in Parlin & Orendorff's extensive agricultural implement works exploded, demolishing the brick engine-house, a part of the main building, and shattering the more adjacent buildings. A fire broke out immediately, but was soon extinguished. The following were killed: Wm. McCamey, engineer; Louis Hunnicut, fireman; W. C. Henderson, Joshun Oldham, A. Mackerson, Robert McGrath, Wm. Miller, and Hiram Palmer, all American employees. Two others were seriously injured, but will probably recover. Two hundred and fifty workmen are thrown out of employment.

Rolling-Mill (168).—At 2.30 o'clock p. m., Dec. 18, two of the boilers of Globe Mill No. 1, at Front and Park streets, Cincinnati, exploded, and killed two men and wounded nine others. Three boilers lying side by side were used in the mill. The one in the center had become weak from long use, and part of one blew out. The entire boiler, which weighed about four tons, was raised from its place and carried high into the air. It fell on the edge of the river, nearly 400 feet away in a straight line. One end struck a barge of coal, which was sunk. As the boiler passed through the air like a rocket it tore through an elevated tramway used in transporting coal in cars pushed by hand. Thomas Malloy and a young man named Bryan stood upon the tramway, a few feet apart, and it was thought the boiler passed directly between them. They both fell to the ground below, one of them dead, and the other fatally injured. Before striking the tramway the boiler passed through a chimney stack and the roof of the mill. Nine men were injured severely, two of them dangerously, by the falling bricks and timbers. A dozen others received scratches and slight bruises. Had the boiler gone in the opposite direction it is thought that not less than 50 men would have been killed in the mill, and it would have landed among buildings crowded with people. The inspector of boilers says that an original flaw in the iron caused a crack which gradually lengthened, until too weak to withstand even ordinary pressure.

SAW-MILL (169).—The boiler in Silas Mason & Son's saw-mill, in Hartwellville, Vt., exploded Dec. 26, killing one of the owners, Marshall S. Mason, aged 24, and Engineer Fred Williams, aged 30. It is feared that two other men are fatally injured, whose names are not learned. The mill was used as a chair factory, and the boiler has, it is said, been repeatedly condemned by boiler repairers.

SAW-MILL (170).—Dec. 27, the boiler of A. B. Payne's saw-mill, at Black River Falls, Wis., exploded, demolishing the building, killing Thomas Beemer, the engineer, and scalding one of the workmen. A part of the boiler, weighing about two tons, is stated to have been hurled 25 rods, tearing through the roof of a laborer's shanty, and falling through another, directly upon the breakfast table. Mr. and Mrs. Canby were fatally injured, and four others hurt. Consternation reigned throughout the camp.

FLOUR-MILL (171).—The boiler in a flour-mill at Perry, Shiawassee County, Mich., exploded Dec. 28, demolishing the mill and killing the engineer; name not reported.

ELEVATOR (172).—The boiler in Snyder & Son's elevator exploded Dec. 29, fatally scalding the seven-year-old son of Engineer Overton, who was playing in the engine-room.

CLASSIFIED LIST OF BOILER EXPLOSIONS FOR THE YEAR 1882.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total, per class.
Saw mills, and wood-working establishments generally	4	6	5	6	7	4	1	5	3	4	1	4	50
Steamboats, steam tugs, and steam vessels generally	1		3	3	2	2	1	1	5	4		2	24
Iron works, rolling mills, foundries, machine and boiler shops	2	3	3	1				3	1	2	1	2	18
Locomotives	6	1				1	1		3		1	1	14
Portable hoisters, and agricultural engines generally		1				1	2	2	1		2		9
Flour mills, and elevators		1			2					2		3	8
Steam-heating, drying, dwellings, public buildings, ranges, etc	7						1						8
Paper mills, bleaching, digesting, etc	2		2	1			1					1	7
Distilleries, breweries, malt, and sugar houses, soap, and chemical works		2						1				1	4
Mines, oil wells, etc	2		1		2	1	1	2				1	10
Miscellaneous	2	1	2	2	1	2	1	4	1	1	2	1	20
Total per month	26	15	16	13	14	11	9	18	14	13	7	16	172

SUMMARY OF BOILER EXPLOSIONS, AND PERSONS KILLED AND INJURED IN 1882.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Number of explosions	26	15	16	13	14	11	9	18	14	13	7	16	172
Number of persons killed	15	22	27	31	14	18	6	41	18	16	15	48	271
Number of persons injured	36	38	31	34	17	26	34	55	28	8	8	44	369

The Locomotive.

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Dome Connections for Steam Boilers.

There are a variety of opinions among engineers as to the necessity of domes on boilers, and without discussing that question, which has already been discussed in the columns of the Locomotive, we will consider the best method of making the connection between the base of the dome and the shell of the boiler.

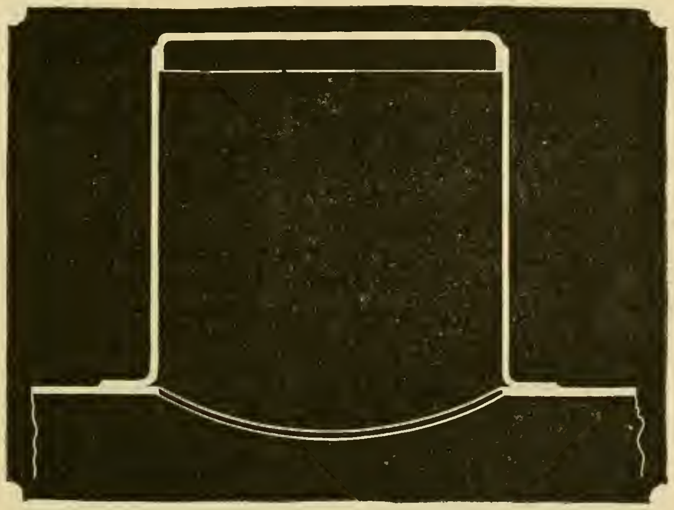


Fig. 1.

The accompanying illustrations show several methods of connection. Fig. 1 shows a very common way of constructing and attaching a dome. In this the base of the dome is simply flanged and riveted to the shell, with either a single or double row of rivets, the opening in the shell being the full size of the dome. This construction cannot be recommended in any case. For, if we examine the strains resulting from steam pressure we shall find that the effect is to separate the sides at the lowest points of the dome, B and C, Fig. 2, and depress the point D. The result of this is to bring a severe strain on the shell and flange at the points B and C, which is usually very manifest in testing a new boiler to about one-third of its calculated bursting pressure. This tendency may be resisted by putting in a stay bolt as shown in Fig. 2, or by other means to be described further on. We do not advise the use of the stay bolt in new boilers, but old ones may sometimes be very much strengthened in this manner.

Fig. 3 shows the construction which should always be adopted when the opening in the shell is the full size of the dome. The domes of locomotive boilers are usually attached in this manner and give little trouble, although subjected to very severe usage.

It will be noticed that the edgewise disposal of the material of the shell, by flanging upward, is admirably calculated to desist the depression of the shell at the point D, Fig. 2.

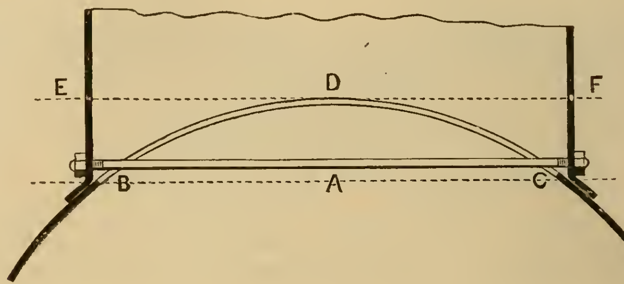


FIG. 2.

The most common form of dome connection is that shown in Fig. 4, by removing the manhole frame, that is, the connection is made exactly as in Fig. 1, but the shell is not cut away to so great an extent. The practice of different boiler makers varies in this particular. Some cut one hole from six to twelve or fifteen inches in diameter, others cut several smaller holes in the shell. This construction, although considerably stronger than that shown in Fig. 1, does not give an increase of strength in direct proportion to the increased amount of iron left in the shell. This arises from the fact that both sides of it are subjected to an equal steam pressure, so that the material of the shell acts mainly as a bent stay between the points B and C, shown in Fig. 2. Still the gain in strength is very considerable, and where the workmanship is good, domes attached in this manner seldom give trouble at proper working pressures.

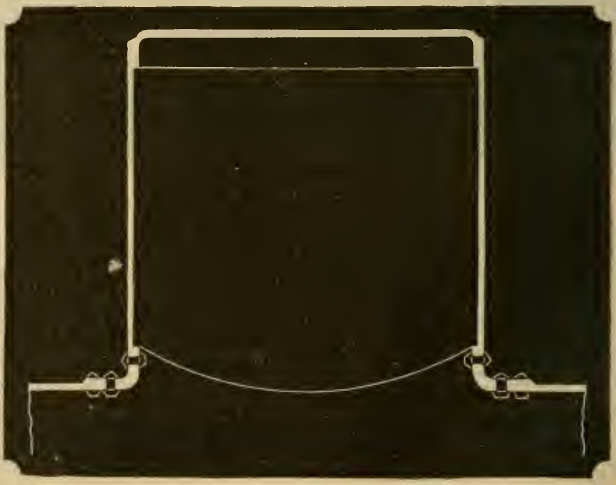


FIG. 3.

A first-rate job may be made of this construction by simply making the opening the size and shape of the ordinary manhole, and riveting the common internal manhole frame to the shell as shown in Fig. 4. This, if rightly proportioned, has sufficient rigidity to prevent any undue depression of the top of the shell, and consequently prevents any severe strains at the points B and C, Fig. 2. It a'so gives an excellent chance to examine the interior of the dome, and make any repairs there which may become necessary, which is an important point and should never be overlooked.

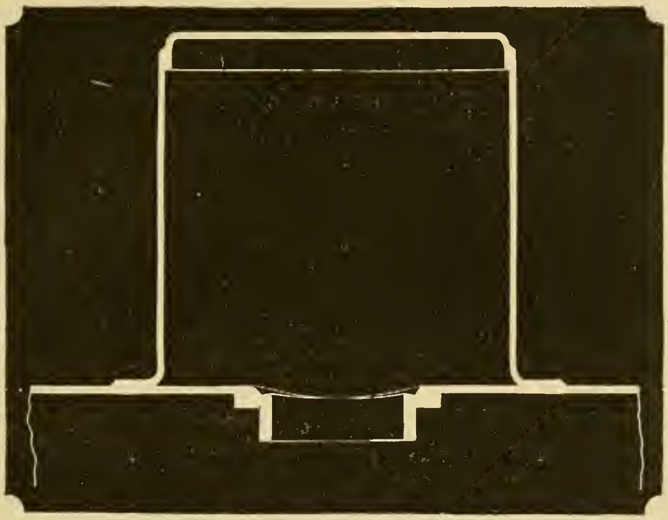


Fig. 4.

The same object may also be attained by the construction shown in Fig. 5. Two bars of ⊥ iron are riveted securely to the outside of the shell as shown. These bars should be made as long as possible, that is, they should extend around the boiler shell

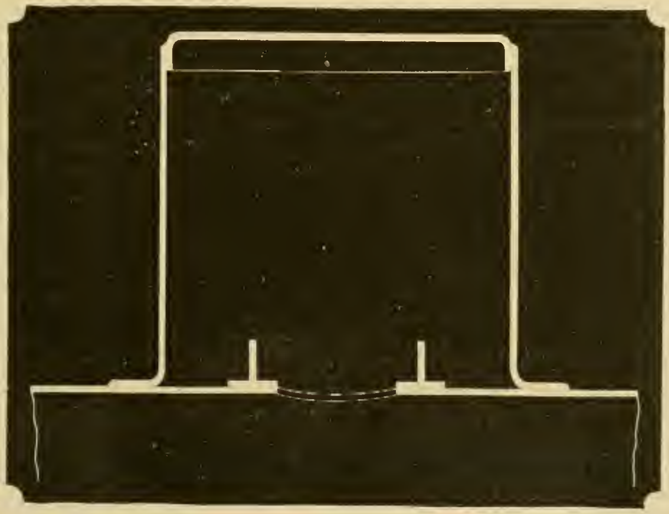


Fig. 5.

until they almost touch the sides of the dome. This stiffens the shell admirably, and while the manhole frame is equally good if not better for a new boiler, the ⊥ irons may more readily be applied to an old boiler which shows distress around the dome.

Of course it will be understood that, as far as strength is concerned, none of foregoing methods of construction are to be considered equal in merit to a dome or drum connected with a *neck* say 12 to 15 inches in diameter. The neck connection should always be adopted wherever practicable. But it is an expensive construction, unless made of cast iron, which cannot be recommended for the purpose, and it should be borne in mind that the size of the opening in the neck should be considerable, else the purpose for which the dome is used may be defeated. In no case should it be so small as to prevent examination of and repairs to the interior of the dome, unless other facilities for that purpose are provided.

We do not recommend putting the manhole into the top of the dome, as is very frequently done. Where a dome is used, the steam-pipe and safety-valve connections should be made to the top of it,—the highest point. Any other opening in it should be carefully avoided. The manhole should always be placed on some other portion of the boiler.

Inspectors' Reports.

January, 1883.

Following is given the record of the work of the Inspectors for the initial month of the year. From it we learn that the total number of visits of inspection made were 2,145, and 4,987 boilers were examined. Of this number 1,975 were examined both externally and internally, and 329 were subjected to hydrostatic pressure. The whole number of defects reported foot up 3,618, of which number 749 we considered to be of so serious a nature as to require immediate attention to insure the safety of the boiler. 57 boilers were condemned.

Appended is the usual tabular view of defects.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	296	32
Cases of incrustation and scale,	374	43
Cases of internal grooving,	14	5
Cases of internal corrosion,	73	13
Cases of external corrosion,	301	53
Broken and loose braces and stays,	72	45
Settings defective,	159	15
Furnaces out of shape,	86	11
Fractured plates,	168	110
Burned plates,	86	60
Blistered plates,	273	28
Defective rivets,	549	46
Defective heads,	48	24
Leakage around tubes,	445	117
Leakage at seams,	288	34
Water gauges defective,	94	11
Blow-out defective,	29	11
Cases of deficiency of water,	16	12
Safety-valves overloaded,	46	28
Safety-valves defective,	33	14
Pressure gauge defective,	165	37
Boilers without pressure gauges,	3	0
Total,	3,618	749

Several months ago we considered what the proper hydrostatic test pressure for new boilers should be, but the periodical application of the test to old boilers in active service was not discussed. Let us now very briefly review the subject. Many high authorities recommend the periodical application of the test to *all* boilers after they are put at work. With certain classes of boilers this is absolutely necessary, for their construction, location, and management will not admit of any other kind of inspection, if the mere application of the test can be called an inspection in any sense of the word. But the proper application of the test pressure, to be of any value whatever, and to *insure no damage* to the boiler, it is necessary that the person making it shall have excellent judgment combined with considerable experience, and no small amount of mechanical skill. These qualities are rarely found except in those who make boiler inspection a profession.

The hydrostatic test should always be applied to new boilers, and to old ones after any considerable repairs have been made. This is the only way by which the staunchness of joints and quality of riveting can be tested while the boiler is in position to allow of any repairs or further work to be done on it which may be necessary. Its value for this purpose cannot be overestimated, but the combined experience of all boiler inspection and insurance associations, both in this country and Europe, shows conclusively that, when a boiler properly designed so that a fairly complete internal and external examination can be made, has once satisfactorily withstood the hydrostatic test, and thus had the quality of its workmanship proved, is put into service, and does its work without showing distress or weakness, the periodical application of the hydrostatic test is wholly unnecessary, proves nothing, and reveals no defects. Of course it goes without saying that the boiler insurance companies are directly interested to a greater extent than any one else can possibly be, in ascertaining and adhering to the method of inspection which is *the most efficient*, and the fact that the above is the ground taken universally by them ought to settle the question beyond the possibility of dispute. Indeed, the application of the test according to the rules laid down by its most eminent advocates, is an absurdity. We are instructed by them to first make a careful internal and external examination to determine the proper working pressure, then apply the test. Now it is evident that if the man who makes the inspection is competent to fix the proper pressure, the test is unnecessary; if he is *not* competent to do so, there is an even chance that he will allow too great a pressure, and the boiler may be subsequently injured by the excessive test pressure which he applies.

The hydrostatic test in itself, gives us no knowledge of the actual strength of a boiler unless we burst the boiler by means of it. It does not reveal the presence of scale, sediment, corrosion, burned and blistered plates, and the thousand and one things that are every day discovered by professional inspectors, who prefer to use their eyes instead of a pump, although the former involves much more hard and disagreeable labor. It may safely be asserted that ninety-nine per cent. of all explosions which occur are due to causes which the hydrostatic test would utterly fail to reveal, while the remaining one per cent. is due to some defect which would be more readily discovered in some other manner.

The fixing of a safe pressure for an old boiler is one of much difficulty sometimes, and can only be done by a man who has had a long experience, and a chance to watch the actual behavior of all kinds of boilers under varying conditions of use. It is something which from its very nature defies any attempt at calculation or to reduce it to a set rule or formula. It is amusing sometimes to see the confidence with which experts, so called, in giving testimony before coroners juries will "figure out" the bursting pressure of a boiler, which perhaps they never saw, which might be in good condition, or might be corroded in places to the thinness of writing paper. All such attempts are sheer nonsense. The proper pressure can be estimated only by a man who has seen thousands of boilers, in every state of dilapidation, who has seen exploded boilers, investigated the causes of their failure, compared the nature and extent of these causes with other similar ones he has met with, and whose progress he may have been watching for years, and who is thus enabled to form an accurate opinion of the strength of any given boiler, whatever the nature or extent of its defects. This being the case, is it possible to suppose that the condition of boilers will be improved, or the safety of those employed in their vicinity will be assured, because some one, who may never have seen the interior of a boiler, has "pumped it up" to some excessive pressure and it "didn't bust?"

But let it not be judged from the foregoing that we are opposed to the proper use of the hydrostatic test. It is only its *abuse* that we object to, and the idea that it is the only way to ascertain the strength of a boiler. We reiterate that it should always be applied to new boilers, old ones extensively repaired, and all those which cannot be examined thoroughly inside and outside.

BOILER EXPLOSIONS.

JANUARY, 1883.

Saw-Mill (1).—The boiler in the saw-mill of H. P. Hollister, three miles northeast of the village of St. Louis, Mich., exploded Jan. 1st, killing S. R. Goodwin and injuring J. Richter severely, and H. Myer slightly. The cause was low water.

Saw-Mill (2).—At about 1 o'clock p. m., Jan. 2d, the flour and saw-mill at Filmore Center, Allegan County, Mich., blew up. Seven men were badly hurt. The son of the proprietor, H. Telman, was injured fatally, dying a few minutes afterward.

Saw-Mill (3).—The boiler in the mill of Nichols & Hesser, near Ada, O., exploded Jan. 3d, killing James Roberts, the fireman, and fatally wounding J. A. Hesser, one of the owners. The boiler was worn out.

Saw-Mill (4).—The two boilers in the mill of the Peninsular Manufacturing Company, North Muskegon, Mich., exploded just after starting up on Thursday afternoon, Jan. 4th. Three men were killed outright, and another died of his injuries the next morning after the accident. Two others were wounded. The names of the killed were John Connors, engineer; Johnny and Freddy Connors, sons of the engineer, aged respectively 14 and 16 years, and John Houck. The two surviving men injured are Silas Blodgett and John Scholes. The cause of the explosion was low water in the boilers. The pumps had become out of order, and Scholes was helping the engineer fix them when the crash came. Scholes was thrown away some distance and alighted in a pile of debris. The establishment was a box and kindling-wood factory, with a saw-mill department.

Sewer-Pipe Works (5).—At 10 o'clock a. m., Jan. 4th, the boiler in McMahon & Carter's sewer-pipe works at Cumberland, West Va., exploded with terrific force, wrecking the building and setting fire to the ruins. John Irnskilley, the engineer, was instantly killed, and John Moneypenny and Riley Grimes were seriously injured. The cause of the explosion is unknown.

Saw-Mill (6).—In Herman & Thatcher's mill, Hickory Township, Forest County, Pa., a boiler exploded, Jan. —, tearing it into ribbons, and using up the engine. Loss, $1,000.

Saw-Mill (7).—One end was blown out of the boiler at Hardie's planing-mill, Marinette, Wis., several days ago. Will Mellen was seriously scalded in the face and in other exposed places, his eyes being affected.—*Lumberman, Jan. 17th.*

Saw-Mill (8).—A saw-mill boiler exploded at Brookhaven, Miss., Jan. 12th, killing a white man and a negro and badly hurting four negroes.

Iron Works (9).—A frightful boiler explosion occurred Jan. 9th, at No. 1 blast furnace of the Bethlehem Iron Company, Bethlehem, Pa., resulting in the death of four men and a woman and in the serious injury of several others. Two boilers, forty inches in diameter, and thirty-six feet in length, exploded, wrecking the interior of the engine-house, and demolishing nearly half of the pattern-shop adjoining. The boiler, thrown through the roof of the old mill, was hurled a distance of 300 feet and fell among about 100 workmen. The damage to the mill machinery was great.

Agricultural Engine (10).—A terrible boiler explosion occurred Jan. 11th, at the residence of Mr. Alfred Gates, a farmer, living three miles and a half from Corry, Pa. The boiler was an upright portable one, ten horse power, and was used for running a hay press, owned by T. S. Heath, of Corry. Just before the explosion one man was standing close by the boiler, another and a little girl not three feet distant, while two more men were a few feet farther away. All at once it shot out from the midst of them into the air, nearly fifty feet, over the top of a large hay barn, landing in the fields two hundred feet away, only blowing out one side of the fire-box; the engine was not damaged much. Moses Weldy, of Corry, received a compound fracture of the right leg; Alfred Gates was badly scalded about the face, neck, and abdomen; the little girl received a slight cut on her neck. The engine and boiler were owned by Lynch & Gilbert, boiler makers, and were new. The boiler had just stood one hundred and eighty pounds cold water pressure. The cause of the explosion is unknown. At the time the gauge indicated forty-five pounds of steam.

Cotton Mill (11).—There was quite a panic at the Perry cotton mill, Perry, R. I., Jan. 15th, caused by the filling of the mill with steam from one of the boilers which, from some cause unknown, burst. None of the operatives were injured, but all reached the street in less than three minutes after the alarm was given. The fireman and engineer were slightly injured.

— Mill (12).—The mud drum of the boiler in Chess' mill blew out Jan. 16th, necessitating the suspension of the works for a day. Fortunately there was no one injured.

Locomotive (13).—An engine on the Mansfield branch of the New Orleans Pacific exploded at the depot at Mansfield, La., Jan. 17th. Engineer Shackleford, Tom Mays, fireman, and Jerry Hardy, brakeman (the two last-named colored), were instantly killed. Mrs. Inglis and Mr. Hanson, the telegraph operator at Marthaville, were mortally wounded. Taylor, the freight agent, and several others were seriously hurt. The body of Tom Mays was blown fifty yards, passing through a plank fence. Scarcely a vestige of the wreck was left on the track. The engine had just blown the whistle to start when the explosion occurred.

Steamer (14).—The steamer Josephine, which left Seattle, W. T., Jan. 17th, for Skoit river, having on board a full freight and twenty passengers, blew up in the afternoon in Port Susan bay, fifty miles north of Seattle. The acting-master, purser, steward, fireman, and several passengers, are reported lost. The explosion occurred while the passengers were at dinner. The crown sheet went straight up through the forward cabin and pilot house, carrying Johnson, the man at the wheel, high into the air, causing his death. Captain Bailey was on deck and was lost; neither he nor Purser Turner were seen after the explosion. The steward and his helper, David Sparks, were instantly killed. A. E. Cannon, a commercial traveler, representing Bates, Reed & Cooley of New York, was killed. Sam Babbitt, a stranger, also killed. Those injured were Dennis Lawler, engineer, Miss Estella Bradish of Lacoma, thigh broken, Hannah Price of Skogid, an old lady, and A. G. Kelley of Skogid, leg broken, and one or two others were slightly hurt. Sixteen persons on board escaped uninjured. The boat broke in two pieces, one sinking and the other floating. The Indians and loggers near by rescued the survivors.

LOCOMOTIVE (15).—The boiler of the engine of the Providence express train on the New York and New England railroad exploded at Norfolk, Mass., Jan. 19th. The engineer was badly scalded. The cab was blown to pieces and the tender seriously damaged. The train was delayed until another engine could be obtained from Boston.

PAPER MILL (16).—A boiler at the Ledger paper mills, Elkton, Md., exploded Jan. 22d, wrecking half of the immense building. John Garrett is missing. Eight others were injured.

FLOUR MILL (17).—The boiler in the flouring mill of J. T. Hodgens, at Portland station, O., on the C. & P. road, exploded Jan. 22d, instantly killing a boy named Lewis, who was firing. The engine-house was wrecked. A portion of the debris was thrown against the railroad station house, doing it some damage.

POTTERY (18).—Aaron Cloward, the engineer at the East Trenton pottery, fell asleep in his engine-room Jan. 27th, neglecting to turn on the safety-valve. A terrific explosion followed, tearing down a two-foot brick wall in which the engine was encased, and burying the engineer beneath nearly a ton weight of bricks. He was alive when extricated, but both his eyes had been blown out and he was frightfully mangled from head to foot.

LOCOMOTIVE (19).—The engine Nescopie, on the Lehigh Valley Railroad, blew up at Mauch Chunk, Pa., Jan. 30th. John Miller, engineer, and Augustus Youngblood, brakeman, of Mauch Chunk, and Lewis Gower and A. Miss, brakeman, were injured, but not seriously. There were five men on the engine at the time, and their escape from death is almost miraculous. The engine, which had been on the road for twenty years, is a complete wreck.

COLLIERY (20).—A boiler at Lincoln Colliery, Pa., operated by Levi Miller & Co., of Pine Grove, exploded with terrific force Jan. 29th. The boiler was hurled about three hundred yards down the side of the mountain. Seven other boilers were displaced, and a complete wreck was made of the boiler-house. George Hummel was severely hurt by flying timbers.

THE TEMPERATURE OF FLAMES.—From the paper of F. Rosetti, in the *Annales de Chimie et de Physique*, we collate that his deductions from experiments with flames emitted by the ordinary gas burner, the Bunsen burner, and the electric light, by means of a thermo-pile and a delicate reflecting galvanometer, gave the following results:

With the temperature of the air at 59° Fahr. the ultimate temperature of the blue flame at the outer edge of surface of a fantail burner was 2,370° Fahr., while that of the interior white flame was 2,100° Fahr. The average temperature of the flame he estabishes at 2,170° Fahr. * * * *

The ultimate temperature of the flame of a Bunsen burner is given at 2,280° Fahr.

The electric light gives as a maximum intensity of heat:

For the positive pole, = 7,050° Fahr.
For the negative pole, = 5,700° Fahr.
For the arc itself, = 8,700° Fahr.

Journal of the Franklin Institute, October, 1880.

The Locomotive.

HARTFORD, MARCH, 1883.

In another column is an editorial from the Cleveland *Leader.* We believe the spirit of the article is correct. Fidelity bonds should not be weakened by being mixed up with all sorts of hazards. We have held from the first that a company could not profitably do a great many kinds of business. Such a company may "skim" around and by cutting rates, succeed in getting in a few premiums, and demoralizing every branch of business that it touches. A company which has been doing this kind of business, and which has been under criticism more than once, is now by order of the court, having its affairs examined.

There may be an apparent success for a time in this method of doing business, but it will in our opinion, in the end, be no credit to its projectors and managers. The great fire and life insurance companies in this country have built up their capitals and fame by confining their business mainly to one line, and the companies that endeavored to do too much have not succeeded. It is profitable, sometimes, to study the causes of the wrecks of many insurance companies which became infatuated with temporary success, and strode on wildly to destruction. If any one can see any additional value in a Fidelity bond that is loaded with a Boiler Insurance Policy, we would like to know where the advantage comes in. It would seem that two more incongruous kinds of business could not be associated together—Fidelity bonds and Boiler Insurance. If the experiment had not been made, we would not suppose that there were men deluded enough to yoke together such entirely dissimilar enterprises. But there will probably always be men, that will believe that Pegasus can be yoked to a common *steer,* and they will try the experiment over and over again.

In the December Locomotive was an item relating to the disasters to shipping in 1881. We clipped it from an English paper that gave credit to *The Nautical Gazette.* We gave the same credit, but find since that *The Nautical Gazette* of New York gathered the statistics and first published them—and we erred in crediting the item to The English *Nautical Gazette.* We are gratified that our attention has been called to this error and that we can make the correction.

Fidelity Insurance.

The following article appeared in the editorial columns of the Cleveland *Leader*, March 13th, also in the Springfield *Republican.*

A bill has been introduced into the Ohio Legislature to amend certain sections of the Revised Statutes of the State of Ohio bearing upon insurance. In this bill is the following section: "A company organized under this chapter may insure and guarantee the fidelity of persons holding places of public or private trusts, make insurance on the health of individuals and against injury, disablement or death resulting from traveling or general accidents by land and water; also accidents to property from causes other than by fire or lightning." The plain interpretation of all this is, that companies insuring against accidents to persons, breakage of plate-glass, explosions of steam boilers, and any other accident except by fire and lightning, may be allowed to hitch on fidelity also. What are fidelity bonds and why are they required? Every business man knows that sureties are required of all persons holding important trusts—the treasurers of large corporations, bank cashiers, and other bank employes, executors, and administrators of estates, persons holding trust funds, and numerous other callings where a guaranty for honesty and faithfulness is required. The properties of widows and minor children and orphans are very generally held in trust, at least for a time, and it matters little how good the reputation of the trustee may be or how high his standing, the court requires him to give a satisfactory bond with approved sureties to protect the interests of those whose property is in his hands and keeping. It will be seen by the above that a bond should be of such a character that no reasonable doubt could be entertained of its absolute safety. Guaranty companies have been organized in England and in Canada for the purpose of guaranteeing the fidelity of persons holding positions of trust. These companies have confined their business solely to this branch. Their entire assets are devoted to it and they have no liabilities except such as grow out of this one business. These companies have grown in public favor, and there seems to be a wide field for such operations, for many persons who are required to furnish bonds with suitable sureties would rather pay a reasonable premium to a guaranty company than to ask a friend to become surety on their bond. But when bonds of this character are required by railroads, banks, savings banks, trust companies, probate courts, and other numerous and important trusts that are placed in the hands of individuals, it is of the utmost importance that they be of undoubted safety.

Under the proposed law in Ohio this important business is to be mixed up with and jeoparded by the hazards incident to the casualty business. For instance, a company may guarantee the fidelity of bank and railroad officials and persons holding important trusts, executors, administrators, etc., and at the same time have its assets jeoparded by accident insurance, plate-glass insurance, boiler insurance, and other casualties to which property may be liable save from fire and lightning. Is this the quality of security which Ohio desires to provide for those having important moneyed interests in its banks, savings banks, and other large corporations, not forgetting the interests of widows and orphans? It hardly seems possible that intelligent legislators would for one moment entertain such a proposition. Suppose Frederick S. Winston, President of the Mutual Life Insurance Company of New York, should apply to the Legislature of that State for permission to allow the Mutual Life Insurance Company to add to its present business that of casualty insurance, and with such permission should proceed to insure plate-glass property against damage by floods and boiler explosions, would the value of a life policy in that foremost of life insurance companies be enhanced thereby? Would not every holder of a life policy cry out against such reckless and wildcat business? And yet the bonds required of executors and administrators, and of all persons holding important trusts, are just as sacred as life insurance policies and should not be jeoparded by the hazards of a casualty business. It should be understood that the premiums collected in the fidelity department, as well as in the other departments, go into one pool, from which the losses of all departments must be met; hence it could not be said with truth, our entire assets are so and so, and our liabilities under the fidelity department are so much, because the entire assets represent the combined branches of business, while the liabilities so stated are for one branch only. There would be a grand opportunity here for deception, and many who were not up in the tricks of the trade would doubtless be trapped by an over-persuasive and plausible agent. It is high time that legislation of this character should be discouraged. It has been tried in other States but without success, and it is to be hoped that Ohio will not open the gates for speculations of this character.

Straightening a Tall Chimney.

We have received the following details in regard to the rectification of the chimney of the Lawrence Manufacturing Co. at Lowell, Mass., which we noticed in our January issue, for which we are indebted to the courtesy of Mr. E. W. Thomas, Superintendent of the Tremont and Suffolk Mills at Lowell.

The total height of chimney above the ground is 220 feet. The form of the stack is octagonal; distance between sides at bottom, 16 feet; near top, under projection, about 12 feet. Foundation laid in concrete on hard pan. The flue is circular and 8 feet in diameter.

The chimney was finished and the cap on, but the staging had not been removed, when it was noticed that the stack had a gradual curve, beginning at a point a little below the center, so that at the top it was about twelve inches out of plumb. The inclination was almost due east. It kept moving gradually until checked by guys which were attached to it. The joints on the convex side of the shell were then sawed at every header, or about seven courses, with a common hand saw, and at the same time iron wedges, about twelve inches long, two inches wide, and one-half inch thick, were driven in on the opposite side, and both man and horse power applied to the guy ropes, until the chimney was brought back to a vertical position. The wedges were left in the chimney permanently, and the guys were left on about three months, or until a casing sixteen inches thick had been built around the stack to a height of about eighty-one feet.

Opinions differ as to the cause of the leaning. Some attributed it to the fact that the same mason was kept at the same corner all the way up; others say it was because continuous easterly rains prevailed during the time it was building, so that the mortar dried faster on one side than it did on the other. All, however, were agreed that the ultimate cause affected the mortar joints and not the foundation, as the foundation was good and could not have settled without showing a different effect. The chimney was built in the fall of 1872.

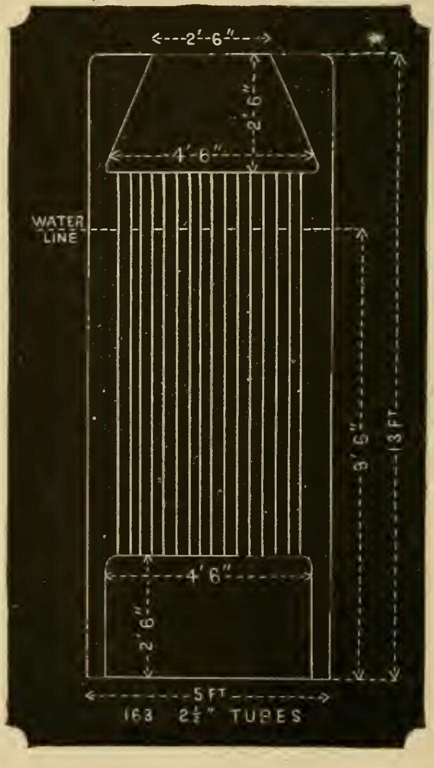
Upright vs. Horizontal Tubular Boliers.

We cheerfully give a place to the following article, believing that the figures given and comparisons made will prove of interest to our readers, and profit to those who think they must have an upright boiler for many purposes where a horizontal tubular could be used to much better advantage. The writer, however, errs in supposing that the boiler illustrated in the December Locomotive was compared with the tubular to the disadvantage of the latter. No comparison whatever was made between them. It was merely given as the proper construction when the upright boiler *must* be used. The horizontal tubular boiler is far superior, both in economy and capacity, to the upright one illustrated.—Ed. Locomotive.

Editor of The Locomotive:

My experience with upright boilers of the type illustrated in the December Locomotive has not been favorable to them. The following from my note book is a case in point:

Two plants of machinery consisting of a number of machines all alike were to be supplied with power. The plants differed only in the number of machines. The engines furnishing the power were substantially the same in economy, and hence the number of machines at work became an exact measure of the steam consumed. One plant was supplied with steam by a pair of horizontal tubular boilers, having shells five feet in diameter by fifteen feet long, set in brick in the usual manner. For the second plant, twelve vertical tubular boilers were furnished of the pattern and dimensions shown in the following sketch:



The first plant consisted of seventeen machines, and for them the two horizontal boilers furnished steam without the slightest difficulty from foaming, though the fires had to be sharply urged owing to the presence of scale mentioned later. At the time these observations were made eight boilers were supplying steam for twelve machines, but only with the very greatest difficulty from foaming. Salt water was used in both cases, but that supplied the vertical boilers was probably somewhat worse than that for the horizontals. With the latter, scale was formed in large quantities, but with the former, between constant foaming at the top and blowing down at the bottom, no scale had formed. Subsequently the feed for the verticals was improved, and this, together with the use of "boiler compounds" and acquired experience, enabled the performance to be gradually raised until the whole battery of twelve boilers drove fifty machines. This was their utmost capacity. With good water, the greatest fair capacity of the boilers may be taken at three machines each. With the same conditions the horizontals would easily have driven nine each. In other words, the vertical boilers, with shells 87 per cent. as large as the horizontals, had only ⅓ the capacity. The reason is easily seen. The internal furnace and up-take rob the boiler of steam room, and the up-right shell contracts the disengaging surface of the water. Following are some figures on these points:

Volume of shell, - - - - - - -	255 cubic feet.
Actual capacity of boiler, - - - - - -	149 " "
Volume of water room, - - - - - -	108 " "
Volume of steam room, - - - - - -	41 " "
Disengaging surface, - - - - - - -	14 square feet.

Were the same shell made into a horizontal tubular boiler without dome, and with say sixty-three and one-half inch tubes (which would give substantially the same heating surface), and with the water line two feet below crown of shell, these figures would be as follows:

Volume of shell, - - - - - - -	255 cubic feet.
Actual capacity of boiler, - - - - - -	203 " "
Volume of water room, - - - - - -	108 " "
Volume of steam room, - - - - - -	95 " "
Disengaging surface, - - - - - - -	64 square feet.

These figures speak for themselves. In practice the water would be carried higher than this, but on the other hand a dome would usually be added, and the increased capacity divided between water room and steam room.

Neither of these patterns of boilers were of my design, my experience with them being confined to their use.

Frederick A. Halsey.

New York, January 31, 1883.

An old farmer was in town last week looking for an editor's table, on which to build a hen's nest. He explained that he had learned from the papers that the biggest eggs were always laid on the editor's table, and he wished to ascertain whether the papers lied or not.

A humane man grabbed a club, jumped in and killed a goat that was chasing a man who carried a red handkerchief in his coat-tail pocket down the street, and the man came back and asked him why he did it. "To save you," replied the humane man. "Save me be hanged!" cried the other. "I've just bought that goat and was coaxing him home."

A man was carrying a coon he had caught when he met three little boys in the road. All of them said, excitedly: "Mister, give me that coon, give me that coon, give me that coon, Mister?" "Well, boys, I'll tell you what I will do. If you will tell me the party you belong to and why, I'll give it to the boy who gives the best reason for his faith." "I'm a Republican, because that party saved the Union," said one. "I'm a Greenbacker, because that party is in favor of plenty of money." When the time of the third boy came, he said: "I'm a Democrat, 'case I want the coon."

The Quality of Nonsense.

Editor of THE LOCOMOTIVE:

"The quality of mercy is not strained," but I think the brains of some would-be authorities on steam must be very badly strained in the production of such utter nonsense as they give us sometimes. In proof whereof, witness the following from the editorial columns of one of your contemporaries. In referring to the comparative merits of the hydrostatic and hammer tests (it seems to have no sort of an idea which is best), it says:

"Why not first have a careful hammer test and then a hydrostatic test, using hot water in the boiler instead of cold water now ordinarily used? The manner of accomplishing this would be very simple. The hammer test having revealed the fact to the mind of the inspector that the boiler can safely stand a certain working steam pressure, pump water into the boiler to a proper high level, get up steam in the boiler to a pressure, say $\frac{1}{2}$ or $\frac{3}{4}$ of that which the hammer test would indicate to be a safe working pressure. Then open the safety-valve and let the steam blow off, *leaving the water in the boiler at the temperature of steam in the boiler previous to such blowing off of steam.* Then pump in cold water, etc. * * * * The above appears to *us* a feasible plan in all cases and one which seems to be subject to no practical objections."

Shades of the immortal Regnault, that your labors should bear no better fruit than this! It is not only wonderful, but it is shameful, that in the United States, in the 19th century, there are schools of technology sending out graduates in such a state of mind as the writer of the above must be in. And the worst of it is, such men think they know it all, when the fact is they have not begun to learn. They generally manage to get into print, some way or other, and thus are enabled to disseminate views which among the ignorant and unpractical classes sometimes work much harm. The writer of the article quoted from shows what Artemus Ward would call his "dense and loathsum ignorance," first, when he recommends pumping cold water into a boiler already partially filled with hot water, a few repetitions of which would inevitably ruin the boiler (he does not tell us what he would do with his fire in the meantime), and second, when he proposes to blow off the steam and leave the water in the boiler at the temperature due to the pressure he had on before blowing off. An ordinary mortal would suppose that when he opens his safety-valve, and allows the steam pressure to fall to that of the atmosphere, the temperature of the water will also invariably fall to 212 degrees, "only this and nothing more." Yours truly, H. F. S.

A Dangerous Explosive.

Chief Inspector Getchell of Cleveland, Ohio, sends us the following clipping:

"William H. Brothwell of Torrington, shut a sealed can of baked beans in his kitchen oven, and in a few minutes they exploded, tearing off the stove door."

Mr. Getchell says: "Now if beans are explosive, I think we shall have to watch engineers, and see that they do not use them to clean scale out of boilers, as they use almost everything else; wheat, rye, oats, and other cereals too numerous to mention."

We are reluctant to discuss the explosive character of beans for obvious reasons, but suggest it as a fruitful subject for investigation by the persons who are imbued with the "gas theory." It will fit in well with some of their views, and we advise them to "catch on" before some "other fellow" gets a controlling interest in the theory. It just occurs to us that possibly Wiggin may have been under the influence of beans when he predicted the great *winds* and storms for March.

The Past Year in the Patent-Office.

The annual report of the Commissioner of Patents for the year ending December 31, 1882, shows that the balance in the treasury on account of the Patent Fund was increased during the year from $1,880,119.32 to $2,205,471.10. The business done was largely in excess of that of the previous year, and more than double that of 1866, as shown by the fees received and the number of patents issued, evidence enough of the rapid development of the service.

The total number of applications relating to patents was 31,522; of these, 30,270 were for inventions, 948 for designs, and 304 for reissues. The number of caveats filed was 2,553; applications for registration of trade marks, 796; labels, 532; disclaimers filed, 20; appeals, 691; making in all 367,114 occasions for investigation and action. The number of patents granted and certificates issued was 20,518. 6,099 patents expired during the year, and 1,791 were withheld for non-payment of final fee.

New York led in the number of patents received (3,779), and was followed at a long distance by Pennsylvania and Massachusetts, close together (1,843 and 1,815), and by Ohio and Illinois, also close together (1,466 and 1,422). New Jersey took out 835 patents, Connecticut 794, Michigan 637, Indiana 613, California 486, and Missouri 485. Wisconsin took 356, Iowa 348, Rhode Island 382, Maryland 372, and the rest smaller numbers. New Mexico took 8, the army and Arizona 7 each, Idaho and Wyoming 4 each, and the Indian Territory brings up the rear with 3. Connecticut led in the ratio of patents to population (1 to 782), and was closely followed by Rhode Island (1 to 980) and Massachusetts (1 to 982). Excluding the District of Columbia, which is not representative, New York ranks next with one patent to 1,345 people, and New Jersey next with 1 to 1,354.

Eleven hundred and thirty-five patents were issued to foreign inventors, England taking the lion's share, 399; Canada took 228; Germany 219, and France 129. Switzerland is credited with 35, Austria with 32, Italy with 20, Belgium with 11, Denmark, Sweden, and Russia, with 10 each. The remaining few were widely scattered.

The Commissioner renews the annual appeal for more help, more room, and more money—needs which are plainly obvious everywhere except in Congress. The urgent necessity of carrying on the suspended work of making a classified abridgement of patents already issued is again insisted upon. In view of the fact that accumulated funds of the office already exceed two million dollars, there can be no reasonable excuse for depriving the office and the inventive public of the benefits of the much needed digest.—*Scientific American.*

Oddest of all methods of self-defense is that of snapping off the tail. The blind-worm or slow worm is a little snake-like lizard, common in the old world. When alarmed it contracts its muscles in such a manner and degree as to break its tail off at a considerable distance from the end. But how can this aid it? The detached tail then dances about very lively, holding the attention of the offender, while the lizard himself slinks away. And for a considerable time the tail retains its capacity of twisting and jumping every time it is struck. The lizard will then grow another tail, so as to be prepared for another adventure. There are other lizards which have a similar power, though in a less degree.—*Popular Science Monthly.*

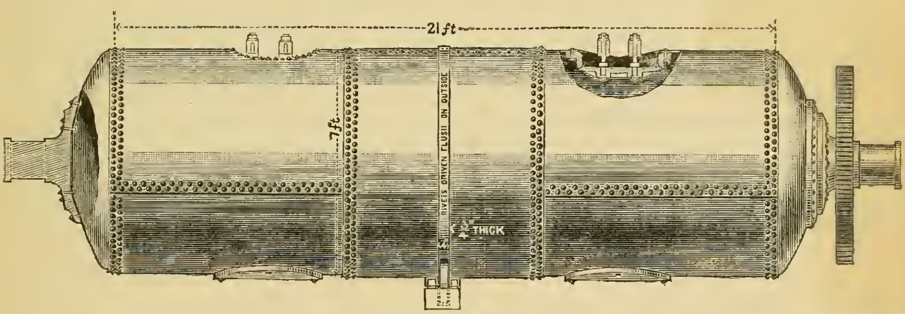
The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY

NEW SERIES—VOL. IV. HARTFORD, CONN., APRIL, 1883. No. 4

Proper Construction of Rotary Digesters.

That the use of rotary digesters, as they are ordinarily constructed, is attended with more than ordinary risk, will, we think, be admitted when the great number of explosions (in proportion to the number in use as compared with steam boilers) of this class of steam vessels is considered. As there is generally no fire in contact with the shell or any other part of these digesters, the contents being heated simply by means of steam from an ordinary boiler, all burning or blistering of plates resulting from deposition of scale or sediment is obviated, all low water, or superheated water, or repulsion of water theories must necessarily fail to apply, as the conditions under which they work preclude any possibility of their occurrence, and we are thus driven to seek a cause for their explosions in either the management or construction of the digesters themselves. For good and sufficient causes we have not far to seek.



SIDE ELEVATION

These digesters are now generally made about seven feet in diameter and twenty-one feet long, with journals about two feet beyond the end of the shell, or say twenty-five feet between bearings. Now a shell twenty-one feet long by seven feet in diameter made of iron one-half inch thick will weigh, with its attachments, about 14,000 pounds, and the charge of stock and alkali which is put into a digester of this size, will probably weigh 18,000 pounds more. This makes a total of about 32,000 pounds carried on two bearings twenty-five feet apart. When we consider, also, that in consequence of the rotary motion of the digester, the strains resulting from this great load are constantly changing in amount and direction, it will be seen that the structure is subjected to peculiarly trying conditions. In addition to this we must also recollect that the steam pressure which is carried in these vessels is sometimes as high as 120 pounds per square inch.

It would not be considered prudent to construct an ordinary steam boiler of these dimensions and give it but two supports, yet these digesters, which are subjected to much severer conditions of working, are invariably given but two, and these are about two feet beyond the ends of the shell. In our opinion this is not only a dangerous practice, but it is wholly unnecessary.

The accompanying cuts are submitted to show an efficient and comparatively inexpensive method of relieving the shell of a portion of the severe strain brought upon it by the great weight, high steam pressure, and severe conditions of use. It consists simply of a bearing in the center of the shell. A strong wrought-iron ring or band is riveted to the shell at the center of its length. This ring should be so attached that it shall run at least approximately true as the digester rotates in its bearings. This is very easily accomplished by putting distance pieces between the ring and the shell of the digester, the thickness of which can be varied to overcome the inequalities in the form of the shell. One of these distance pieces should be used for each rivet in the ring, the rivet passing through ring, distance piece, and shell, with the holes in the ring counter-sunk and rivets driven "flush" on the outside so as to offer no resistance to the rolls which form the bearing. The ring may be from 4 to 6 inches in width, and from $\frac{3}{4}$ to 1 inch in thickness, as may be found to be necessary.

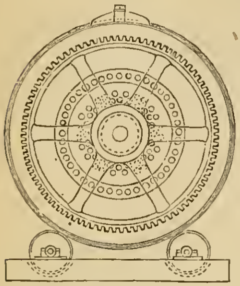


FIG. 2.

The remaining details require little or no explanation. The rolls may be from 16 to 20 inches in diameter, with 3 to 4 inches face, the bearings, simple boxes such as are ordinarily used for wall boxes for line shafts and other purposes. If the maker of the digester enjoys a reputation for excellent workmanship, these boxes may be simply bolted to any convenient support for them, as a brick pier or well supported beam, otherwise it will probably be found advisable to bolt them to a stiff beam which shall in its turn rest upon stiff springs, such as a volute or a rubber car spring, so that any imperfections of workmanship may be compensated for. We believe the application of this center support will not only relieve many severely taxed digesters, but may be the means of averting terrible disasters. We do not claim that this plan for center supports is original with us. It has been used before, and in some cases abandoned, but where abandoned, so far as we can learn, there was no band or ring for the small wheels to run on. The rough exterior of the boiler, with its lap-joints, offered serious obstacles to the smooth running of the wheels. This difficulty is obviated by the plan explained above.

Inspectors' Reports.

FEBRUARY, 1883.

Below is given the usual monthly statement of the work of the inspectors of the company. From it we learn that there were made 2,148 visits of inspection by the different inspectors, during which 4,329 boilers were examined. Of this number, 1,096 were thoroughly examined, both internally and externally, and 281 were subjected to the hydrostatic test, most of the latter being new boilers. The whole number of defects reported foots up 2,362, of which 491 were thought to be of a dangerous character. 50 boilers were condemned.

Appended is the usual tabular summary of defects.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	216	24
Cases of incrustation and scale,	283	31
Cases of internal grooving,	16	12
Cases of internal corrosion,	58	11
Cases of external corrosion,	170	22

Nature of Defects.	Whole number.	Dangerous.
Broken and loose braces and stays,	26	11
Defective settings,	140	17
Furnaces out of shape,	48	13
Fractured plates,	77	37
Burned plates,	62	23
Blistered plates,	178	49
Cases of defective riveting,	293	43
Defective heads,	25	11
Leaky tubes,	282	41
Leaky seams,	158	12
Water gauges defective,	111	33
Blow-out defective,	23	6
Cases of deficiency of water,	9	7
Safety-valves overloaded,	34	22
Safety-valves defective in construction,	27	13
Pressure gauges defective,	122	51
Boilers without pressure gauges,	4	2
Total,	2,362	491

Strange as it may appear to intelligent men who have thoroughly examined the matter, there are still to be found plenty of boiler-makers who persist in putting feed-pipes into boilers in such a manner that cold feed-water will be discharged directly against the hot plates of the shell. This is all wrong, and it would seem that a man who had any regard for his reputation as a mechanic, would pursue a different course, but such is not the fact in all cases.

The effect of discharging cold feed-water directly upon the highly heated plates of a boiler-shell is to produce very severe local contraction, which none but the very best boiler plate can stand for any length of time. Hundreds of good boilers have been ruined solely from this cause, which common sense should teach a man to avoid, to say nothing of the teachings of experience. Regarding this practice, we cannot do better than to give a few extracts from Mr. Robert Wilson's Treatise on Steam Boilers. Mr. Wilson says:

"In externally fired boilers the usual plan is to carry the feed-pipe from the crown down to within a few inches of the boiler bottom, which receives the impact of the cold water. The natural tendency of this mode of delivery is to lower the temperature of the plates in the vicinity of the feed-pipe orifice every time the water enters, thus increasing unnecessarily the wear and tear of the boiler. When the feed is not heated, and the plates on to which it is delivered are exposed to a high temperature, this practice is simply dangerous, and is one of the most frequent causes of transverse seam rips. Even with feed-water at a high temperature, say 250°, the difference between this and the temperature of the plates may still be very great."

As good an arrangement of feed-pipes for the ordinary horizontal boiler as can be desired, is the following. Enter the pipe through the front head toward one side of the boiler and about 3″ above the tubes, extend it along to within about 18″ of the back head, carry it across to the other side of the boiler, and then turn the end downward. By this means, all feed-valves are at the front end of the boiler where they are readily accessible, and the feed-water, whether hot or cold, has time to acquire a high temperature before it is discharged from the pipe or can come in contact with the shell plates.

BOILER EXPLOSIONS.

The two following explosions which occurred in January, came to our notice too late for insertion in the March Locomotive.

Sawmill (21.)—The boiler in John H. Bates' saw-mill at Vassar, Mich., burst January 2d, destroying the mill and injuring two workmen. The mill was running at the time, and all the workmen escaped injury except two.

Sawmill (22.)—The boiler in Waugh's stave factory at Bismark station on the Canada Southern railway, exploded January 8th, shattering the mill and frightfully scalding the night watchman, besides injuring nine others more or less.

FEBRUARY, 1883.

——— (23.)—At Easton, Pa., the Catasaqua Manufacturing Company's works were much damaged by the explosion of a boiler, February 6th.

Colliery (24.)—By an explosion in the Logan colliery at Pottsville, Pa., February 7th, several Polish miners were badly injured, some of them fatally.

Colliery (25.)—A stationary boiler belonging to the Lehigh Valley Railroad Company, Lost Creek, Pa., exploded February 7th. Barney Hellenthal was killed. The building was demolished.

Colliery (26.)—The boiler in the Shepard coal mine, about three miles west of Boone, Ia., exploded February 7th, instantly killing the engineer, George Fleming of Boone, and fatally injuring another man.

Tile Factory (27.)—A fatal boiler explosion occurred February 9th, in P. New's tile factory, at Taylorville, Ill., a few miles from St. Louis. The explosion wrecked the building completely, scattering timbers and machinery hundreds of yards around, and shaking the whole city. Five men—P. New, proprietor, John Jones, engineer; Samuel Lenan, John McCollom, and William Dishel, employees—were killed instantly, and Henry New, a young nephew of the proprietor, and Landy Vandeveer were so badly injured by steam that they died during the day.

Sawmill (28.)—The saw mill of B. J. Grier, at Charlotte, Eaton county, Mich., blew up February 9th, instantly killing the proprietor and William Gordon, the engineer.

Sawmill (29.)—The boiler of E. E. Stone's portable saw-mill at Spencer, Mass., blew up February 4th. No one injured.

Sawmill (30.)—The boiler of a portable saw-mill on the farm of P. E. Studebaker, South Bend, Ind., burst February 21st. Leander Snyder, an off-bearer, was hurled among some refuse lumber, and a splinter was thrust through one eye into the brain. He died in a few hours. Albert Cordray and Joseph Wells were also injured.

Brewery (31.)—A boiler in Banholzer's brewery, St. Paul, Minn., exploded February 23d, wounding eleven persons. Among them were five women, who were after malt. The loss is between $15,000 and $20,000.

Portable (32.)—The boiler of a hoisting engine on Phillips & Conner's coal wharf, South Boston, exploded February 23d, instantly killing Joseph Gookin, a stevedore, and very seriously injuring two others, James Gorman and Charles Hurley, who were taken to the city hospital. The extent of their injuries is not known.

Locomotive (33.)—An engine on the Northwestern road exploded at Harvard Junction, Ill., February 26th, killing two men.

Sawmill (34.)—James Chamberlain, and W. C. Wescot were instantly killed at Drifton, Pa., February 26th, by a boiler explosion in a saw-mill. Two of the employees were seriously injured, and little hope is entertained of their recovery. A little daughter of Mr. Chamberlain narrowly escaped death.

The Locomotive.

HARTFORD, APRIL, 1883.

In these days of sudden changes in temperature, it is important that every man should look well after his physical condition. A cold is generally regarded as of little importance, and is frequently neglected until it terminates in some alarming disease. Men of strong constitution very often think that they can keep down and work off any slight indisposition. But how many cases come before our minds of men vigorous and strong being suddenly stricken down and carried off in a few days. In a great many cases these results are due to a want of proper attention in the first stages of the trouble. When a cold is first noticed, give it attention at once. Don't wait to see how you feel to-morrow, but set about it at once and get the mastery of it. While we have the fullest confidence in doctors of skill and experience, we have no little faith in old-fashioned remedies in the first stages of a cold. Put the feet into hot water, drink copiously of hot teas—sage tea is one of the best, and this herb should be in the house of every family,—go to bed, and put a rubber bag of hot water by your side, and get up a free and copious perspiration. Don't be afraid of homely herb drinks. They are better and safer than "hot whiskies. Boneset or thoroughwort makes a most excellent drink when one has a cold. No man, especially if he has others dependent upon him, has any right to neglect the warnings of nature as indicated by a cold. A man may be surrounded by a happy family; the income from his labor enables him to give them all the comforts and many of the luxuries of life. That little family is dependent on him for their comfort and happiness. Now if from neglect of a cold he presently finds himself in the close grip of pneumonia, what anxious faces stand around his sick bed. Every symptom is watched with the greatest solicitude, for with the outgoing breath of the father come in the sad realities of an experience that soon learns to know what the cold charities of the world are. It is then the duty of every man to be watchful of first symptoms, and if possible overcome them, for the sake of the family that depends upon him and lives in kindness of his heart and the sunshine of his smiles.

Twenty years with the Indicator, is the title of a new work by Thos. Pray, Jr., Managing Editor of *Cotton, Wool, and Iron*. This work is filled with practical illustrations of the value of the indicator to steam users. We have not space for as extended a notice of the work as we would like to give, but all persons interested in the Steam Engine Indicator should secure a copy. Mr. Pray is a man of remarkable versatility. In addition to his labors on his paper, he takes up the Indicator, microscopy, investigation into and study of cotton fiber, and the photography of microscopic objects. We hope and expect that he will some day give us the results of his investigations in these latter fields.

The Cunningham Iron Works have placed in this office a very fine specimen of machine riveting. The work was done on a machine in their works at Charlestown, Mass., and is used by them.

We give our readers this month a table of squares, cubes, square roots, and cube roots of all numbers from 1 to 1,000. It has been compared with the tables in *Trautwine*, *Haswell*, and *Clark's Manual*, and we believe it to be absolutely correct.

Table of Squares, Cubes, and Square and Cube Roots, of all Numbers from 1 to 1,000.

No.	Square.	Cube.	Square Root.	Cube Root.	No.	Square.	Cube.	Square Root.	Cube Root.
1	1	1	1.	1.	79	6241	493039	8.8882	4.2908
2	4	8	1.4142	1.2599	80	6400	512000	8.9443	4.3089
3	9	27	1.7321	1.4422	81	6561	531441	9.	4.3267
4	16	64	2.	1.5874	82	6724	551368	9.0554	4.3445
5	25	125	2.2361	1.7100	83	6889	571787	9.1104	4.3621
6	36	216	2.4495	1.8171	84	7056	592704	9.1652	4.3795
7	49	343	2.6458	1.9129	85	7225	614125	9.2195	4.3968
8	64	512	2.8284	2.	86	7396	636056	9.2736	4.4140
9	81	729	3.	2.0801	87	7569	658503	9.3274	4.4310
10	100	1000	3.1623	2 1544	88	7744	681472	9.3808	4.4480
11	121	1331	3.3166	2.2240	89	7921	704969	9.4340	4.4647
12	144	1728	3.4641	2.2894	90	8100	729000	9.4868	4.4814
13	169	2197	3.6056	2.3513	91	8281	753571	9.5394	4.4979
14	196	2744	3.7417	2.4101	92	8464	778688	9.5917	4.5144
15	225	3375	3.8730	2.4662	93	8649	804357	9.6437	4.5307
16	256	4096	4.	2.5198	94	8836	830584	9.6954	4.5468
17	289	4913	4.1231	2.5713	95	9025	857375	9.7468	4.5629
18	324	5832	4.2426	2.6207	96	9216	884736	9.7980	4.5789
19	361	6859	4.3589	2.6684	97	9409	912673	9.8489	4.5947
20	400	8000	4 4721	2.7144	98	9604	941192	9.8995	4.6104
21	441	9261	4 5826	2.7589	99	9801	970299	9.9499	4.6261
22	484	10648	4 6904	2.8020	100	10000	1000000	10.	4.6416
23	529	12167	4.7958	2.8439	101	10201	1030301	10.0499	4.6570
24	576	13824	4.8990	2.8845	102	10404	1061208	10.0995	4.6723
25	625	15625	5.	2.9240	103	10609	1092727	10.1489	4.6875
26	676	17576	5.0990	2.9625	104	10816	1124864	10.1980	4.7027
27	729	19683	5.1962	3.	105	11025	1157625	10.2470	4.7177
28	784	21952	5.2915	3.0366	106	11236	1191016	10.2956	4.7326
29	841	24389	5 3852	3 0723	107	11449	1225043	10.3441	4.7475
30	900	27000	5.4772	3.1072	108	11664	12 9712	10.3923	4.7622
31	961	29791	5.5678	3.1414	109	11881	1295029	10.4403	4.7769
32	1024	32768	5.6569	3.1748	110	12100	1331000	10.4881	4.7914
33	1089	35937	5.7446	3.2075	111	12321	1367631	10.5357	4.8059
34	1156	39304	5.8310	3.2396	112	12544	1404928	10.5830	4.8203
35	1225	42875	5.9161	3.2711	113	12769	1442897	10.6301	4.8346
36	1296	46656	6.	3.3019	114	12996	1481544	10.6771	4.8488
37	1369	50653	6.0828	3.3322	115	13225	1520875	10 7238	4.8629
38	1444	54872	6.1644	3.3620	116	13456	1560896	10.7703	4.8770
39	1521	59319	6.2450	3.3912	117	13689	1601613	10 8167	4.8910
40	1600	64000	6.3246	3.4200	118	13924	1643032	10.8628	4.9049
41	1681	68921	6.4031	3.4482	119	14161	1685159	10.9087	4.9187
42	1764	74088	6.4807	3.4760	120	14400	1728000	10.9545	4.9324
43	1849	79507	6 5574	3.5034	121	14641	1771561	11.	4.9461
44	1936	85184	6 6332	3.5303	122	14884	1815848	11.0454	4.9597
45	2025	91125	6.7082	3.5569	123	15129	1860867	11.0905	4.9732
46	2116	97336	6.7823	3.5830	124	15376	1906624	11.1355	4.9866
47	2209	103823	6.8557	3.6088	125	15625	1953125	11.1803	5.
48	2304	110592	6.9282	3.6342	126	15876	2000376	11.2250	5.0133
49	2401	117649	7.	3.6593	127	16129	2048383	11.2694	5.0265
50	2500	125000	7.0711	3.6840	128	16384	2097152	11.3137	5.0397
51	2601	132 51	7 1414	3.7084	129	16641	2146689	11.3578	5.0528
52	2704	140608	7.2111	3.7325	130	16900	2197000	11.4018	5.0658
53	2809	148877	7.2801	3.7563	131	17161	2248091	11.4455	5 0788
54	2916	157464	7 3485	3.7798	132	17424	2299968	11.4891	5.0916
55	3025	166375	7.4162	3.8030	133	17689	2352637	11 5326	5.1045
56	3136	175616	7.4833	3.8259	134	17956	2406104	11.5758	5.1172
57	3249	185193	7.5498	3.8485	135	18225	2460375	11.6190	5.1299
58	3364	195112	7.6158	3 8709	136	18496	2515456	11.6619	5.1426
59	3481	205379	7.6811	3.8930	137	18769	2571353	11.7047	5.1551
60	3600	216000	7.7460	3 9149	138	19044	2628072	11.7473	5.1676
61	3721	226981	7.8102	3 9365	139	19321	2685619	11.7898	5.1801
62	3844	238328	7.8740	3.9579	140	19600	2744000	11.8322	5.1925
63	3969	250047	7.9373	3.9791	141	19881	2803221	11.8743	5 2048
64	4096	262144	8	4.	142	20164	2863288	11.9164	5.2171
65	4225	274625	8 0623	4.0207	143	20449	2924207	11.9583	5.2293
66	4356	287496	8.1240	4.0412	144	20736	2985984	12.	5.2415
67	4489	300763	8 1854	4.0615	145	21025	3048625	12.0416	5.2536
68	4624	314432	8.2462	4 0817	146	21316	3112136	12.0830	5.2656
69	4761	328509	8 3066	4.1016	147	21609	3176523	12.1244	5.2776
70	4900	343000	8.3666	4.1213	148	21904	3241792	12.1655	5.2896
71	5041	357911	8.4261	4.1408	149	22201	3307949	12.2066	5.3015
72	5184	373248	8.4853	4.1602	150	22500	3375000	12.2474	5.3133
73	5329	389017	8.5440	4 1793	151	22801	3442951	12.2882	5.3251
74	5476	405224	8.6023	4.1983	152	23104	3511808	12.3288	5.3368
75	5625	421875	8.6603	4.2172	153	23409	3581577	12.3693	5.3485
76	5776	438976	8.7178	4.2358	154	23716	3652264	12 4097	5.3601
77	5929	456533	8 7750	4.2543	155	24025	3723875	12.4499	5 3717
78	6084	474552	8.8318	4.2727	156	24336	3796416	12.4900	5.3832

TABLE.—Continued.

No.	Square.	Cube.	Square Root.	Cube Root.	No.	Square.	Cube.	Square Root.	Cube Root.
157	24649	3869893	12.5300	5.3947	241	58081	13997521	15.5242	6.2231
158	24964	3944312	12.5698	5.4061	242	58564	14172488	15.5563	6.2317
159	25281	4019679	12.6095	5.4175	243	59049	14348907	15.5885	6.2403
160	25600	4096000	12.6491	5.4288	244	59536	14526784	15.6205	6.2488
161	25921	4173281	12.6886	5.4401	245	60025	14706125	15.6525	6.2573
162	26244	4251528	12.7279	5.4514	246	60516	14886936	15.6844	6.2658
163	26569	4330747	12.7671	5.4626	247	61009	15069223	15.7162	6.2743
164	26896	4410944	12.8062	5.4737	248	61504	15252992	15.7480	6.2828
165	27225	4492125	12.8452	5.4848	249	62001	15438249	15.7797	6.2912
166	27556	4574296	12.8841	5.4959	250	62500	15625000	15.8114	6.2996
167	27889	4657463	12.9228	5.5069	251	63001	15813251	15.8430	6.3080
168	28224	4741632	12.9615	5.5178	252	63504	16003008	15.8745	6.3164
169	28561	4826809	13.	5.5288	253	64009	16194277	15.9060	6.3247
170	28900	4913000	13.0384	5.5397	254	64516	16387064	15.9374	6.3330
171	29241	5000211	13.0767	5.5505	255	65025	16581375	15.9687	6.3413
172	29584	5088448	13.1149	5.5613	256	65536	16777216	16.	6.3496
173	29929	5177717	13.1529	5.5721	257	66049	16974593	16.0312	6.3579
174	30276	5268024	13.1909	5.5828	258	66564	17173512	16.0624	6.3661
175	30625	5359375	13.2288	5.5934	259	67081	17373979	16.0935	6.3743
176	30976	5451776	13.2665	5.6041	260	67600	17576000	16.1245	6.3825
177	31329	5545233	13.3041	5.6147	261	68121	17779581	16.1555	6.3907
178	31684	5639752	13.3417	5.6252	262	68644	17984728	16.1864	6.3988
179	32041	5735339	13.3791	5.6357	263	69169	18191447	16.2173	6.4070
180	32400	5832000	13.4164	5.6462	264	69696	18399744	16.2481	6.4151
181	32761	5929741	13.4536	5.6567	265	70225	18609625	16.2788	6.4232
182	33124	6028568	13.4907	5.6671	266	70756	18821096	16.3095	6.4312
183	33489	6128487	13.5277	5.6774	267	71289	19034163	16.3401	6.4393
184	33856	6229504	13.5647	5.6877	268	71824	19248832	16.3707	6.4473
185	34225	6331625	13.6015	5.6980	269	72361	19465109	16.4012	6.4553
186	34596	6434856	13.6382	5.7083	270	72900	19683000	16.4317	6.4633
187	34969	6539203	13.6748	5.7185	271	73441	19902511	16.4621	6.4713
188	35344	6644672	13.7113	5.7287	272	73984	20123648	16.4924	6.4792
189	35721	6751269	13.7477	5.7388	273	74529	20346417	16.5227	6.4872
190	36100	6859000	13.7840	5.7489	274	75076	20570824	16.5529	6.4951
191	36481	6967871	13.8203	5.7590	275	75625	20796875	16.5831	6.5030
192	36864	7077888	13.8564	5.7690	276	76176	21024576	16.6132	6.5108
193	37249	7189057	13.8924	5.7790	277	76729	21253933	16.6433	6.5187
194	37636	7301384	13.9284	5.7890	278	77284	21484952	16.6733	6.5265
195	38025	7414875	13.9642	5.7989	279	77841	21717639	16.7033	6.5343
196	38416	7529536	14.	5.8088	280	78400	21952000	16.7332	6.5421
197	38809	7645373	14.0357	5.8186	281	78961	22188041	16.7631	6.5499
198	39204	7762392	14.0712	5.8285	282	79524	22425768	16.7929	6.5577
199	39601	7880599	14.1067	5.8383	283	80089	22665187	16.8826	6.5654
200	40000	8000000	14.1421	5.8480	284	80656	22906304	16.8523	6.5731
201	40401	8120601	14.1774	5.8578	285	81225	23149125	16.8819	6.5808
202	40804	8242408	14.2127	5.8675	286	81796	23393656	16.9115	6.5885
203	41209	8365427	14.2478	5.8771	287	82369	23639903	16.9411	6.5962
204	41616	8489664	14.2829	5.8868	288	82944	23887872	16.9706	6.6039
205	42025	8615125	14.3178	5.8964	289	83521	24137569	17.	6.6115
206	42436	8741816	14.3527	5.9059	290	84100	24389000	17.0294	6.6191
207	42849	8869743	14.3875	5.9155	291	84681	24642171	17.0587	6.6267
208	43264	8998912	14.4222	5.9250	292	85264	24897088	17.0880	6.6343
209	43681	9129329	14.4568	5.9345	293	85849	25153757	17.1172	6.6419
210	44100	9261000	14.4914	5.9439	294	86436	25412184	17.1464	6.6494
211	44521	9393931	14.5258	5.9533	295	87025	25672375	17.1756	6.6569
212	44944	9528128	14.5602	5.9627	296	87616	25934336	17.2047	6.6644
213	45369	9663597	14.5945	5.9721	297	88209	26198073	17.2337	6.6719
214	45796	9800344	14.6287	5.9814	298	88804	26463592	17.2627	6.6794
215	46225	9938375	14.6629	5.9907	299	89401	26730899	17.2916	6.6869
216	46656	10077696	14.6969	6.	300	90000	27000000	17.3205	6.6943
217	47089	10218313	14.7309	6.0092	301	90601	27270901	17.3494	6.7018
218	47524	10360232	14.7648	6.0185	302	91204	27543608	17.3781	6.7092
219	47961	10503459	14.7986	6.0277	303	91809	27818127	17.4069	6.7166
220	48400	10648000	14.8324	6.0368	304	92416	28094464	17.4356	6.7240
221	48841	10793861	14.8661	6.0459	305	93025	28372625	17.4642	6.7313
222	49284	10941048	14.8997	6.0550	306	93636	28652616	17.4929	6.7387
223	49729	11089567	14.9332	6.0641	307	94249	28934443	17.5214	6.7460
224	50176	11239424	14.9666	6.0732	308	94864	29218112	17.5499	6.7533
225	50625	11390625	15.	6.0822	309	95481	29503629	17.5784	6.7606
226	51076	11543176	15.0333	6.0912	310	96100	29791000	17.6068	6.7679
227	51529	11697083	15.0665	6.1002	311	96721	30080231	17.6352	6.7752
228	51984	11852352	15.0997	6.1091	312	97344	30371328	17.6635	6.7824
229	52441	12008989	15.1327	6.1180	313	97969	30664297	17.6918	6.7897
230	52900	12167000	15.1658	6.1269	314	98596	30959144	17.7200	6.7969
231	53361	12326391	15.1987	6.1358	315	99225	31255875	17.7482	6.8041
232	53824	12487168	15.2315	6.1446	316	99856	31554496	17.7764	6.8113
233	54289	12649337	15.2643	6.1534	317	100489	31855013	17.8045	6.8185
234	54756	12812904	15.2971	6.1622	318	101124	32157432	17.8326	6.8256
235	55225	12977875	15.3297	6.1710	319	101761	32461759	17.8606	6.8328
236	55696	13144256	15.3623	6.1797	320	102400	32768000	17.8885	6.8399
237	56169	13312053	15.3948	6.1885	321	103041	33076161	17.9165	6.8470
238	56644	13481272	15.4272	6.1972	322	103684	33386248	17.9444	6.8541
239	57121	13651919	15.4596	6.2058	323	104329	33698267	17.9722	6.8612
240	57600	13824000	15.4919	6.2145	324	104976	34012224	18.	6.8683

TABLE.—CONTINUED.

No.	Square.	Cube.	Square Root.	Cube Root.	No.	Square.	Cube.	Square Root.	Cube Root.
325	105625	34328125	18.0278	6.8753	409	167281	68417929	20.2237	7.4229
326	106276	34645976	18.0555	6.8824	410	168100	68921000	20.2485	7.4290
327	106929	34965783	18.0831	6.8894	411	168921	69426531	20.2731	7.4350
328	107584	35287552	18.1108	6.8964	412	169744	69934528	20.2978	7.4410
329	108241	35611289	18.1384	6.9034	413	170569	70444997	20.3224	7.4470
330	108900	35937000	18.1659	6.9104	414	171396	70957944	20.3470	7.4530
331	109561	36264691	18.1934	6.9174	415	172225	71473375	20.3715	7.4590
332	110224	36594368	18.2209	6.9244	416	173056	71991296	20.3961	7.4650
333	110889	36926037	18.2483	6.9313	417	173889	72511713	20.4206	7.4710
334	111556	37259704	18.2757	6.9382	418	174724	73034632	20.4450	7.4770
335	112225	37595375	18.3030	6.9451	419	175561	73560059	20.4695	7.4829
336	112896	37933056	18.3303	6.9521	420	176400	74088000	20.4939	7.4889
337	113569	38272753	18.3576	6.9589	421	177241	74618461	20.5183	7.4948
338	114244	38614472	18.3848	6.9658	422	178084	75151448	20.5426	7.5007
339	114921	38958219	18.4120	6.9727	423	178929	75686967	20.5670	7.5067
340	115600	39304000	18.4391	6.9795	424	179776	76225024	30.5913	7.5126
341	116281	39651821	18.4662	6.9864	425	180625	76765625	20.6155	7.5185
342	116964	40001688	18.4932	6.9932	426	181476	77308776	20.6398	7.5244
343	117649	40353607	18.5203	7.	427	182329	77854483	20.6640	7.5302
344	118336	40707584	18.5472	7.0068	428	183184	78402752	20.6882	7.5361
345	119025	41063625	18.5742	7.0136	429	184041	78953589	20.7123	7.5420
346	119716	41421736	18.6011	7.0203	430	184900	79507000	20.7364	7.5478
347	120409	41781923	18.6279	7.0271	431	185761	80062991	20.7605	7.5537
348	121104	42144192	18.6548	7.0338	432	186624	80621568	20.7846	7.5595
349	121801	42508549	18.6815	7.0406	433	187489	81182737	20.8087	7.5654
350	122500	42875000	18.7083	7.0473	434	188356	81746504	20.8327	7.5712
351	123201	43243551	18.7350	7.0540	435	189225	82312875	20.8567	7.5770
352	123904	43614208	18.7617	7.0607	436	190096	82881856	20.8806	7.5828
353	124609	43986977	18.7883	7.0674	437	190969	83453453	20.9045	7.5886
354	125316	44361864	18.8149	7.0740	438	191844	84027672	20.9284	7.5944
355	126025	44738875	18.8414	7.0807	439	192721	84604519	20.9523	7.6001
356	126736	45118016	18.8680	7.0873	440	193600	85184000	20.9762	7.6059
357	127449	45499293	18.8944	7.0940	441	194481	85766121	21.	7.6117
358	128164	45882712	18.9209	7.1006	442	195364	86350888	21.0238	7.6174
359	128881	46268279	18.9473	7.1072	443	196249	86938307	21.0476	7.6232
360	129600	46656000	18.9737	7.1138	444	197136	87528384	21.0713	7.6289
361	130321	47045881	19.	7.1204	445	198025	88121125	21.0950	7.6346
362	131044	47437928	19.0263	7.1269	446	198916	88716536	21.1187	7.6403
363	131769	47832147	19.0526	7.1335	447	199809	89314623	21.1424	7.6460
364	132496	48228544	19.0788	7.1400	448	200704	89915392	21.1660	7.6517
365	133225	48627125	19.1050	7.1466	449	201601	90518849	21.1896	7.6574
366	133956	49027896	19.1311	7.1531	450	202500	91125000	21.2132	7.6631
367	134689	49430863	19.1572	7.1596	451	203401	91733851	21.2368	7.6688
368	135424	49836032	19.1833	7.1661	452	204304	92345408	21.2603	7.6744
369	136161	50243409	19.2094	7.1726	453	205209	92959677	21.2838	7.6801
370	136900	50653000	19.2354	7.1791	454	206116	93576664	21.3073	7.6857
371	137641	51064811	19.2614	7.1855	455	207025	94196375	21.3307	7.6914
372	138384	51478848	19.2873	7.1920	456	207936	94818816	21.3542	7.6970
373	139129	51895117	19.3132	7.1984	457	208849	95443993	21.3776	7.7026
374	139876	52313624	19.3391	7.2048	458	209764	96071912	21.4009	7.7082
375	140625	52734375	19.3649	7.2112	459	210681	96702579	21.4243	7.7138
376	141376	53157376	19.3907	7.2177	460	211600	97336000	21.4476	7.7194
377	142129	53582633	19.4165	7.2240	461	212521	97972181	21.4709	7.7250
378	142884	54010152	19.4422	7.2304	462	213444	98611128	21.4942	7.7306
379	143641	54439939	19.4679	7.2368	463	214369	99252847	21.5174	7.7362
380	144400	54872000	19.4936	7.2432	464	215296	99897344	21.5407	7.7418
381	145161	55306341	19.5192	7.2495	465	216225	100544625	21.5639	7.7473
382	145924	55742968	19.5448	7.2558	466	217156	101194696	21.5870	7.7529
383	146689	56181887	19.5704	7.2622	467	218089	101847563	21.6102	7.7584
384	147456	56623104	19.5959	7.2685	468	219024	102503232	21.6333	7.7639
385	148225	57066625	19.6214	7.2748	469	219961	103161709	21.6564	7.7695
386	148996	57512456	19.6469	7.2811	470	220900	103823000	21.6795	7.7750
387	149769	57960603	19.6723	7.2874	471	221841	104487111	21.7025	7.7805
388	150544	58411072	19.6977	7.2936	472	222784	105154048	21.7256	7.7860
389	151321	58863869	19.7231	7.2999	473	223729	105823817	21.7486	7.7915
390	152100	59319000	19.7484	7.3061	474	224676	106496424	21.7715	7.7970
391	152881	59776471	19.7737	7.3124	475	225625	107171875	21.7945	7.8025
392	153664	60236288	19.7990	7.3186	476	226576	107850176	21.8174	7.8079
393	154449	60698457	19.8242	7.3248	477	227529	108531333	21.8403	7.8134
394	155236	61162984	19.8494	7.3310	478	228484	109215352	21.8632	7.8188
395	156025	61629875	19.8746	7.3372	479	229441	109902239	21.8861	7.8243
396	156816	62099136	19.8997	7.3434	480	230400	100592000	21.9089	7.8297
397	157609	62570773	19.9249	7.3496	481	231361	111284641	21.9317	7.8352
398	158404	63044792	19.9499	7.3558	482	232324	111980168	21.9545	7.8406
399	159201	63521199	19.9750	7.3619	483	233289	112678587	21.9773	7.8460
400	160000	64000000	20.	7.3681	484	234256	113379904	22.	7.8514
401	160801	64481201	20.0250	7.3742	485	235225	114084125	22.0227	7.8568
402	161604	64964808	20.0499	7.3803	486	236196	114791256	22.0454	7.8622
403	162409	65450827	20.0749	7.3864	487	237169	115501303	22.0681	7.8676
404	163216	65939264	20.0998	7.3925	488	238144	116214272	22.0907	7.8730
405	164025	66430125	20.1246	7.3986	489	239121	116930169	22.1133	7.8784
406	164836	66923416	20.1494	7.4047	490	240100	117649000	22.1359	7.8837
407	165649	67419143	20.1742	7.4108	491	241081	118370771	22.1585	7.8891
408	166464	67917312	20.1990	7.4169	492	242064	119095488	22.1811	7.8944

TABLE.—Continued.

No.	Square.	Cube.	Square Root.	Cube Root.
493	243049	119823157	22.2036	7.8998
494	244036	120553784	22.2261	7.9051
495	245025	121287375	22.2486	7.9105
496	246016	122023936	22.2711	7.9158
497	247009	122763473	22.2935	7.9211
498	248004	123505992	22.3159	7.9264
499	249001	124251499	22.3383	7.9317
500	250000	125000000	22.3607	7.9370
501	251001	125751501	22.3830	7.9423
502	252004	126506008	22.4054	7.9476
503	253009	127263527	22.4277	7.9528
504	254016	128024064	22.4499	7.9581
505	255025	128787625	22.4722	7.9634
506	256036	129554216	22.4944	7.9686
507	257049	130323843	22.5167	7.9739
508	258064	131096512	22.5389	7.9791
509	259081	131872229	22.5610	7.9843
510	260100	132651000	22.5832	7.9896
511	261121	133432831	22.6053	7.9948
512	262144	134217728	22.6274	8.
513	263169	135005697	22.6495	8.0052
514	264196	135796744	22.6716	8.0104
515	265225	136590875	22.6936	8.0156
516	266256	137388096	22.7156	8.0208
517	267289	138188413	22.7376	8.0260
518	268324	138991832	22.7596	8.0311
519	269361	139798359	22.7816	8.0363
520	270400	140608000	22.8035	8.0415
521	271441	141420761	22.8254	8.0466
522	272484	142236648	22.8473	8.0517
523	273529	143055667	22.8692	8.0569
524	274576	143877824	22.8910	8.0620
525	275625	144703125	22.9129	8.0671
526	276676	145531576	22.9347	8.0723
527	277729	146363183	22.9565	8.0774
528	278784	147197952	22.9783	8.0825
529	279841	148035889	23.	8.0876
530	280900	148877000	23.0217	8.0927
531	281961	149721291	23.0434	8.0978
532	283024	150568768	23.0651	8.1028
533	284089	151419437	23.0868	8.1079
534	285156	152273304	23.1084	8.1130
535	286225	153130375	23.1301	8.1180
536	287296	153990656	23.1517	8.1231
537	288369	154854153	23.1733	8.1281
538	289444	155720872	23.1948	8.1332
539	290521	156590819	23.2164	8.1382
540	291600	157464000	23.2379	8.1433
541	292681	158340421	23.2594	8.1483
542	293764	159220088	23.2809	8.1533
543	294849	160103007	23.3024	8.1583
544	295936	160989184	23.3238	8.1633
545	297025	161878625	23.3452	8.1683
546	298116	162771336	23.3666	8.1733
547	299209	163667323	23.3880	8.1783
548	300304	164566592	23.4094	8.1833
549	301401	165469149	23.4307	8.1882
550	302500	166375000	23.4521	8.1932
551	303601	167284151	23.4734	8.1982
552	304704	168196608	23.4947	8.2031
553	305809	169112377	23.5160	8.2081
554	306916	170031464	23.5372	8.2130
555	308025	170953875	23.5584	8.2180
556	309136	171879616	23.5797	8.2229
557	310249	172808693	23.6008	8.2278
558	311364	173741112	23.6220	8.2327
559	312481	174676879	23.6432	8.2377
560	313600	175616000	23.6643	8.2426
561	314721	176558481	23.6854	8.2475
562	315844	177504328	23.7065	8.2524
563	316969	178453547	23.7276	8.2573
564	318096	179406144	23.7487	8.2621
565	319225	180362125	23.7697	8.2670
566	320356	181321496	23.7908	8.2719
567	321489	182284263	23.8118	8.2768
568	322624	183250432	23.8328	8.2816
569	323761	184220009	23.8537	8.2865
570	324900	185193000	23.8747	8.2913
571	326041	186169411	23.8956	8.2962
572	327184	187149248	23.9165	8.3010
573	328329	188132517	23.9374	8.3059
574	329476	189119224	23.9583	8.3107
575	330625	190109375	23.9792	8.3155
576	331776	191102976	24.	8.3203

No.	Square.	Cube.	Square Root.	Cube Root.
577	332929	192100033	24.0208	8.3251
578	334084	193100552	24.0416	8.3300
579	335241	194104539	24.0624	8.3348
580	336400	195112000	24.0832	8.3396
581	337561	196122941	24.1039	8.3443
582	338724	197137368	24.1247	8.3491
583	339889	198155287	24.1454	8.3539
584	341056	199176704	24.1661	8.3587
585	342225	200201625	24.1868	8.3634
586	343396	201230056	24.2074	8.3682
587	344569	202262003	24.2281	8.3730
588	345744	203297472	24.2487	8.3777
589	346921	204336469	24.2693	8.3825
590	348100	205379000	24.2899	8.3872
591	349281	206425071	24.3105	8.3919
592	350464	207474688	24.3311	8.3967
593	351649	208527857	24.3516	8.4014
594	352836	209584584	24.3721	8.4061
595	354025	210644875	24.3926	8.4108
596	355216	211708736	24.4131	8.4155
597	356409	212776173	24.4336	8.4202
598	357604	213847192	24.4540	8.4249
599	358801	214921799	24.4745	8.4296
600	360000	216000000	24.4949	8.4343
601	361201	217081801	24.5153	8.4390
602	362404	218167208	24.5357	8.4437
603	363609	219256227	24.5561	8.4484
604	364816	220348864	24.5764	8.4530
605	366025	221445125	24.5967	8.4577
606	367236	222545016	24.6171	8.4623
607	368449	223648543	24.6374	8.4670
608	369664	224755712	24.6577	8.4716
609	370881	225866529	24.6779	8.4763
610	372100	226981000	24.6982	8.4809
611	373321	228099131	24.7184	8.4856
612	374544	229220928	24.7386	8.4902
613	375769	230346397	24.7588	8.4948
614	376996	231475544	24.7790	8.4994
615	378225	232608375	24.7992	8.5040
616	379456	233744896	24.8193	8.5086
617	380689	234885113	24.8395	8.5132
618	381924	236029032	24.8596	8.5178
619	383161	237176659	24.8797	8.5224
620	384400	238328000	24.8998	8.5270
621	385641	239483061	24.9199	8.5316
622	386884	240641848	24.9399	8.5362
623	388129	241804367	24.9600	8.5408
624	389376	242970624	24.9800	8.5453
625	390625	244140625	25.	8.5499
626	391876	245314376	25.0200	8.5544
627	393129	246491883	25.0400	8.5590
628	394384	247673152	25.0599	8.5635
629	395641	248858189	25.0799	8.5681
630	396900	250047000	25.0998	8.5726
631	398161	251239591	25.1197	8.5772
632	399424	252435968	25.1396	8.5817
633	400689	253636137	25.1595	8.5862
634	401956	254840104	25.1794	8.5907
635	403225	256047875	25.1992	8.5952
636	404496	257259456	25.2190	8.5997
637	405769	258474853	25.2389	8.6043
638	407044	259694072	25.2587	8.6088
639	408321	260917119	25.2784	8.6132
640	409600	262144000	25.2982	8.6177
641	410881	263374721	25.3180	8.6222
642	412164	264609288	25.3377	8.6267
643	413449	265847707	25.3574	8.6312
644	414736	267089984	25.3772	8.6357
645	416025	268336125	25.3969	8.6401
646	417316	269586136	25.4165	8.6446
647	418609	270840023	25.4362	8.6490
648	419904	272097792	25.4558	8.6535
649	421201	273359449	25.4755	8.6579
650	422500	274625000	25.4951	8.6624
651	423801	275894451	25.5147	8.6668
652	425104	277167808	25.5343	8.6713
653	426409	278445077	25.5539	8.6757
654	427716	279726264	25.5734	8.6801
655	429025	281011375	25.5930	8.6845
656	430336	282300416	25.6125	8.6890
657	431649	283593393	25.6320	8.6934
658	432964	284890312	25.6515	8.6978
659	434281	286191179	25.6710	8.7022
660	435600	287496000	25.6905	8.7066

TABLE.—CONTINUED.

No.	Square.	Cube.	Square Root.	Cube Root.
661	436921	288804781	25.7099	8.7110
662	438244	290117528	25.7294	8.7154
663	439569	291434247	25.7488	8.7198
664	440896	292754944	25.7682	8.7241
665	442225	294079625	25.7876	8.7285
666	443556	295408296	25.8070	8.7329
667	444889	296740963	25.8263	8.7373
668	446224	298077632	25.8457	8.7416
669	447561	299418309	25.8650	8.7460
670	448900	300763000	25.8844	8.7503
671	450241	302111711	25.9037	8.7547
672	451584	303464448	25.9230	8.7590
673	452929	304821217	25.9422	8.7634
674	454276	306182024	25.9615	8.7677
675	455625	307546875	25.9808	8.7721
676	456976	308915776	26.	8.7764
677	458329	310288733	26.0192	8.7807
678	459684	311665752	26.0384	8.7850
679	461041	313046839	26.0576	8.7893
680	462400	314432000	26.0768	8.7937
681	463761	315821241	26.0960	8.7980
682	465124	317214568	26.1151	8.8023
683	466489	318611987	26.1343	8.8066
684	467856	320013504	26.1534	8.8109
685	469225	321419125	26.1725	8.8152
686	470596	322828856	26.1916	8.8194
687	471969	324242703	26.2107	8.8237
688	473344	325660672	26.2298	8.8280
689	474721	327082769	26.2488	8.8323
690	476100	328509000	26.2679	8.8366
691	477481	329939371	26.2869	8.8408
692	478864	331373888	26.3059	8.8451
693	480249	332812557	26.3249	8.8493
694	481636	334255384	26.3439	8.8536
695	483025	335702375	26.3629	8.8578
696	484416	337153536	26.3818	8.8621
697	485809	338608873	26.4008	8.8663
698	487204	340068392	26.4197	8.8706
699	488601	341532099	26.4386	8.8748
700	490000	343000000	26.4575	8.8790
701	491401	344472101	26.4764	8.8833
702	492804	345948408	26.4953	8.8875
703	494209	347428927	26.5141	8.8917
704	495616	348913664	26.5330	8.8959
705	497025	350402625	26.5518	8.9001
706	498436	351895816	26.5707	8.9043
707	499849	353393243	26.5895	8.9085
708	501264	354894912	26.6083	8.9127
709	502681	356400829	26.6271	8.9169
710	504100	357911000	26.6458	8.9211
711	505521	359425431	26.6646	8.9253
712	506944	360944128	26.6833	8.9295
713	508369	362467097	26.7021	8.9337
714	509796	363994344	26.7208	8.9378
715	511225	365525875	26.7395	8.9420
716	512656	367061696	26.7582	8.9462
717	514089	368601813	26.7769	8.9503
718	515524	370146232	26.7955	8.9545
719	516961	371694959	26.8142	8.9587
720	518400	373248000	26.8328	8.9628
721	519841	374805361	26.8514	8.9670
722	521284	376367048	26.8701	8.9711
723	522729	377933067	26.8887	8.9752
724	524176	379503424	26.9072	8.9794
725	525625	381078125	26.9258	8.9835
726	527076	382657176	26.9444	8.9876
727	528529	384240583	26.9629	8.9918
728	529984	385828352	26.9815	8.9959
729	531441	387420489	27	9.
730	532900	389017000	27.0185	9.0041
731	534361	390617891	27.0370	9.0082
732	535824	392223168	27.0555	9.0123
733	537289	393832837	27.0740	9.0164
734	538756	395446904	27.0924	9.0205
735	540225	397065375	27.1109	9.0246
736	541696	398688256	27.1293	9.0287
737	543169	400315553	27.1477	9.0328
738	544644	401947272	27.1662	9.0369
739	546121	403583419	27.1846	9.0410
740	547600	405224000	27.2029	9.0450
741	549081	406869021	27.2213	9.0491
742	550564	408518488	27.2397	9.0532
743	552049	410172407	27.2580	9.0572
744	553536	411830784	27.2764	9.0613
745	555025	413493625	27.2947	9.0654
746	556516	415160936	27.3130	9.0694
747	558009	416832723	27.3313	9.0735
748	559504	418508992	27.3496	9.0775
749	561001	420189749	27.3679	9.0816
750	562500	421875000	27.3861	9.0856
751	564001	423564751	27.4044	9.0896
752	565504	425259008	27.4226	9.0937
753	567009	426957777	27.4408	9.0977
754	568516	428661064	27.4591	9.1017
755	570025	430368875	27.4773	9.1057
756	571536	432081216	27.4955	9.1098
757	573049	433798093	27.5136	9.1138
758	574564	435519512	27.5318	9.1178
759	576081	437245479	27.5500	9.1218
760	577600	438976000	27.5681	9.1258
761	579121	440711081	27.5862	9.1298
762	580644	442450728	27.6043	9.1338
763	582169	444194947	27.6225	9.1378
764	583696	445943744	27.6405	9.1418
765	585225	447697125	27.6586	9.1458
766	586756	449455096	27.6767	9.1498
767	588289	451217663	27.6948	9.1537
768	589824	452984832	27.7128	9.1577
769	591361	454756609	27.7308	9.1617
770	592900	456533000	27.7489	9.1657
771	594441	458314011	27.7669	9.1696
772	595984	460099648	27.7849	9.1736
773	597529	461889917	27.8029	9.1775
774	599076	463684824	27.8209	9.1815
775	600625	465484375	27.8388	9.1855
776	602176	467288576	27.8568	9.1894
777	603729	469097433	27.8747	9.1933
778	605284	470910952	27.8927	9.1973
779	606841	472729139	27.9106	9.2012
780	608400	474552000	27.9285	9.2052
781	609961	476379541	27.9464	9.2091
782	611524	478211768	27.9643	9.2130
783	613089	480048687	27.9821	9.2170
784	614656	481890304	28.	9.2209
785	616225	483736625	28.0179	9.2248
786	617796	485587656	28.0357	9.2287
787	619369	487443403	28.0535	9.2326
788	620944	489303872	28.0713	9.2365
789	622521	491169069	28.0891	9.2404
790	624100	493039000	28.1069	9.2443
791	625681	494913671	28.1247	9.2482
792	627264	496793088	28.1425	9.2521
793	628849	498677257	28.1603	9.2560
794	630436	500566184	28.1780	9.2599
795	632025	502459875	28.1957	9.2638
796	633616	504358336	28.2135	9.2677
797	635209	506261573	28.2312	9.2716
798	636804	508169592	28.2489	9.2754
799	638401	510082399	28.2666	9.2793
800	640000	512000000	28.2843	9.2832
801	641601	513922401	28.3019	9.2870
802	643204	515849608	28.3196	9.2909
803	644809	517781627	28.3373	9.2948
804	646416	519718464	28.3549	9.2986
805	648025	521660125	28.3725	9.3025
806	649636	523606616	28.3901	9.3063
807	651249	525557943	28.4077	9.3102
808	652864	527514112	28.4253	9.3140
809	654481	529475129	28.4429	9.3179
810	656100	531441000	28.4605	9.3217
811	657721	533411731	28.4781	9.3255
812	659344	535387328	28.4956	9.3294
813	660969	537367797	28.5132	9.3332
814	662596	539353144	28.5307	9.3370
815	664225	541343375	28.5482	9.3408
816	665856	543338496	28.5657	9.3447
817	667489	545338513	28.5832	9.3485
818	669124	547343432	28.6007	9.3523
819	670761	549353259	28.6182	9.3561
820	672400	551368000	28.6356	9.3599
821	674041	553387661	28.6531	9.3637
822	675684	555412248	28.6705	9.3675
823	677329	557441767	28.6880	9.3713
824	678976	559476224	28.7054	9.3751
825	680625	561515625	28.7228	9.3789
826	682276	563559976	28.7402	9.3827
827	683929	565609283	28.7576	9.3865
828	685584	567663552	28.7750	9.3902
829	687241	569722789	28.7924	9.3940
830	688900	571787000	28.8097	9.3978

TABLE.—Continued.

No.	Square.	Cube.	Square Root.	Cube Root.	No.	Square.	Cube.	Square Root.	Cube Root.
831	690561	573856191	28.8271	9.4016	916	839056	768575296	30.2655	9.7118
832	692224	575930368	28.8444	9.4053	917	840889	771095213	30.2820	9.7153
833	693889	578009537	28.8617	9.4091	918	842724	773620632	30.2985	9.7188
834	695556	580093704	28.8791	9.4129	919	844561	776151559	30.3150	9.7224
835	697225	582182875	28.8964	9.4166	920	846400	778688000	30.3315	9.7259
836	698896	584277056	28.9137	9.4204	921	848241	781229961	30.3480	9.7294
837	700569	586376253	28.9310	9.4241	922	850084	783777448	30.3645	9.7329
838	702244	588480472	28.9482	9.4279	923	851929	786330467	30.3809	9.7364
839	703921	590589719	28.9655	9.4316	924	853776	788889024	30.3974	9.7400
840	705600	592704000	28.9828	9.4354	925	855625	791453125	30.4138	9.7435
841	707281	594823321	29.	9.4391	926	857476	794022776	30.4302	9.7470
842	708964	596947688	29.0172	9.4429	927	859329	796597983	30.4467	9.7505
843	710649	599077107	29.0345	9.4466	928	861184	799178752	30.4631	9.7540
844	712336	601211584	29.0517	9.4503	929	863041	801765089	30.4795	9.7575
845	714025	603351125	29.0689	9.4541	930	864900	804357000	30.4959	9.7610
846	715716	605495736	29.0861	9.4578	931	866761	806954491	30.5123	9.7645
847	717409	607645423	29.1033	9.4615	932	868624	809557568	30.5287	9.7680
848	719104	609800192	29.1204	9.4652	933	870489	812166237	30.5450	9.7715
849	720801	611960049	29.1376	9.4690	934	872356	814780504	30.5614	9.7750
850	722500	614125000	29.1548	9.4727	935	874225	817400375	30.5778	9.7785
851	724201	616295051	29.1719	9.4764	936	876096	820025856	30.5941	9.7819
852	725904	618470208	29.1890	9.4801	937	877969	822656953	30.6105	9.7854
853	727609	620650477	29.2062	9.4838	938	879844	825293672	30.6268	9.7889
854	729316	622835864	29.2233	9.4875	939	881721	827936019	30.6431	9.7924
855	731025	625026375	29.2404	9.4912	940	883600	830584000	30.6594	9.7959
856	732736	627222016	29.2575	9.4949	941	885481	833237621	30.6757	9.7993
857	734449	629422793	29.2746	9.4986	942	887364	835896888	30.6920	9.8028
858	736164	631628712	29.2916	9.5023	943	889249	838561807	30.7083	9.8063
859	737881	633839779	29.3087	9.5060	944	891136	841232384	30.7246	9.8097
860	739600	636056000	29.3258	9.5097	945	893025	843908625	30.7409	9.8132
861	741321	638277381	29.3428	9.5134	946	894916	846590536	30.7571	9.8167
862	743044	640503928	29.3598	9.5171	947	896809	849278123	30.7734	9.8201
863	744769	642735647	29.3769	9.5207	948	898704	851971392	30.7896	9.8236
864	746496	644972544	29.3939	9.5244	949	900601	854670349	30.8058	9.8270
865	748225	647214625	29.4109	9.5281	950	902500	857375000	30.8221	9.8305
866	749956	649461896	29.4279	9.5317	951	904401	860085351	30.8383	9.8339
867	751689	651714363	29.4449	9.5354	952	906304	862801408	30.8545	9.8374
868	753424	653972032	29.4618	9.5391	953	908209	865523177	30.8707	9.8408
869	755161	656234909	29.4788	9.5427	954	910116	868250664	30.8869	9.8443
870	756900	658503000	29.4958	9.5464	955	912025	870983875	30.9031	9.8477
871	758641	660776311	29.5127	9.5501	956	913936	873722816	30.9192	9.8511
872	760384	663054848	29.5296	9.5537	957	915849	876467493	30.9354	9.8546
873	762129	665338617	29.5466	9.5574	958	917764	879217912	30.9516	9.8580
874	763876	667627624	29.5635	9.5610	959	919681	881974079	30.9677	9.8614
875	765625	669921875	29.5804	9.5647	960	921600	884736000	30.9839	9.8648
876	767376	672221376	29.5973	9.5683	961	923521	887503681	31.	9.8683
877	769129	674526133	29.6142	9.5719	962	925444	890277128	31.0161	9.8717
878	770884	676836152	29.6311	9.5756	963	927369	893056347	31.0322	9.8751
879	772641	679151439	29.6479	9.5792	964	929296	895841344	31.0483	9.8785
880	774400	681472000	29.6648	9.5828	965	931225	898632125	31.0644	9.8819
881	776161	683797841	29.6816	9.5865	966	933156	901428696	31.0805	9.8854
882	777924	686128968	29.6985	9.5901	967	935089	904231063	31.0966	9.8888
883	779689	688465387	29.7153	9.5937	968	937024	907039232	31.1127	9.8922
884	781456	690807104	29.7321	9.5973	969	938961	909853209	31.1288	9.8956
885	783225	693154125	29.7489	9.6010	970	940900	912673000	31.1448	9.8990
886	784996	695506456	29.7658	9.6046	971	942841	915498611	31.1609	9.9024
887	786769	697864103	29.7825	9.6082	972	944784	918330048	31.1769	9.9058
888	788544	700227072	29.7993	9.6118	973	946729	921167317	31.1929	9.9092
889	790321	702595369	29.8161	9.6154	974	948676	924010424	31.2090	9.9126
890	792100	704969000	29.8329	9.6190	975	950625	926859375	31.2250	9.9160
891	793881	707347971	29.8496	9.6226	976	952576	929714176	31.2410	9.9194
892	795664	709732288	29.8664	9.6262	977	954529	932574833	31.2570	9.9227
893	797449	712121957	29.8831	9.6298	978	956484	935441352	31.2730	9.9261
894	799236	714516984	29.8998	9.6334	979	958441	938313739	31.2890	9.9295
895	801025	716917375	29.9166	9.6370	980	960400	941192000	31.3050	9.9329
896	802816	719323136	29.9333	9.6406	981	962361	944076141	31.3209	9.9363
897	804609	721734273	29.9500	9.6442	982	964324	946966168	31.3369	9.9396
898	806404	724150792	29.9666	9.6477	983	966289	949862087	31.3528	9.9430
899	808201	726572699	29.9833	9.6513	984	968256	952763904	31.3688	9.9464
900	810000	729000000	30.	9.6549	985	970225	955671625	31.3847	9.9497
901	811801	731432701	30.0167	9.6585	986	972196	958585256	31.4006	9.9531
902	813604	733870808	30.0333	9.6620	987	974169	961504803	31.4166	9.9565
903	815409	736314327	30.0500	9.6656	988	976144	964430272	31.4325	9.9598
904	817216	738763264	30.0666	9.6692	989	978121	967361669	31.4484	9.9632
905	819025	741217625	30.0832	9.6727	990	980100	970299000	31.4643	9.9666
906	820836	743677416	30.0998	9.6763	991	982081	973242271	31.4802	9.9699
907	822649	746142643	30.1164	9.6799	992	984064	976191488	31.4960	9.9733
908	824464	748613312	30.1330	9.6834	993	986049	979146657	31.5119	9.9766
909	826281	751089429	30.1496	9.6870	994	988036	982107784	31.5278	9.9800
910	828100	753571000	30.1662	9.6905	995	990025	985074875	31.5436	9.9833
911	829921	756058031	30.1828	9.6941	996	992016	988047936	31.5595	9.9866
912	831744	758550528	30.1993	9.6976	997	994009	991026973	31.5753	9.9900
913	833569	761048497	30.2159	9.7012	998	996004	994011992	31.5911	9.9933
914	835396	763551944	30.2324	9.7047	999	998001	997002999	31.6070	9.9967
915	837225	766060875	30.2490	9.7082	1,000	1000000	1000000000	31.6228	10.

What Kind of Boiler is the Best?

Editor Locomotive, *Hartford*, *Conn.*

The thoroughly practical and conservative manner in which you discuss matters and things pertaining to steam boilers, prompts me to call your attention to what seems to me a matter of great importance and concern to manufacturers and all others who use steam boilers, and equally so, if not more important to your company as inspectors and insurers. I refer to the vexed question of which kind of boiler is the best for ordinary use, all things considered?

Hardly a week passes in which I do not receive from some enterprising manufacturer or patentee, a circular descriptive of this or that boiler, and its many points of superiority over everything else in the market. I make due allowance for the enthusiasm of each. and naturally enough, expect every one to commend his own wares. What really bothers me is the fact that most of these circulars abound in columns of figures giving what purports to be results of competitive tests in which their boiler excelled all others in economy. No two of these circulars agree—I might even be guilty of the hibernianism of saying no one of them does—yet strangely enough many of them refer to a test of boilers made by Commissioners at the U. S. Centennial Exhibition of 1876.

Your inspector reports that my old boilers are thinning down from long service, and that it will soon be necessary to replace them with new ones. This has interested me in the question of securing the best and most economical boiler in the market, and caused me to read carefully many of the aforesaid circulars, and to select from among them three or four of what appeared to me to be the best, any one of which claimed to be immeasurably superior to the old fogy boilers I have been using. My engineer, a good, practical man, in whom I have a good deal of confidence, and who has been in my employ many years, came into my office one day, and I gave him the pamphlets and told him to read them over carefully and tell me which he thought was the best. He amazed me by reporting that he would not advise me to buy either, and he gave me his reasons, referring me to places where certain of these boilers had failed to give satisfaction, and proved in the end expensive experiments. He did not appear to be very favorably impressed with the reports of experts, and said it did not follow that because a boiler received the first premium at some fair, that it was the best for practical use, some of the poorest specimens he ever saw having received that distinction.

An agent of one of the boilers has called upon me since, and when I repeated to him, as near as I could, the defects noticed by my engineer, the agent said he was wrong, and it was evident he was an ignorant fellow who could not see further than his nose, and he probably had some friend in the neighborhood he wanted to give the job to. I do not believe this, for although my engineer may possibly be mistaken in his opinion, I doubt if he would deliberately mislead me.

Will you not turn the head-light of "The Locomotive" upon this disputed question, and illuminate it for my benefit, and possibly for many others who may be similarly situated, and will not question either your ability or fairness to decide the subject upon its merits. Very respectfully, F. M. P.

Philadelphia, Pa., Jan. 12, 1883.

We have held the above communication for some time, because other matters have taken up the limited space in the Locomotive.

The writer is not the only one who is in a dilemma on this subject. The past few years have been fruitful in new mechanical devices, as any one familiar with the Patent Office Reports well knows. The steam boiler field has not been left unworked, nor that of steam boiler appliances and attachments, and yet how few, comparatively, of these have been found of practical value, or possessing advantages that gave them long existence. In selecting a boiler the purchaser has to consider the original cost, simplicity of construction, and the ease with which the boiler can be cleaned and repaired. That which seems to answer these conditions most fully, is the wrought iron or steel horizontal tubular, or flue boiler. It is the boiler in general use the country over, and in our opinion, when properly constructed, and properly set, is as economical as any boiler yet devised. It is well adapted to the various conditions under which boilers are used in all parts of the country. Any and all kinds of fuel can be used. And it can be easily and readily repaired by ordinary boiler-makers, which in works remote from great centers is a very great advantage—and even in great centers may avoid expensive delays. We have very little confidence in competitive tests. An advantage of one or two per cent. may be obtained by a boiler that, in the long run, would be troublesome in use, and ultimately prove an expensive investment.

The criticisms which are raised against wrought iron and steel boilers, are mainly due to the boiler-makers themselves. Competition is pretty sharp, and the temptation to use poor material and do cheap work is very great. But it tells against the man in the long run. It becomes a matter of importance then to boiler-makers that their products be first class in every particular. The steam-user is not entirely free from criticism. His desire to drive a close bargain will often tell against his interests. Men generally get about what they pay for.

The setting of boilers is a very important matter, and upon this, in a great measure, depends their efficiency. It will pay the steam-user to employ men of known ability and integrity to build their boilers. Be willing to pay a fair price for a good thing.

Explanation of Table of Properties of Saturated Steam.

Having received several inquiries in regard to the table of properties of saturated steam published in the August (1882) number of THE LOCOMOTIVE, we take this opportunity to answer them all.

The table in question was computed in this office. It is intended merely to show engineers and others, at a glance, some of the more important properties of steam, such as the relation between temperature and pressure, total and latent heat (so called) of evaporation, etc., at different pressures above the atmosphere, or the pressures as shown by the gauge. It is *not* intended for a table to be used in nice calculations relating to steam. For this purpose much fuller and more convenient tables are to be found in almost any work on the steam engine.

The various formulae by which the relation between pressure and temperature, and the total and latent heat of evaporation as given in the table were determined, are, of course, based on the experiments of Regnault, who is our only *authority* in the matter. The densities and volumes were calculated by formulas based on the theoretical investigations of Rankine and the experiments of Tate and Unwin, who are our only experimental authorities on *these* points.

The following is the formula by which the temperatures were calculated from the given pressures. It was deduced by Mr. W. M. Buchanan from Regnault's experiments, and is quite accurate for temperatures ranging from 130° to 446° Fahrenheit. It is the simplest formula we know of which can lay any claim to accuracy. It is quite generally used in England, and the temperatures given in the steam table in the *Encyclopædia Brittanica* were calculated by it. It, as well as formulae (4), (5), (6), and (7), and a very complete table of the properties of saturated steam, may be found in D. K. Clark's well known *Manual*:

$$\text{temperature} = \frac{2938.16}{6.1993544 - \log \text{pressure}} - 371.85 \quad . \; . \; . \quad (1)$$

An example will show the application of the formula. Suppose we wish to ascertain the temperature of steam of 80 pounds pressure as indicated by the steam gauge.

The pressure as above shown by the gauge, 80 pounds per square inch, being the pressure above the atmosphere, we must add 14.7 pounds to obtain the absolute pressure from which all calculations are made.

Then $80+14.7=94.7$. The log of $94.7=1.97635$. So we have $\frac{2938.16}{6.1993544-1.97635}=\frac{2938.16}{4.223}=695.75$, and $695.75-371.85=323.9$ degrees, the required temperature.

The quantities in the third column of the table, the heat required to raise the temperature of one pound of water from 32° Fahr. to the temperature of evaporation, were calculated by our own formula, deduced from the results of Regnault's experiments. The ordinary formula in use for this purpose, $h=H-(1115.2-.708\,t)$ which is due to Clausius, does not, in our opinion, agree so closely with experiment as it should. Our formula is as follows:

$$h=t-32+\frac{(t-7)^3}{10{,}000{,}000} \quad \ldots\ldots\ldots \quad (2),$$

which agrees well with Regnault's figures from 32° to 400° Fahr., and is a much easier formula than Clausius's to work by if there is a table of cubes at hand. The application of the formula is as follows: Suppose we wish to ascertain the quantity of heat necessary to raise the temperature of a pound of water from 32° to 323.9° Fahr., the temperature due to a pressure 80 pounds per square inch above the atmosphere.

Then $t-32=$ 291.9
and $(t-7)^3=31{,}855{,}013$, which divided by 10,000,000= 3.18

Their sum=295.08

thermal units, the required answer. It will be observed that the division by 10,000,000 is performed by simply pointing off seven figures from the right of the given cube. In looking for the cube of $t-7$, it is always sufficient to take the *nearest whole number;* thus in the above example, $t-7$ which is 316.9°, is taken=317°.

The fourth column of the table, the latent heat of evaporation of one pound of steam, is calculated by simply subtracting the numbers in the third column from the corresponding numbers in the fifth column, or they may be computed by our formula, which is as follows:

$$L=1{,}113.94-.695\,t-\frac{(t-7)^3}{10{,}000{,}000} \quad \ldots\ldots\ldots \quad (3)$$

The application of this formula is similar to that of formula (2).

The total heat in one pound of steam at different pressures, as given in the fifth column of the table, was calculated by the usual formula based on Regnault's experiments, which is as follows:

$$H=1{,}081.94+.305\,t \quad \ldots\ldots\ldots \quad (4)$$

A single example will show its application. What is the total number of thermal units in one pound of steam at 80 pounds gauge pressure?

The temperature of steam at this pressure is 323.9° F. Then $323.9\times.305=98.79$ and $98.79+1{,}081.94=1{,}180.7$ thermal units.

The sixth column of the table was computed by Mr. Brownlee's formula, which was deduced from Prof. Rankine's well known expression, $pv^{\frac{17}{16}}=$constant. This formula was deduced by Prof. Rankine, partly from theoretical considerations and partly from the results of experiment. Mr. Brownlee's formula is merely a simplified form of Rankine's formula, and is as follows:

$$\text{Logarithm of density}=.941\log.\,p-2.519 \quad \ldots\ldots\ldots \quad (5)$$

This formula is very accurate for pressures from 1 to 250 pound per square inch absolute.

An example will show its application. Required the weight of a cubic foot of steam of 80 pounds gauge pressure.

80+14.7=94.7=absolute pressure. Log. 94.7=1.97635. .941×1.97635=1.859745. 1.859745—2.519=$\bar{1}$.340745=log. of the weight of a cubic foot in pounds. The number corresponding to this log. is .2192, the required weight.

The volume of one pound of steam being the reciprocal of its density, may be obtained by simply dividing 1 by the quantities in the sixth column. In this way the seventh column of the table was calculated. Thus using the last example, if one foot of steam at 80 pounds pressure weighs .2192 pound, the volume of one pound is $=\frac{1}{.2192}=$ 4.56 cubic feet. Or, the volume may be computed directly from the pressure by inversion of the above formula.

Thus Log. of volume=2.519—.941 log. p . . . . (6)

The relative volume of steam and water, or the number of cubic feet of steam from one cubic foot of water, may be found by simply multiplying the volume of one pound of steam by the weight of one cubic foot of water. This varies somewhat at different temperatures. In the table in question, the volume of the steam is compared with the volume of water at 62° Fahr. The weight of one cubic foot of water at 62 °Fahr.=62.355 pounds, and the quantities given in the last column were calculated by multiplying those in the seventh column by 62.355. For example, the cubic feet of steam at 200 pounds pressure, from one cubic foot of water at 62° Fahr.=2.11×62.355=132, or the result may be calculated directly from the pressure by multiplying Mr. Brownlee's formula (6) for volume, by 62.355 when it takes the form,
log. of cubic feet of steam from one cubic foot of water at 62°=4.31388—(.941×log. p) (7), which will give the same results as before. If it is wished to compare the volume of steam with water of any other temperature, we have simply to take the weight of a cubic foot of water at the given temperature, instead of 62.355. A few such weights are appended from D. K. Clark's *Manual:*

Weight of one cubic foot of water—

At 32°	Fahrenheit	=62.418	pounds.
" 39°.1	"	=62.425	"
" 62°	"	=62.355	"
" 100°	"	=62.022	"
" 212°	"	=59.76	"

The Eye and the Electric Light.

There is no doubt that staring at a powerful electric light is deleterious to the eyes. Most electric light engineers employ spectacles of blue or neutral tinted glass to examine the arc by. The cause of the damage done to the sight is generally attributed to the intense brilliancy of the light dazzling the optic; but recent experiments by M. Chardonnet show that the excess of ultra-violet rays may have something to do with it. He finds that the crystalline lens of the eye absorbs the ultra-violet rays of light, and that persons who have had it removed in operations for cataract can see the ultra-violet rays. As the electric arc is rich in ultra-violet rays, M. Chardonnet thinks they may fatigue the eye abnormally. The light of an incandescence lamp, such as that of Edison, gives out, on the contrary, little or no ultra-violet rays, and M. Chardonnet believes it, therefore, better suited to the eyesight. Nevertheless the incandescence lamp requires to be hidden from the eye by semi-transparent or clouded screens, for the intense brilliance of the carbon filaments cannot be looked at without impairing the eyesight, for a time at least.—*Engineering.*

The Locomotive.

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The Proper Construction of Feed-Pipes.

In our issue of last month we commented briefly upon the injurious effect of feeding cold water directly into a steam boiler through feed-pipes improperly located. We now submit cuts showing the arrangement which we have found by experience to be the best, under all circumstances, of anything yet devised.

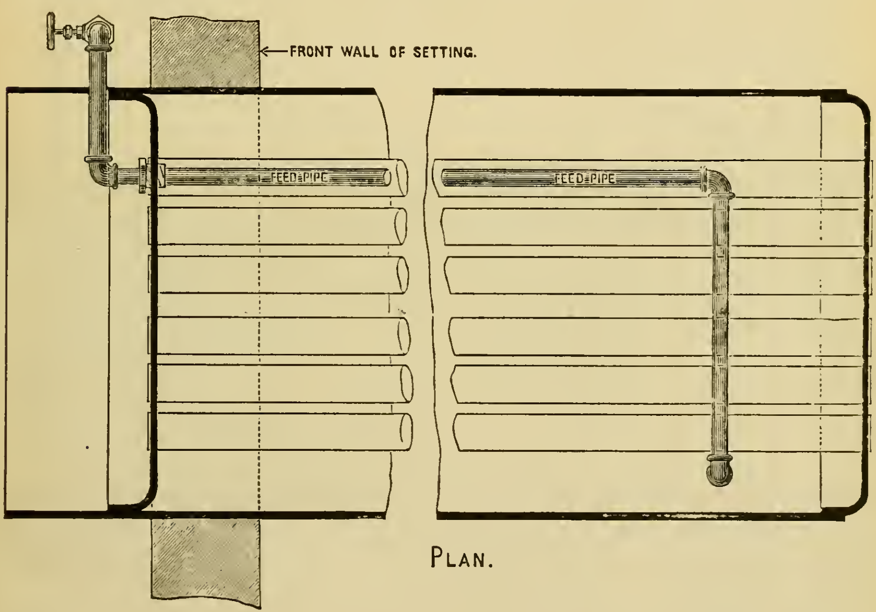


FIG. 1.

Fig. 1 is a horizontal section through the shell of an horizontal tubular boiler with a projecting front, showing the essential features of the construction. The pipe enters the front connection through the side of the projecting portion of the shell, then turns and enters the boiler through the front tube sheet, about three inches above the top of the upper row of tubes, then passes along to within about eighteen inches of the back tube sheet, then crosses over to the other side of the boiler and finally turns downward, so that the feed water is discharged between the tubes and the shell in the coolest part of the boiler. The feed water, being compelled to traverse the entire length of this long pipe, has time to acquire a high temperature before coming in contact with any part of the boiler shell, and thus any injury to the shell from local contraction is prevented.

Fig. 2 shows, on a smaller scale, a complete side elevation of the boiler in which the

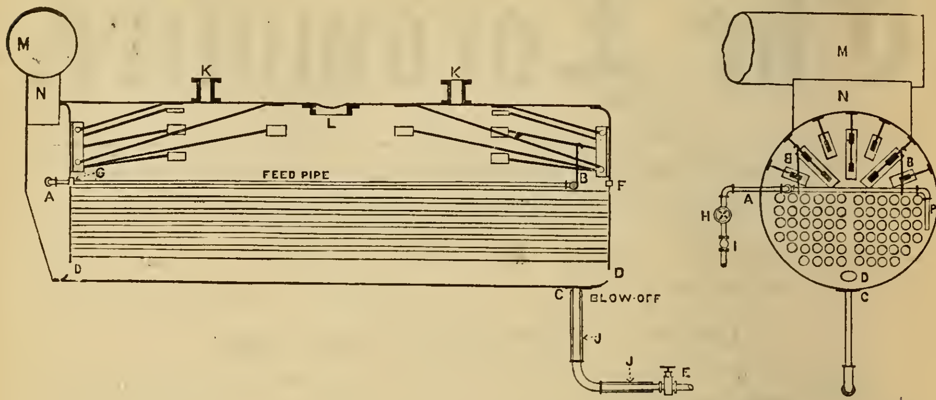


FIG. 2.

course of the pipe is fully shown. The back end of the pipe should be suspended from the head braces to keep it in position as shown.

Fig. 3 shows the arrangement of pipes for a battery of two or more boilers. In this case a larger pipe, from two to two and one-half inches in diameter, according to the number of boilers in the battery, is run along the front, just above the furnace doors, and the individual pipes for each boiler lead out of it. Each of these pipes should be

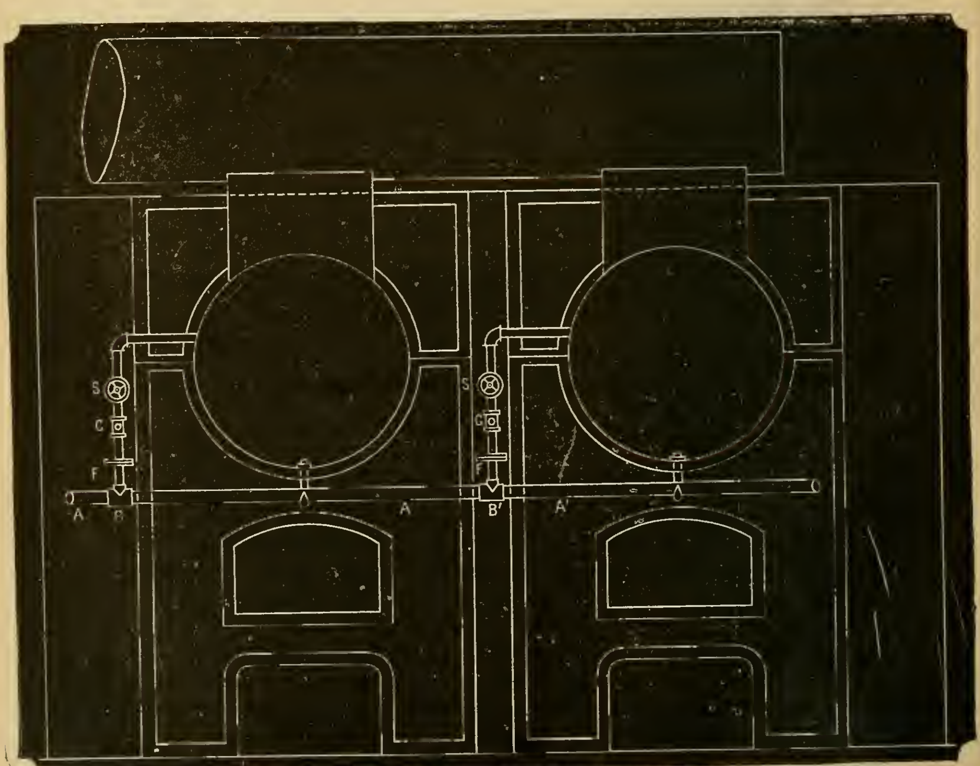


FIG. 3.

provided with its own independent stop-valve and check-valve, and each should have one flanged joint as shown. This makes it a very easy matter to disconnect either one of these pipes for repairs without disturbing any of the others. In the cut, two boilers only are shown. In a battery of two boilers, the tee shown at B′ would have a plug screwed into its end and the pipe would stop there; for more than two boilers, the pipe would be continued past this boiler as shown in the cut at A′, and so on for any required number of boilers. The whole arrangement is very neat, convenient and accessible, and is one generally adopted by the most experienced engineers throughout the New England States.

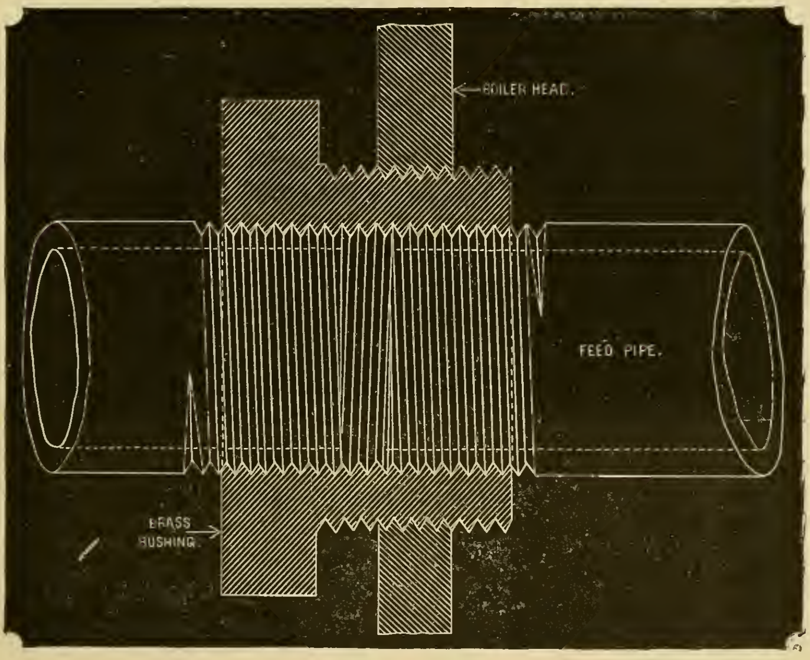


Fig. 4.

Fig. 4 shows the method of making the connection through the front tube sheet. A brass bushing is screwed tightly into the tube sheet. This bushing is drilled and tapped to receive the ends of the feed-pipe, which are firmly screwed up to make a good joint without their ends meeting. This makes a very substantial and durable job.

Boilers made by this company's specifications are always provided with this style of feed-pipe, and in many cases where fractured plates have resulted from the use of cold feed water, with pipes simply entered into the head or shell, this arrangement has been substituted upon our recommendation, and no further trouble has occurred.

At a recent meeting of the Society of Physical and Natural Sciences, at Karlsruhe, M. Bissinger made a communication on the magnetization of bars of steel and iron when broken on the testing machine. The phenomenon is not due to elongation of the bar, but to the actual breakage; and both parts are converted into two magnets of sensibly equal power. The shock and trembling of the metal is probably the cause of the magnetization. And here we are reminded of Professor Hughes' recent experiments. In the testing machine the bars are placed vertically, and the south pole is formed at their upper part. The different iron objects near the machine at the moment of rupture and vibration are also magnetized, but to a less degree.—*Engineering.*

Inspectors' Reports.

MARCH, 1883.

The summary of the work done by the inspectors of the Company for the month of March is given below. 2,746 trips were made by the inspectors, and 4,964 boilers were examined. Of this number 1,668 were examined internally, and 354 others were tested by hydrostatic pressure. 37 boilers were condemned; 3,385 defects were reported, of which number 631, or 18½ per cent. were considered dangerous, as per the following detailed statement:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	272	20
Cases of incrustation and scale,	334	25
Cases of internal grooving,	9	3
Cases of internal corrosion,	81	1
Cases of external corrosion,	159	24
Broken and loose braces and stays,	46	29
Defective settings,	104	14
Furnaces out of shape,	116	16
Fractured plates,	124	46
Burned plates,	71	18
Blistered plates,	260	51
Cases of defective riveting,	486	49
Defective heads,	34	12
Leaky tubes,	540	54
Leaky seams,	257	60
Water gauges defective,	136	34
Blow-out defective,	27	10
Cases of deficiency of water,	27	15
Safety-valves overloaded,	46	23
Safety-valves defective in construction,	38	19
Pressure gauges defective,	212	102
Boilers without pressure gauges,	6	6
Total,	3,385	631

AN artificial aurora has been produced by a Professor Lemström, of Helsingfors, in the following manner: On the tops of two hills, 2,600 feet and 3,300 feet in height, he placed a network of copper wires, about eight feet from the ground, and insulated after the manner of telegraph wires. To this system of wires he soldered several hundreds of pointed metal rods in a vertical position. Each system was connected by an insulated copper wire to a zinc plate, embedded deeply in the ground at the bottom of the hill. Upon making connection between the system of wires and the zinc plate, currents of positive electricity of varying intensities passed from the atmosphere down to the earth, while a yellowish-white light rose above the rods, showing in the spectroscope the characteristic lines of the aurora borealis. Rays of light 360 feet in length were observed to rise from the rods in one instance. The professor intends to repeat his experiments on a more extended scale.

BOILER EXPLOSIONS.

MARCH, 1883.

Saw mill (35).—A boiler explosion occurred March 1st in the box factory at Westville, Ind., owned by Timothy Johnson, and managed by A. O. Hatton. The cause was a poorly-repaired sheet. It was thrown through the factory and blacksmith shop, bringing up near a depot, about 500 feet distant. Hatton's body was found a few feet from the wreck, and near it the corpse of Henry Hilton, the engineer. Anderson Reynolds, aged 21, had both arms broken and received severe internal injuries. Grant Hinton, of the blacksmith shop, was thrown violently into a corn-field, several rods away, and escaped with slight injuries.

Saw Mill (36).—On March 2d, the boiler exploded in the mill of George H. Dodge & Co., located at Dowlon's Spur, Minn., between Rock Creek and Pine City. The machinery was considerably injured, and the building damaged slightly. A night watchman named Westerman was badly scalded.

——— (37).—A boiler, at the works of the Fuller & Johnson Manufacturing Company, Madison, Wisconsin, exploded March 3d.

Pulp Mill (38).—A boiler exploded in the mill of the Canada Pulp Company, at La Tortue, on Wednesday evening, March 7th. P. Murphy and D. Mason were blown through the side of the boiler-house, and were instantly killed. A workman named Maurice, and a number of others were seriously wounded.

Heating Boiler (39).—Henry Earnest, a Dayton & Michigan employee, was seriously injured March 8th, by the explosion of the Searl's heater, in one of the mail and express cars, which he was filling. Although there had been no fire in the heater for some hours, it exploded, and the plug struck him with great force in the breast. One of the unfortunate man's eyeballs was blown entirely out of its socket, and the other injured so that he will probably lose his sight.

Locomotive (40).—While on a side track, one of the locomotives attached to a freight train, on the Northwestern road at Rochelle, Ill., blew up. The engineer was instantly killed, his body being found some distance from the scene of the accident. The fireman is not expected to live.

Colliery (41).—One of the boilers of the Locust Spring colliery, near Locust Gap, Northumberland County, Pa., exploded March 11th. John Noble and Charles Richmond, Jr., were fatally scalded. The cause of the explosion is unknown.

Saw Mill (42).—The boiler in D. P. Nichols' mill, Abbotsford, Wis., blew up March 15th, killing Charles Rogansen, the engineer, and slightly injuring Ed. Wilkins, the sawyer, J. B. Risley, A. J. Bellfuss, the latter a merchant in Abbotsford. The engineer was found outside the mill, several rods away, on a pile of logs, with his jaw and one leg broken, and a cut on the back of his head. He lived but half an hour.

Bakery (43).—The steam boiler in the basement of the city bakery, Grand Haven, Mich., exploded March 20th, shattering the rooms above, and doing considerable damage to the store and meat market adjoining. The bakery is owned by Henry Van Werwen, who estimates his individual loss at something over $200.

Flax Mill (44).—The boiler of John Cassidy's flax mill, Knightstown, Ind., exploded March 23d. Con Cleary, the engineer, was killed outright. Frank Brosias was injured, and died in a few hours. (Another dispatch says the explosion was in the saw mill of Forbes & Applegate.—Ed. Loco.)

Paper Mill (45).—One of the rotary rag-boilers, in C. H. Dexter & Sons manilla paper mill, at Windsor Locks, Conn., exploded March 24th, completely destroying that portion of the mill in which the boiler was located. Two men were slightly injured.

Tug Boat (46).—The tow boat Polar Star, en route to St. Louis, exploded her boilers opposite Belmont. Mo., March 31st. The upper works were blown to atoms, and the hull drifted down the river. Captain Atkinson was blown about 300 yards, and was picked up by a skiff. The cause of the explosion is unknown. The following are known to be killed: Adam Murphy, fireman; Joe Bell, fireman (both colored); Sam Vantsel (white), watchman; and three colored roustabouts, Sandy Montland, Aaron Shield, and George Taylor.

Saw Mill (47).—The boiler in Fred. Myer's saw mill, at Leesburg, Ind., exploded March 31st, while the hands were eating breakfast. No one was hurt, but the mill is a total wreck. Loss, $1,200.

Saw Mill (48).—Lark & Pant's mill boiler, Round Lake, Mich., lately burst, shattering the building, but injuring no one, as the hands were all at dinner.

Killing Rats by Electricity.—Ralph Corbit, an ingenious twelve-year-old boy of Honeybrook, Chester county, has devised a novel plan of getting rid of the rats which infest his father's cellar. He has constructed out of old fruit jars a battery of three Leyden jars, which he connects and places upon a large iron plate which touches the tin foil on the outside. The bait is so arranged that when the rat steps upon the plate and seizes the bait, he at once makes the connection between the outside and inside of the jars and they are discharged through his body, killing him literally as quick as lightning. He charges the jars by means of an electrical machine, also constructed by himself. He ran a couple of wires through the floor to the cellar from the room above, and as soon as he would hear a rat squeak, he would immediately recharge the battery. The first time he put the machine in operation he slaughtered twenty-five rats in a space of three hours, and in two days the cellar was entirely cleared of the pests.—*West Chester Local.*

At the recent meeting of the National Academy of Science held in Washington, Dr. S. Weir Mitchell read an interesting paper on the Effect of Serpent Poison, a subject which he has been investigating for the past twenty years. His conclusions are as follows: Up to this date all observers have regarded the venoms as representing a single poison. We have been able to show that the venom of the moccasin and *C. Adamanteus* contains three proteids—one analogous to peptone, and a putrefacient; one akin to globulin, and a much more fatal poison, probably attacking the respiratory centres, and destroying the power of the blood to clot; and a third resembling albumen and probably harmless. Finally we have learned that the poisons of the rattlesnake, *C. Adamanteus*—copperhead, *Agkistrodon Contortrix*, and moccasin, *Toxicophis Piscivorus*—are capable of being destroyed by bromine, iodine, hydro-bromo acid (33 per cent.), sodium hydrate, potassium hydrate, and, as Lacerda has shown, by potassium permanganate.

By a recent boiler explosion at St. Dizier, France, twenty-six persons were killed and thirty-eight injured. St. Dizier is a manufacturing town in the Department of the Haute-Marne, about ten miles north of Vassy.

The Locomotive.

HARTFORD, MAY, 1883.

The bill recently before the Ohio legislature, authorizing companies to do an unlimited number of different kinds of insurance, on one and the same capital, was defeated. The sound sense of the better portion of the citizens of the State was entirely opposed to it, and the legislature did itself credit in refusing to pass the bill. Similar privileges were asked of the authorities of the State of New York several years ago, but the request was not granted. There will be, without doubt, efforts made in the same direction before other legislatures in the future; and it becomes a serious question in every State, What shall our insurance legislation be? Shall the laws be so framed that our citizens shall be free from adventurers in this business, or shall the flood gates be opened wide to any and all kinds of speculation in the business of insurance? The success of large corporations in any department of business has been attained by single and careful fidelity to its one business. Men who aim to do a great many kinds of business rarely succeed in any. We firmly believe in the policy that one class of business intelligently managed is the best for all parties concerned. In the business of insurance it is eminently so. Discredit cast upon the methods or management of insurance companies creates distrust, and acts more or less injuriously upon all.

The unveiling of the statue of Professor Henry in the grounds of the Smithsonian Institution, at Washington, occurred recently. President Noah Porter of Yale College delivered the oration. The statue is in bronze, of heroic size. Its execution was committed to the sculptor, W. W. Story. On the back of the programme of the day was the following brief epitome of Professor Henry's scientific career: Henry was the first inventor (1828) of the "spool wound" magnet, capable of being actuated through a long conducting wire of great distance. He first devised and operated an electro-magnetic telegraph, with a bell signal (1830-1831) at Albany, through the circuit of a mile of copper wire. He first invented the electro-magnetic engine (1831), employing the first automatic commutator or pole-changer. He first discovered (1832) the self-induction of an electrical current on passing through a long conductor. He first devised (1835) a compound telegraphic circuit by which the primary circuit, enfeebled by distant action, may control a local secondary circuit of great power. He first discovered (1838) the successive orders of electrical induction in a series of closed circuits. He first discovered (1842) the oscillating character of an electrical discharge. He first showed by the thermo-galvanometer (1845) that the solar spots radiate less heat than the surrounding photosphere. He first established, through the agency of the Smithsonian Institution (1849), a system of simultaneous meteorological observations by telegraph, the results of which were daily plotted on a map, and weather forecasts made from them.

Prof. Longley recently read a paper on "The Spectrum of an Argand gas burner," giving the results of his experiments in determining the relative proportions of waste and light in the production of gas. His conclusions were that of the total amount of energy expended in the gas-making process only one per cent. results in light, while ninety-nine per cent. represents clear waste.

Bracing and Supporting Long Cylinder Boilers.

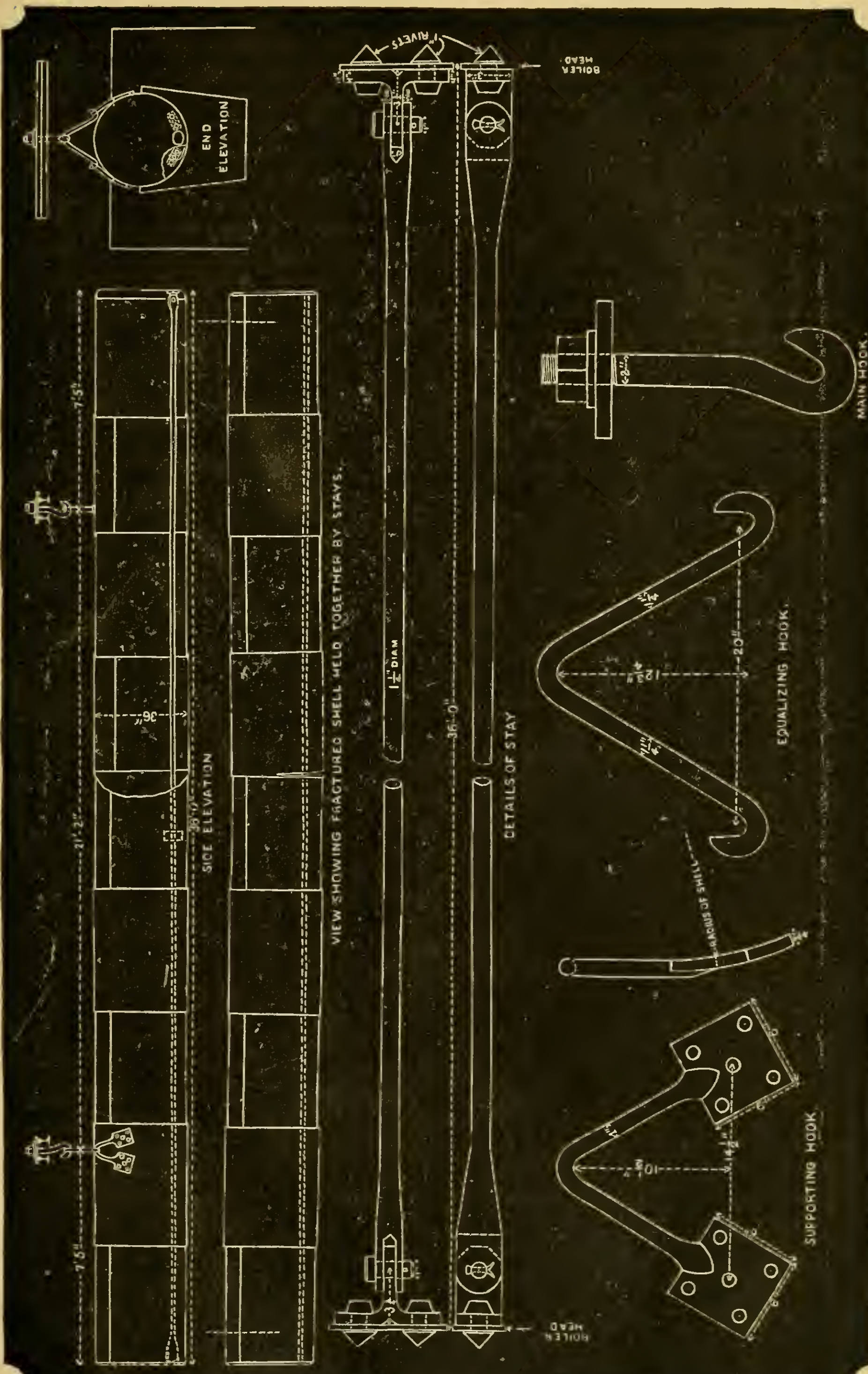
In the Locomotive for February last we gave an account of the explosion of a long plain cylinder boiler, with a discussion of some of the peculiar dangers attending the use of this type of boiler, unless special precautions are taken in their construction and management. Two most important points to be observed in their construction and setting are, the longitudinal bracing or tying together, and the method of supporting them.

The accompanying cuts show some of the details of construction relating to these points, for a boiler 36 inches in diameter and 36 feet long. The first figures in the cut show the different elevations of the boiler, in which the longitudinal bracing and the supporting hangers are plainly represented. The fore and aft braces, it may be observed, are not for the purpose of bracing the heads, but simply to hold the two halves of the boiler together in case of rupture at the girth seams, as shown in the second figure in the cut, until the boiler can be put out of use. We have known of cases where rupture has occurred at the girth seams of cylinder boilers for a length of half the circumference of the shell, yet these stays held the two halves of the boiler together, and prevented the explosion, which would inevitably have occurred in their absence. It is quite unnecessary to remark that the end fastenings of these stays should be of the most substantial and reliable construction.

The methods of hanging or supporting this class of boilers have been very fully discussed in previous numbers of the Locomotive. (See Vol. II, New Series, March 1881.) A self-adjusting or compensating hanger recommended for the middle support of the boiler, which will always adapt itself to any changes of position resulting from expansion of the boiler shell. Some such arrangement as this ought to always be used for boilers above 30 feet or so in length, and might be applied with advantage to those of all lengths. But for boilers under 30 feet in length two hangers are to be preferred to three, unless the middle one is of the compensating kind; but care should be used in placing them so that no undue strain may be brought on the girth seams near the middle of the shell. The hangers should be so located that the downward bending moment in the center of the shell shall be equal to the upward bending moment at the points where the hangers are attached. When this condition is fulfilled, the strains resulting from these moments are a minimum. To fulfil this condition the distance from ends of boiler to center of hanger should be $\frac{1}{4.83}$ part of the entire length; or, practically, three-fifths of the length of the shell should lie between the hangers, and one-fifth should project beyond the hanger at each end. By placing the hangers in this manner the strains on the girth seams resulting from the weight of the boiler and its supply of water are reduced surprisingly from those which obtain when the supports are placed close to the ends of the shell. Thus, in the boiler shown in the cut on opposite page, the hangers should be placed about 7 feet 5 ins. from the ends. Then the strain on top of the shell at the points where the hangers are attached, is equal to that brought on the under side of the shell at the middle of its length, and which is caused by the weight of the excess in length of that portion of the shell between the hangers over that projecting beyond them at either end.

The details of both the stay rods and hangers require no explanation. The dimensions given are suitable for a boiler 36 feet long by 36 inches in diameter. For other sizes they would, of course, be different.

The electric light in the lighthouse at Sydney, N. S. W., will be the largest of the kind in the world. The merging beam is said to have a luminous intensity exceeding 12,000,000 candles.


END ELEVATION
SIDE ELEVATION
VIEW SHOWING FRACTURED SHELL HELD TOGETHER BY STAYS.
DETAILS OF STAY
1" RIVETS
BOILER HEAD
36'-0"
21'-2"
MAIN HOOK.
EQUALIZING HOOK.
SUPPORTING HOOK.
RADIUS OF SHELL
20"

Fuel for the Army.

We have recently received from Quartermaster-General Meigs a very interesting pamphlet, with the above title, showing the results of experiments made under his direction to determine the calorific value of different varieties of coal. The experiments included about every variety of American coal and a few samples of English coal. The object of the experiments was to determine the relative value of the different coals supplied to the U. S. army for fuel, and the equivalent value of the same in cords of oak wood, and appear to have been very carefully carried out. The measure of value is, of course, the quantity of water evaporated from and at 212° F. per pound of coal. Two series of experiments were made; one with Snyder's "Little Giant" boiler, and another with an improved vertical water tube boiler designed by Gen. Meigs. This latter boiler gave very excellent results for a small boiler of the vertical type. We append a portion of the summary of experiments with the last-named boiler.

COMPARATIVE STATEMENT OF RESULTS OF THE EXPERIMENTS IN EVAPORATING WATER BY THE VARIOUS COALS USED AT MILITARY POSTS AND STATIONS.

RESULTS OF EXPERIMENTS WITH BOILER DESIGNED BY GENERAL M. C. MEIGS.

	Designation of Coal.	Mine, where located.	Percentage of combustible in coal.	Number of lbs. of water evaporated per lb. of coal from atmospheric pressure and 212°.	Equivalent in lbs. of coal per one cord of standard oak.
1	Semi-bituminous, Standard Coal Co.,..	Brothers Valley, Somerset County, Pa.,.......	88.99	9.85	1,521
2	Semi-bitu'nous, Philson Iron Coal Co ,	Berlin, Somerset County, Pa.,................	90.92	9.75	1,537
3	Forest Improvement anthracite,......	Richardson colliery, Schuylkill County, Pa.,...	79.43	9.37	1,598
4	Wilkesbarre anthracite,..............	Black Diamond, Northumberland County, Pa.,	80.77	9 37	1,598
5	Scranton anth'cite, Del.& H. Canal Co.,	Luzerne County, Pa.,..........................	77.3	9.28	1,614
6	Lykens Valley anthracite..............	Danphin County, Pa	83.97	9.07	1,651
7	Bitu'nous c'l, Simpson, Horner & Sons,	Monongahela River, Pa.,.....................	92.15	9 07	1,653
8	Los Cerrillos anthracite,.	Ortez grant, New Mexico,.....................	88.25	9.04	1,657
9	Scranton anth'cite, D.,L.& W.R.R.Co.,	Luzerne County, Pa.,..........................	82.85	8.87	1,6-7
10	Bituminous coal, T. Fawcett & Sons .	Near Pittsburgh, Pa.,..........................	94 04	8.78	1,706
11	Los Cerrillos bituminous,.	Ortez grant, New Mexico.....	86.74	8.60	1,742
12	West Virginia splint,................	Paint Creek, West Virginia,....	91.90	8.34	1.796
13	Free-burning medium hard,...........	Raven Run mine,........................	81.20	8.24	1,818
14	McAllister coal,.....................	Tobosky Co., Choctaw Nation, Indian Territ'y,	94.20	7.68	1,950
15	Scotch splint (Duke of Hamilton),...	Glasgow,.........	93.28	7.61	1,970
16	Davison, West Hartley,...............	West Hartley district,........................	94.01	7.60	1,970
17	South Wellington coal,....	S.Wellington col'ry, Departure Bay, Vanc'v's I.,	91.83	7.59	1,974
18	Cowpen, West Hartley................	Cowpen colliery, Newcastle upon-Tyne,.......	93.89	7.52	1,993
19	Bituminous coal, Mitchell & Co.,.....	La Plata mine, near Fort Lewis, Colorado,....	89.10	7.49	2,000
20	Indiana cannel coal.....	Daviess County, Indiana,......................	75.18	7.32	2,040
21	Nanaimo coal, ...	Chase River, Nanaimo, Vancouver's Island,...	86.76	7.30	2,070
22	Cowpen Cambois, West Hartley,......	West Hartley district,........................	93.79	7.04	2.129
23	Wellington coal,.....................	Wellington mine, Departure Bay, Vancouv's I.,	90.62	6.71	2,233
24	Bituminous Leavenworth coal,.......	Leavenworth coal shaft, Leavenworth, Kans.,.	88.91	6.49	2,307
25	Bituminous cañon coal,.......	Coal Creek colliery, Fremont County, Col., ...	90.	6.45	2,323
26	Bituminous coal,..........	Chestnut mine, Rock Creek Cañon, Montana,.	67.57	6.07	2,466
27	Rocky Mountain coal,...............	Rock Spring mine, Nebraska,.................	93.50	6.01	2.491
28	Eastport, Coos Bay coal,.............	Mine at the head of the Coos Bay, Oregon.....	91.16	5.24	2,859
29	Pittsburg coal,.......	Pittsburg Mount Diablo mine, Somersville, Contra Costa County, Cal.,.................	89.	5.05	2,965
30	Weber coal..........................	Chalk Creek, Summit County, Utah,..........	89.98	4.73	3,168
31	Lignite coal, ...	Military Reservation, Fort Stevenson, Dakota,	93.77	4.03	3,712

The Fall of a Chimney at Bradford, England.

We have received from Mr. John Waugh, Chief Engineer of the Yorkshire Boiler Insurance and Steam Users' Co., Limited, a copy of his report to the directors of his company, on the disastrous fall of the chimney at Newland's Mill, Bradford, on the 28th of December last. We append the following extracts from the report:

"The history of the chimney is as follows:

"The late Sir Hy. Wm. Ripley, Bart., was desirous of erecting a chimney, and in May of the year 1862 sent for a firm of builders to give a tender. There were no plans or specifications prepared at the time the tender was given. The following dimensions formed the basis of the tender: Chimney to be 80 yards high, 9 ft. flue; base 24 ft. square, with two courses of footings 12 in. thick, the first 28 ft. square, and the second 24 ft., placed on a good bed of concrete at the bottom as a foundation. Towards the end of May, a site was selected for the erection of this ponderous structure. An old coal shaft was chosen as the center, and it was decided to fill up the old pit with concrete, thus forming a center pillar. It was also decided to put down four piers of lime concrete, and upon these five pillars a tabling of lime concrete, 2 ft. 6 in. thick, the base courses or footings of the chimney resting upon this lime concrete. Care was also taken to pack the old works, which were found to surround the old shaft, with stones and oak wedges.

"Before the erection of the chimney, the clerk of the works is said to have advised either dressed insides or solid brick-work. This, however, was not adopted, and in July, 1862, the first courses—stones outside, brick lining inside, and 'backing' in between the two—were commenced. Before the ground level was reached the building was formed into a regular octagon, and so carried forward with a regular batter of $\frac{7}{8}$ in. to the yard, reaching to a height of 40 yards. From December, 1862, to the 28th of February, 1863, the works were stopped. On the latter date, work was resumed.

". . . From March to the 7th of June, some 30 more yards were added, making the structure 70 yards in height. On the evening of this day the chimney was left plumb.

"On the morning of the 8th of June, the foreman-builder detected something wrong with the chimney. 'It was bulged out on the one side and hollow on the other. We stopped work, and I went and fetched the employers.' (Evidence of Joseph Moulson, foreman builder.) So far as can be remembered, the night of the 7th of June was a calm night.

"Sights of the chimney were taken and recorded, showing the exact amount of deviation from the plumb line. A man famous for chimney repairing and straightening was called in, and the work of straightening the chimney was entrusted to him.

"About eighteen yards from the ground line, a course of stones was cut out on the opposite side to the canting over. Two men out and two inside with long chisels cut away, say, for 1 ft. wide on the outside, a 7-in. stone course and through the backing; from the inside through the brick lining, and meeting the opening cut through the backing from the outside. This space was filled up with stones $\frac{1}{2}$ in. less in thickness than the depth of the stones cut out. On the top of these substituted stones long feather-edged iron wedges were placed to make up the $\frac{1}{2}$ in. difference. This operation was continued nearly half way round the chimney, with the exception of the angles which were left in.

"Before proceeding to draw the wedges, mastic cement was introduced by means of syringes on to the surface of the stones. The wedges were withdrawn by means of large hammers, used by the men inside and outside the chimney, knocking them from side to side. 'When we moved the wedges a bit, it seemed as if men were striking a forty-horse boiler: that was the throughs breaking.'

"This operation did not bring the chimney plumb, and a second cut was decided upon and carried out by Woodman, about 2 feet above the first cut, with the same result as to the breaking of the throughs. When the weight came over, described by another witness—John Dobson—(*i. e.*, by the withdrawal of the wedges), 'I heard noises like the discharge of pistols.'

"However, the chimney was declared to be as nearly perpendicular as possible. The corner stones were crushed, by the upper portion of the chimney coming over, for some 12 feet above and 12 feet below the cuttings. These were replaced, and the chimney was declared to be straight, and Woodman's work was accomplished. The chimney was then carried upwards to its completion.

"About three years after its completion, the chimney was found to be cracked and broken on the opposite side to that on which the cuts had been made. About seven weeks were employed in effecting the necessary repairs.

"Some ten years ago cracks were noticed, and the chimney was repaired about that time. In October of last year, one or two of the tenants in Newland's Mill began to be uneasy about the cracks in the chimney. . .

"These cracks, towards the end of December, developed into bulges. Builders, architects, and others were called in to examine. It was decided to pull out the bulges and repair the outer casing, the general opinion being that the outer casing alone was at fault.

"On Saturday, the 23d of December, the 'damaged portion of the outside walling, about ten yards in length,' was pulled down. This was on the east side. There was also a damaged piece on the southeast face, which it was thought desirable to remove, and an attempt to remove it was made. The stones of the outer casing were so tightly nipped together, although standing some 3 in. from the backing, that the attempt to remove the bulge failed.

"On the Tuesday following, that is, December 26th, some small portion of the outer casing fell. On Wednesday, a large piece of the outer casing fell, breaking down the scaffolding erected for the purpose of repairing the chimney. This was the portion of the outer casing which could not be removed on the Saturday previous.

"The night of the 27th was windy, amounting to half a gale, or about 16 lb. per foot super of wind pressure. On the morning of the 28th, before the mill had stopped for the breakfast half-hour, more stones of the outer casing fell out. A few minutes past eight o'clock, the chimney began to settle down, bursting out stones and lime on all sides about the place where the chimney was cut. For a few seconds, the crushing down and bursting out of the lower portion of the chimney by the weight of the upper portion continued, then, reeling a little, as if uncertain as to the direction in which it would fall, the upper portion fell in a southeasterly direction, killing fifty-four persons, and destroying an amount of property estimated at 20,000*l*.

"So much for the history of the chimney.

"A few observations only are necessary in addition to the evidence I gave at the inquest In the first place, the site selected—an old coal-pit, surrounded by old workings—was unfortunate. Every possible care was taken to pack these with stones and oak wedges, but no amount of care can make old workings solid. . .

"The piers of lime concrete ought never to have been put in to carry a weight of 4,000 tons. The foundations for the chimney, under the circumstances—old coal-pit and old coal workings—ought to have been from the coal seating itself, brought up solid, not resting upon a table top, even with five legs or pillars under it, composed of cement concrete; and it must be remembered the pillars upon which the chimney was built were composed of lime concrete. The structure was not homogeneous, nor could the introduction of throughs, one to the yard on each face, make it so. . .

"There may be doubts in the minds of those who patiently investigated this disaster as to whether the chimney went out of plumb during the night of the 7th of June, 1863, owing to the subsidence of the foundations. In my mind there is no doubt whatever. Looking at the foundations from an engineering point of view, I don't hesitate to say that they were bad for the purpose. Those who were engaged on the work at the time thought so too. . .

"From the subsidence of the foundation, or other cause, the chimney was discovered to be out of plumb, and Mr. Woodman agreed with the owner to straighten it. I have already described the *modus operandi*. In a word, Woodman gave to the chimney its death blow. The first cut was a source of great weakness to the structure. Whilst the cutting was only partly round the chimney, when the weight was brought over the chimney would open on the opposite side. The breaking of the 'throughs' above and below the cut no doubt must have destroyed the cohesion of the inner lining, backing, and outer wall stones.

"But the second cut, within two feet of the first, with all the evils of the first cut repeated! It is not to be wondered at that the chimney fell; but the wonder is that the structure stood so long as it did. From the day these cuts were effected, the interven-ing 2 feet of the chimney has been pounded by the rocking of the upper portion; and no wonder that in the end the chimney gave way just where it did. . .

A Singular Case of Corrosion of Steel, by Prof. Chas. E. Munroe, U. S. N. A.— Through the kindness of Chief Engineer Farmer, my attention has recently been called to the appearance of two cold chisels found in the U. S. S. "Triana" in 1874, and which have since been preserved in the Department of Steam Engineering at the Naval Academy. These chisels were taken from the channelway leading from the jet condenser, and they were located between the foot valve and the air pump. Both chisels were of steel throughout, as was proved by tempering the head. For use, of course, only the points had been tempered. During the time of exposure to the action of the salt water in the channelway the chisels were deeply corroded, but the corrosion was confined entirely to the soft metal, the tempered points not being attacked in the least. The corrosion was deepest at the line of contact between the tempered points and the untem-pered metal of the haft. The line of immersion, on tempering, is as distinctly marked as if drawn with a shading pen. Since meeting with these chisels I have heard of a similar case of corrosion, although the object has been lost. It was a hammer which had been taken from the boiler of a merchant steamer, the tempered faces of which were intact, while the soft metal was corroded.

Remembering the heated discussion going on in metallurgical circles on the question "What is Steel?" I shall not attempt to decide whether the change which takes place in the tempering of steel is a chemical or a physical one; but it is evident that this change produces a body which is not so readily acted upon by salt water as untempered steel is. It is also probable that when the untempered and tempered steels are brought in contact in the presence of salt water we have an electro-chemical couple, and that this hastens the destruction of the untempered metal. I beg to suggest that this observation may have a practical bearing upon the construction of steel ships.—*Proc. U. S. Naval Institute, No.* 21.

An exchange says that a varnish composed of 120 parts of mercury, 10 parts tin, 20 parts green vitriol, 120 parts water, and 15 parts hydrochloric acid of 1.2 specific gravity, furnishes a good protective coating for iron exposed to the weather.

Experiments on Flanging Steel Plates cold by Hydraulic Pressure.

We clip the following from *Cotton, Wool, and Iron.* It was communicated to the Institution of Mechanical Engineers by Messrs. Easton and Anderson of London, and was originally published in *Iron.*

A pair of moulds were made to fit a hydraulic press, capable of exerting a pressure of about 250 tons. They were so shaped that, at one operation, they would make a flange both on the outside and inside of an annular steel plate, and thus produce a double-flanged annulus. A taper was given to the moulds, to facilitate the removal of the plate after flanging. There was a slight hollow, one-eighth inch deep, formed on the annular face of the upper mould, and a corresponding rounding on the lower one, to flatten the face of the plate. Experience showed that in this mould, and also in the second mould, a depth of one-sixteenth inch would have been sufficient. The plates were Landore Siemens S. S. quality, three-eighths inch thick. Their edges were beveled in the lathe, to an extent of one-eighth inch in the thickness on the inside, and one-sixteenth inch on the outside edge; after flanging, a slight bevel suitable for caulking still remained. Both the outside and inside circles were cut out in the lathe. These first moulds, not proving altogether satisfactory, were altered in shape, and turned on the working faces. The first plate was successfully flanged cold, with a pressure of about 250 tons. In the second plate, a little deeper flange was attempted, but it cracked at the inner flange. A plate of S. flanging quality was then annealed and tried cold; but it cracked in six places on the inner flange. A similar plate, not annealed, also cracked, but in one place only. Some more S. S. plates were then ordered, specially for this work, and were flanged cold and unannealed. The first one cracked in the inner flange; but this was probably due to an attempt to get a very deep flange, standing up about $2\frac{9}{16}$ inches from the under side of the plate; the next, with a flange of about $2\frac{3}{8}$ inches deep, did not crack. The third cracked at the bend of the external flange, on the outside, showing a crack about three inches long nearly through the plate. A plate annealed for about four hours, and pressed when cool enough to be held in the hand, cracked badly at the inner flange. Two others, annealed for about sixteen hours, turned out quite sound. A batch of twelve, heated in a plate-furnace and cooled in ashes for forty-eight hours, were then flanged with perfectly satisfactory results, there being no sign of cracking even on the inner edge of the hole, where the best unannealed plates had shown slight signs of skin cracks, started, no doubt, by the roughness of the sharp edge. Another lot were annealed for about sixteen hours; but having had a thick layer of ashes over them, they were still warm when pressed. Out of four which were flanged, two cracked, one slightly on the inner edge and one very badly. The rest of these were put back to be carefully re-annealed, and out of the fourteen twelve were sound. In all these annealed plates, the actual duration of the flanging process in the mould had been very short, from one-fourth minute to one-half minute. Another lot of twenty-one plates, thoroughly annealed, were now flanged, allowing the operation to extend over about $3\frac{1}{2}$ minutes; and, at the same time, the ragged edge round the hole was carefully filed off, so as to give no starting place for a crack. The result appeared to be satisfactory, as only two cracked, and those not badly. The approximate thickness of the edge of the external flanges was thirteen thirty-seconds inch, showing an increase of one thirty-second inch; that of the internal flange was five-sixteenths inch, showing a reduction of one-sixteenth inch. The average pressure required for the annealed S. S. plates was about 200 tons. It would seem, as a general result, that for cold flanging, involving compression only, as on the outer flange, these plates, even of the lower or S. quality, are perfectly trustworthy, even unannealed; as only in one case did a crack appear in the external flange. But for flanging involving considerable stretching of the material, as on the inner flange, only S. S. quality will do at all, and the slightest irregularity in the metal will cause a crack. The results showed that this might be expected in from ten to fifteen per cent. of the plates.

The Rational Limit of Safety for Materials.

It is evident, says Professor Wood, that materials may be strained any amount within the elastic limit. Their recuperative power, if such a term may properly be used in connection with materials, lies in their elasticity. If that is damaged the life of the material is damaged and its powers of resistance are weakened. There is no known relation between the coefficient of elasticity and the ultimate strength of materials. The coefficient of elasticity may be high, and the modulus of strength comparatively low. In other words, the limit of elasticity of some metals may be passed by a strain of less than one-third their ultimate strength, while in others it may exceed one-half their ultimate strength. We see, then, the unphilosophical mode of fixing an arbitrary modulus of safety, or even a factor of safety, when it is made with reference to the ultimate strength. But an examination of the results of experiments shows that the limit of elasticity is rarely passed for strains which are less than one-third of the ultimate strength of the metal, and hence the factors of safety which are commonly used in practice are generally safe. But if the limit of elasticity were definitely known, it is quite possible that a smaller factor of safety might sometimes be used. This method of determining the limit has been recognized by some writers, and the propriety of it has been admitted by many practical men, but the difficulty of determining the elastic limit has generally precluded its use. The experiments which are necessary for determining it are necessarily more delicate than those for determining the ultimate strength.

In regard to the margin that should be left for safety, much depends upon the character of the loading. If the load is simply a dead weight, the margin may be comparatively small; but if the structure is to be subjected to percussive forces or shocks, it is evident that the margin should be comparatively large, on account of the indeterminate effect produced by the force. In the case of railroad bridges, for instance, the vertical posts or ties, as the case may be, are generally subjected to more sudden strains, due to a passing load, than the upper and lower chords, and hence should be relatively stronger. The same remark applies to the inclined ties and braces that form the trussing, and to any parts that are subjected to severe local strains.

In machines that are subjected to a constant jar while in use, it is very difficult to determine the proper margin which is consistent with economy and safety. Indeed, in such cases economy, as well as safety, generally consists in making them excessively strong, as a single breakage may cost much more than the extra material necessary to fully insure safety. The mechanical execution of a structure should be taken into consideration in determining the proper value of the margin of safety. If the joints are imperfectly made, excessive strains may fall upon certain points, and to insure safety the margin should be larger. No workmanship is perfect, but the elasticity of materials is favorable to such imperfections as necessarily exist; for when only a portion of the surface which is intended to resist a strain is brought into action, that portion is extended or compressed, as the case may be, and thus brings into action a still larger surface.—*Mechanics.*

There are said to be 18,000 locomotive engines in use in the United States. Pennsylvania has the largest number, 5,700, while in New England there are but 1,700.

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The Locomotive.

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New Series—Vol. IV. HARTFORD, CONN., JUNE, 1883. No. 6.

Explosion at a Bending Works.

We illustrate in this number portions of a boiler from the scene of a terrific explosion which occurred in one of our western cities, by which one man was killed, and boilers, buildings, and machinery, estimated at some fifteen thousand dollars, was destroyed.

The boiler was one of two used, of the marine return tubular type, 12½ feet long, 54 inches in diameter at shell, built of iron, .289 of an inch thick; as no brands were found, it would be fair to assume that the material was of only ordinary quality, and this appeared also to be confirmed by an inspection of the ruptured sheets. The boiler was about ten years old, and had been repaired several times; practically rebuilt at time of last repairs, some eight months previous. Those controlling the boiler regarded it as in safe running order at a pressure of 80 lbs., which was the ordinary working pressure. Up to within a year the work had been much heavier, and a working pressure of 90 to 100 lbs. had been maintained.

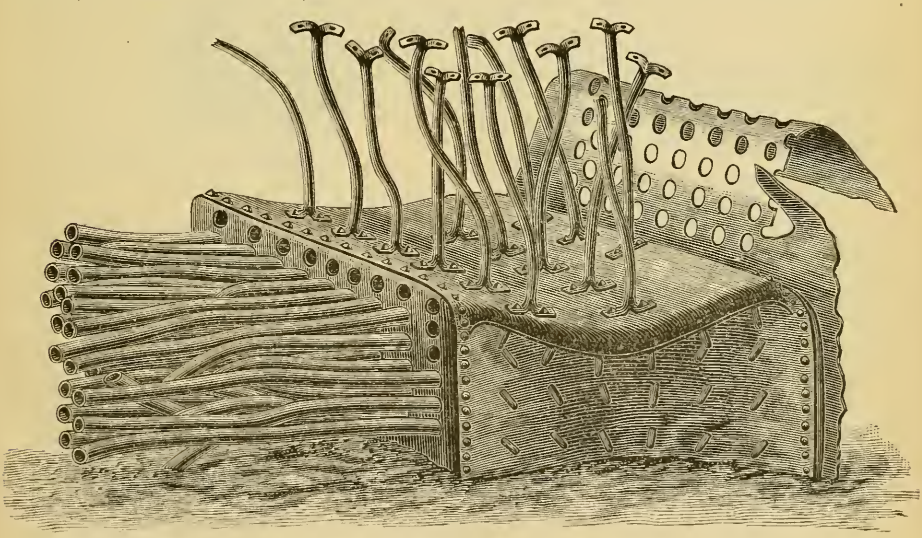


Fig. 1.

The fuel was shavings and the refuse of a wood-working mill, mixed with coal when that was insufficient.

The feed-water was from a well upon the premises, pumped through an open heater, which, while heating the feed to a good temperature, did not prevent its forming a troublesome limy scale upon the shell and tubes of the boiler. There was a muddy deposit as well, from that or some other source.

The design of the boiler was ill adapted to the locality and work, for it had been necessary to remove the tubes about once a year to dislodge the scale and deposit from between the rows, so we were informed; indeed, that was the only way in which it could be done. The day preceding the explosion the boiler had been shut down under repairs, which were not completed until late in the evening, at which time the night-watchman began filling the boiler with water preparatory to getting up steam for the next day's work. The repairs referred to were about the steam-dome, and the water-level in the boiler was lowered enough to permit the boilermaker to stand upon the tubes while doing the work. In filling up again, which had to be done by hand, a man who assisted the watchman stated that he carried some three hundred pails of water, which were poured in through the man-hole until the water gauge-glass indicated that there was enough. From that time until six o'clock in the morning, the time of the explosion, the watchman was alone, and nothing is known of what transpired, except so far as it is revealed by an examination of the exploded boiler.

THE STORY OF THE WRECK.

It appeared that the initial rupture occurred about the wagon top on left-hand side of No. 1 boiler, probably about the base of the dome, for that boiler was not lifted from the ground, but was shifted around upon its base, so that it stood nearly at right-angles to its former position. The adjacent boiler, No. 2 (which had not been in use for some time previous), on the right-hand side, was moved some ten feet to the left and occupied about the same relative position when found.

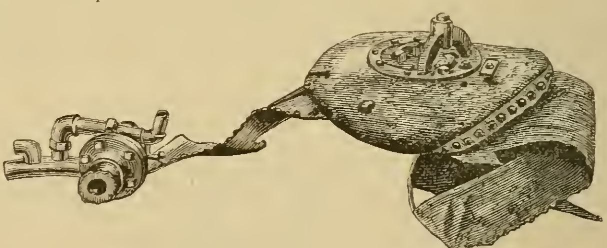


Fig. 2.

It appears probable that the initial rupture occurred about the base of the dome (Fig. 2), from the fact that that part of the boiler was stripped off and projected to a considerable height, and was afterwards found in a yard about 800 feet away. It is assumed that the secondary rupture was of the horizontal seam on top of boiler, releasing the side sheets of furnace, which turned downwards, straightened out, ripped and tore in the line of screw-stays on the sides, but remained attached to the base.

The crown-sheet stays (Fig. 1), it will be observed, are curved to the right and left from the centre line where they attached to the wagon-top, indicating the direction of the force exerted when the horizontal seam yielded. The tubes, with a few exceptions, pulled out of both heads, and a ring of plates containing the smoke-box and back-head (Fig. 3), which was set in a wall forming part of the masonry setting, was wrenched off and projected endwise into an adjoining room, destroying some valuable machinery; a trip-hammer lying in the path of its projection was moved about six feet from its foundation, badly broken, and a portion of the frame and cylinder remained attached to it, as shown in this figure. The bottom plate of the smoke-box was badly corroded from a leaky hand-hole plate. This ring of plates was detached from the other part of the shell through the encircling line where it was bricked into the wall, and the line of separation was as clear-cut as if done with the shears.

At time of last repairs a new steel fire-box had been put in this boiler in place of the original iron one, condemned and removed. The steel fire box was badly bulged upon the crown and also at the sides (see Fig. 1), and there were many indications that it had been badly over-heated through lack of water, yet it did not fracture. The story of the wreck, as revealed by the distorted and battered parts of the boiler and its attachments, is quite an interesting one, for it reveals serious defects that ordinarily do not attract the attention of those owning or operating steam boilers, yet would not escape the attention of the trained boiler inspector. Of the most prominent defects were :

1st. The weakness of the shell at dome. The opening in shell under dome measured 30x30 inches, being cut out full size of the dome first put on, which it is reported ruptured under a hydrostatic proof-pressure of 150 lbs. at shop, and the builders afterwards replaced it by one of 36 inches diameter. An attempt to reinforce this weak place was made at that time or subsequently by putting a flat band of iron across the opening; but not being properly placed it had practically little if any value. The tendency of the stress upon the boiler at that place was to distend the shell which, dangerously weakened by the large dome opening, was insufficient in strength to preserve its form; in consequence it flattened, the dome was thereby distorted and gave signs of distress by leaking about the flange. This effect not being understood, it was treated simply as an ordinary leak, to be stopped in the usual way. In time the material reached the limit of its strength and rupture occurred.

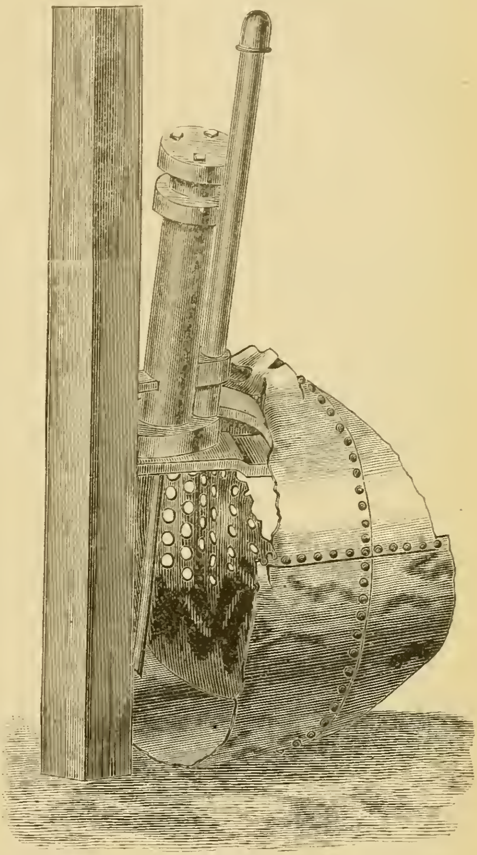


Fig. 3.

2d. The wagon-top was braced to the crown-sheet by solid crow-foot stays of one inch diameter, pitched 7″x12″ between centres; at 80 lbs. pressure, the stress upon each of these stays, supposing that they drew equally, would be 6,720 lbs., while the safe load upon a stay having the same sectional area would be 6,000x7854=4,712.4 lbs. The construction of the crow-foot attachment of the stay was such that it would be likely to spring considerably under a full load, and this, if it occurred, would increase the danger by permitting a distortion of that part of the boiler.

3d. The safe working pressure of a new boiler 54 inches in diameter, single-riveted, built of plates .289 inches thick, of unstamped iron, assumed to have a strength not exceeding 45,000 lbs., would be 80 lbs., according to the rules of the U. S. Steamboat Inspection Service, but in the case under consideration the shell of the boiler was evidently stronger than the fire-box part, through arrangement of stays and weakening effect of cutting away so much of the shell at dome, it would not safely warrant a higher pressure than 50 lbs. Recollecting the fact that for years this boiler had sustained a working pressure of from 90 to 100 pounds, the disastrous effect of this overloading is apparent, and explosion seemed inevitable.

THE IMMEDIATE CAUSE OF THE EXPLOSION.

It appears from the statement of the man who assisted in filling the boiler that a proper quantity of water was put into the boiler. It also appears that at the time of the explosion the water did not cover the crown-sheet. It is not unlikely it may have leaked out in the interval of a few hours, if it be true, as we were informed, that the check-valve on that boiler leaked badly only the day before; the water may have escaped without attracting the watchman's attention, who was inexperienced in the care of boilers; he assumed, perhaps, that the water was there in sufficient quantity, and anticipating slow work in getting up steam from cold water he forced the fires, for he told his companion when he parted from him "that he should start fires early." If fires were started early and forced as they might have been with the fuel at his command, steam would have been generated rapidly; and were the safety valve inoperative—a very common cause of explosions, but concerning which we could not satisfy ourselves in this case, owing to our inability to recover the valve—the condition of the boiler was such that it would not have required an excessive pressure of steam to explode it.

Getting up steam on a boiler or a battery of boilers is thought to be a matter of no special importance in most manufacturing establishments, and when it has to be done in the night is commonly entrusted to the watchman, whose knowledge is limited to building a fire and keeping it agoing until an engineer gets there in the morning. This is a great mistake that already has cost many lives and thousands of dollars expenditure repairing damages to property caused by their inexperience or recklessness. How many boilers have been injured by watchmen under such circumstances only those familiar with such matters can tell.

Inspectors' Reports.

APRIL, 1883.

The following is the summary of the reports of the Inspectors for the month of April last. The number of inspection trips made was 2,364, the whole number of boilers inspected 5,113, while the number of boilers thoroughly examined both internally and externally foots up 2,085, an increase of over 18 per cent. over the number inspected during the corresponding month last year. The number of boilers subjected to the hydrostatic test was 362, while 43 were condemned. The usual analysis of defects is appended.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	415	92
Cases of incrustation and scale,	581	49
Cases of internal grooving,	24	6
Cases of internal corrosion,	152	19
Cases of external corrosion,	208	35
Broken and loose braces and stays,	32	13
Defective settings,	129	28
Furnaces out of shape,	125	17
Fractured plates,	120	62
Burned plates,	205	51
Blistered plates,	250	29
Cases of defective riveting,	311	123
Defective heads,	41	24
Leaky tubes,	252	50

Leaky seams,	134	26
Water gauges defective,	112	25
Blow-out defective,	25	6
Cases of deficiency of water,	14	9
Safety-valves overloaded,	38	21
Safety-valves defective in construction,	28	17
Pressure gauges defective,	232	34
Boilers without pressure gauges,	1	1
Total,	3,429	737

BOILER EXPLOSIONS.

APRIL, 1883.

SAW-MILL (49).—The boiler in Fred. Meyer's saw-mill, seven miles north of Warsaw, Ind., exploded April 1st, destroying the mill and machinery, but injuring no one. Loss, $1,200.

—— MILL (50).—A boiler in one of the Griffin mills, Moss Point, Miss., exploded April 3d, instantly killing Jim Cooper, colored, of New Orleans. Simon Lasky and William Brown, colored, of Mobile, were scalded and have since died. Five other colored men and one white man were seriously injured.

—— MILL (51).—The boiler attached to an engine of seventy-five horse power exploded in the factory of George Bishop, at Newbern, N. C., April 6th. The engineer, Abram Brown, and fireman Frank Emmett were killed. The house of Isaiah Wood, one hundred yards distant, was destroyed, and Mrs. Wood was, it is believed, fatally injured. Two employes in the factory named Duncan and Staubb, were hurt by the flying bricks. Half of the factory was demolished and all the houses in the vicinity were more or less damaged.

WOOD-WORKING MILL (52).—Two boilers in Hitchcock & Bradley's shaft and pole works, Ashtabula, Ohio, exploded April 12th, demolishing the building, which was a three-story brick structure, and wrecking McGuire's carriage works, adjoining. The loss is $15,000. Charles Grubham, the night watchman, whose business was to get up steam in the morning, was killed.

WOOD-WORKING MILL (53).—A boiler in the Hudson Chair Factory, Hudson, Wis., exploded April 12th, and William Poaska was burned and bruised so severely that he died at 7.30 that evening. Superintendent Fisher was struck on the head by flying debris and severely hurt. A young man named Rilley was injured slightly. The wreck was complete, and pieces of the building were carried one-quarter of a mile. Fifty men in the neighboring room escaped without injury. The casings of the boiler were torn to ribbons. Total damage about $10,000.

SAW-MILL (54).—A boiler in the saw-mill of William Marks, five miles south of North East, Pa., exploded April 14th, badly injuring five men who were standing within six feet of the boiler. The boiler was of the locomotive fire-box type, and was eighteen years old. The main part of it was thrown thirty rods, nearly straight ahead, and the fire-box twenty rods in the opposite direction. The engine was running at the time. The boiler was foaming; the amount of steam is not known, but it was probably 175 pounds. The gauge showed a pressure of 95 pounds, but it was out of repair.

SAW-MILL (55).—The boiler of Donald McCleay's planing-mill, Portland, Or., burst April 18th. W. A. Gheen, engineer, was killed, and two others wounded, not dangerously. The front of the mill was blown out.

YARN-MILL (56).—The boiler in the yarn-mill of Rose & Scofield, Evansville, Ind., exploded April 21st, instantly killing Ferdinand Schultheis. Three sheets of the boiler were blown over three hundred feet from the building, making a wreck of the mill. The mill was isolated, and the explosion took place during the dinner hour, or the loss of life would have been greater.

SAW-MILL (57).—The boiler in the portable mill of Robert Cope, in Plainfield township, Mich., exploded April 26th. The mill was completely demolished, and the fireman, Dayton Johnson, had his skull crushed, and will probably die. The boiler was second-hand, and had been burned. Loss, $1,000.

MINE (58).—A St. Paul dispatch of the 7th instant says: The first steamer of the season arrived from Silver Islet this morning and brought the first news of a boiler explosion in a mine there in April. One man was killed and a number seriously scalded. The mine was greatly damaged.

COATING STEEL WITH COPPER.—Experiments are at present carried on in Belgium to preserve steel, and steel gun barrels in particular, by coating them thinly with copper by a process of which M. F. Weil is the inventor. Its peculiarity consists in the composition of the baths used, in which the usual and always dangerous cyanides of the alkalies are replaced by organic acids and glycerine. According to M. Weil, these baths require no renewal of organic elements, and can be used continuously when they are saturated with peroxide of copper. They possess also the advantage, owing to the property inherent in organic alkaloids of dissolving the peroxide of iron without attacking the metallic iron itself, of cleansing the steel before the commencement of the coppering process, and more perfectly than can be done mechanically. The coppering is effected by putting porous clay vessels filled with caustic soda lye, in which zinc plates have been immersed, in the basin containing the organic copper base (alkaloid) and the steel. The zinc plates are connected by a thick copper wire with the steel articles to be coated with copper. The caustic lye may be used over and over again. Should it become saturated with oxide of zinc, it is sufficient for its regeneration to treat it with sulphide of sodium, when the oxide (of zinc) will be precipitated and a by-product obtained, by which the cost of the process will be considerably reduced. The coppering process, it is said, occupies but a very short time.—*Mechanics.*

A DEPARTURE IN THE ENUMERATION OF TIME.—The Cleveland, Akron, and Columbus Railroad has made a new departure in the enumeration of time, called the "twenty-four-hour system." By this plan the day begins at midnight and the hours are numbered consecutively from 1 to 24. The object is to prevent mistakes in time tables, such as that of 8 A. M. being confounded with 8 P. M., by having the same hours read 8 o'clock and 16 o'clock, respectively—the distinctions A. M. and P. M. being dropped entirely. It is proposed that watches and clocks have an interior circle to show the extra figures designating the latter 12 hours of the day. It is evident that there is need of a new system of time for the moving of trains, and we shall undoubtedly have it before many years, but there is a great risk assumed in adopting any radical change that contains complications which are in the least degree puzzling to the average trainman. Railway managers will therefore make such changes with the greatest caution. The continuous enumeration of the 24 hours of the day is the simplest change from the present practice which has been suggested, and as the Cleveland, Columbus, and Akron is the first road to adopt it, the result will be watched with much interest.—*Mechanics.*

The Locomotive.

HARTFORD, JUNE, 1881.

We call attention to the article on page 104, entitled "*Who First Successfully Applied Steam for Propelling Vessels.*" Dr. William Wood, its author, has been for years gathering the facts relating to the history of John Fitch's investigations into, and experiments with, steam as applied in this direction, and as a result gives to the public this noble tribute to his memory and worth. Born in poverty and with none to encourage his early efforts,—by singular devotion to what he believed was possible to accomplish, and by force of will under intelligent investigation, he gained the attention and endorsement of eminent men, and secured the recognition and favor of State legislatures, and finally a patent from the Federal Congress for a term of fourteen years. At this period, however, the country was poor, having just emerged from the long and terrible struggle for independence. Few men could be found that were willing to furnish the funds necessary to develop and carry out new and comparatively untried plans. Fitch was unable to secure the aid which he sought, and so this remarkable man, doomed to disappointments and discouragements, finally broke down in health and committed suicide. In looking over his autobiography it is sad to find the following record: "*The day will come when some more powerful man will get fame and riches from* MY *invention; but nobody will believe that poor John Fitch can do anything worthy of attention.*" Many an inventor has met with a similar experience on the eve of complete success. Poverty and the failure to enlist men of means in their enterprise have stood immovably in the way of progress, and their cherished plans have been doomed to bitter disappointment. Others more fortunate have taken up their plans and inventions, and profiting by their failures and successes have gone on to wealth and renown. The preparation of this portion of the life and labors of John Fitch by Dr. Wood has been to do justice to the memory of one who is almost forgotten, and who lies buried in an obscure and neglected grave on the banks of the Ohio River. The State of Connecticut would do a graceful and grateful act by placing in the rotunda or on the grounds of its beautiful capitol a statute of John Fitch.

A most wonderful and important application of the electric light to surgical diagnosis is described in the *Annals of Anatomy* by Dr. Roswell Park of Chicago. Jos. Leiter, a well-known instrument maker of Vienna, has succeeded in producing electrical instruments by which the interior portions of the human body may be strongly illuminated and thoroughly examined by the eye of the surgeon.

It consists of a bent tube which contains a window at one end, electric wires, and tubes for the introduction of a water circulation, by means of rubber bags, for the purpose of keeping the tube cool while the electric light is burning; also, for the introduction of water into the stomach to distend the same. The tube is introduced into the mouth and pushed down until its lower end reaches the stomach. The lower extremity of the tube is provided with a platinum wire which is made to glow under the electric current which is produced by a battery. The tube is also provided with reflectors, prisms, and lenses for directing the light through the tube.

The eye of the surgeon is applied at the upper end of the tube after it has been inserted in the stomach. The mechanism employed, by a rotating motion, enables him to examine the coatings of the stomach with ease. Similar instruments have been constructed for examining the throat, ear, and bladder. There is something novel and decidedly unpleasant in contemplating the introduction of the electric light into one's stomach, but we are getting accustomed to the surprises that science is continually forcing upon us.

Who first Successfully Applied Steam for Propelling Vessels.

[From the Hartford Times, April 19th, 1883.]

In my school-boys days it was very generally conceded that the honor belonged to Robert Fulton, and no doubt at the present time the majority of the community entertain the same opinion. When I located in South Windsor, in 1847, I often heard the old people say that John Fitch, a former resident of the town, was the first man that propelled a boat by steam. This led me to investigate the subject. The libraries of our own state, both public and private—of New York City—the state libraries of New York, New Jersey, Pennsylvania, Delaware, and Virginia, were examined by myself or by proxy. Every possible effort was taken to elucidate the subject. These investigations were pursued until 1858, when I saw a notice of the publication of the life of John Fitch. I procured the work, and found the publisher, Mr. Wescott, in his statements, compiled in a great measure from Fitch's private manuscripts, was so full and complete, and so perfectly in harmony with my investigations, that I put away my papers, supposing the facts therein contained were sufficient to give honor to whom honor is due. But from articles which I have since seen in our papers and magazines, giving credit to others who never thought of steam as a motive power for vessels until years after Fitch's success, I am led to resurrect my manuscripts in order to do justice to one who prophetically said, "The day will come when some more powerful man will get fame and riches from my invention; but nobody believes that poor John Fitch can do anything worthy of attention." The first claimant is Blasco de Garay. Thomas Gonzales, director of the Royal Archives of Simancas, in Spain, published an account of the invention of Blasco de Garay in 1826. "Blasco de Garay, a Spaniard, exhibited to the Emperor and King, Charles the Fifth, in the year 1543, an engine by which ships and vessels of the largest size could be propelled even in a calm, without the aid of oars or sails. Notwithstanding the opposition which this project encountered, the Emperor resolved that an experiment should be made, and it was made with success in the harbor of Barcelona, on the 17th of June, 1543. At its slowest rate, it moved a league an hour. Garay never publicly exposed the construction of his engine, but it was observed at the time of the experiment, that it consisted of a large caldron or vessel of boiling water, and a movable wheel attached to each side of the ship. The ship was of 200 tons burden, and was called the Trinity. The captain was Peter de Scarza. By order of Charles the Fifth, and the Prince, Philip the Second, his son, there were present at the time Henry de Toledo, the Governor, Peter Cardona, the treasurer Ravago, the vice-chancellor Francis Gralla, and many other persons of rank, and several sea-captains. The Emperor and Prince and others with them applauded the engine, and especially the expertness with which it could be tacked. The exhibition being finished, Garay took from the ship his engine, and having deposited the woodwork in the arsenal of Barcelona, kept the rest himself. * * * The above was collected from the original registers preserved in the Royal Archives at Simancas—among the public papers of Catalonia, and those of the secretary of war for the year 1543." (The above was published in the North Am. Review, vol. 23; also in a note in Spark's Am. Biography, vol. 16.)

The Hon. Edward Everett, in his address before the Essex county agricultural fair, at Danvers Plains, Mass., in the fall of 1858, reiterates this same statement. It seems to me incredible that the vessel should have been propelled by steam, long before steam was known as a motive power, and if its power had then for the first time been discovered, it is still more incredible, that with such high dignitaries on board, who for a moment would not have hesitated to furnish all necessary means to immortalize their own countrymen and nation, that they should have allowed such a wonderful invention to pass into total obscurity. And is it not remarkable, to say the least, that no notice of this discovery ever appeared in any paper, journal, or magazine, for 283 years after the experiment—not until hundreds of steamboats were in daily use in this country and Europe. Conversing with Hon. James Dixon, our senator to Congress, respecting the Spanish claimant, I expressed doubts as to the reliability of the statement, and a desire to investigate the subject. He very kindly offered to assist me, and through our minister to Spain, the arsenal at Barcelona, and the royal archives at Simancas, were examined, and all the information possible was obtained, and the conclusion arrived at was that the vessel was moved by wheels and muscular power—not by steam. Since then I saw in the Scientific American of November 20th, 1858, that John Macgregor, Esq., barrister at law, London, has been investigating the subject, and in a paper read before the London Society of Arts, says: "Some months ago I inspected two letters written in A. D. 1543, by Blasco de Garay, and now preserved in the national archives at Simancas, in Spain. These give the particulars of experiments at Malaga and Barcelona with large vessels propelled by paddle-wheels, turned by forty men. By many authors, and for a long time it has been positively affirmed, that Blasco de Garay used a steam engine for marine propulsion, but, after careful and minute investigations at Simancas, Madrid, and Barcelona, I cannot find one particle of reliable evidence for this assertion."

There are many who claim to have conceived the idea of propelling vessels by steam, who for want of means, or faith, in the discovery, never perfected their plans. I will only name some of the principal claimants.

Solomon de Caus was a man of rare mechanical ingenuity, and has through some historians been credited as discovering the force of steam and its applicability to moving powers. It is to be regretted that educated men who have the reputation of knowing what they assert, should publicly make statements, that as a matter of fact have little, if any foundation in them. In the address of Hon. Edward Everett, referred to above, he quotes from a letter of that celebrated woman, Marion de Lorme, written 1641, giving an account of her visit to the mad-house in Paris with the Marquis of Worcester. She says: "when passing the house she saw a frightful face through the bars, exclaiming 'I am not mad, I am not mad,' and have made a discovery which will enrich the kingdom that will adopt it." The guide then told her that "this poor Solomon de Caus came from Normandy, four years before, to exhibit to the King an invention by which, by the power of steam, you could move a carriage or navigate the ocean, and, in short, said the guide, there was nothing you could not do by the power of steam;" and he has written a book upon the subject, called "Moving Powers." Cardinal Richelieu, who virtually wielded the power of France, turned his back upon him. De Caus followed him from place to place, exhibiting his drawings and pressing his claims, until the Cardinal, getting out of patience, sent him to the mad-house. The Marquis of Worcester was very much interested in the book, and incorporated considerable portions of it in his work, "The Century of Inventions." "But you see," says Everett, in this recital, "How France proved herself in 1651 as Spain had proved herself in 1543, unable to take up and wield this mortal thunderbolt." Unfortunately for the statement of Mr. Everett of 1651, and of Marion de Lorme of 1641, Solomon de Caus died in 1634 or 5—the exact month is not known. I should not have referred to this man, had not his name been so publicly quoted. The simple facts are these. He comes before the public in 1612, when he was in London, in the service of the Prince of Wales. In 1615 he was at Frankfort and published "Les raisons de forces mouvantes avec divers machines tant utiles que plaisantes," etc. (The laws governing moving forces with various machines both useful and amusing, etc.)

This, I suppose, is the work referred to which the Marquis of Worcester incorporated so extensively in his book, "The Century of Inventions." The "Nouvelle Biographie Generale," which is considered authority, gives an extended notice of De Caus, and says, "that the story of his having been imprisoned 'as a fool' has no foundation in fact."

In the "Century of Inventions," written by the Marquis of Worcester in 1655 (though not published until 1663), allusion is made to an engine "which placed in vessels, ships, or boats, shall draw them up rivers, against the stream, and if need be, pass London bridge against the current at low water." The Marquis lived in the exciting times of the civil wars between Charles the First and his Parliament. Taking sides with the King, he lost all his fortune, and was imprisoned in Ireland by his adversaries, thus putting a stop to his brilliant anticipations.

Daniel Papin in 1690, conceived the idea of employing steam to propel ships by paddles. In 1708 he submitted a plan to move vessels by steam, to the Royal Society, of which he was a member, and was anxious to test his invention if the society would pay the expense. The present Sir Isaac Newton thought "the expense would be more than the society could afford to pay, although he did not doubt but that his invention might be made available for the moving of ships and galleys." It is to be regretted that the society did not assist Dr. Papin, for no doubt his inventions would have developed the power of steam and its applicability to moving forces; for, a few years afterwards, Newcomen, adopting Papin's cylinder with Savery's mode of condensation, completed the atmospheric engine. England claims the honor of first applying steam for maritime purposes, through Jonathan Hulls, who, in 1736, took out a patent for a boat to be propelled by the aid of steam. In 1737 he published a pamphlet in London, illustrative of his plan. Its title is, "A Description and Draught of a New Invented Machine for carrying Vessels or Ships out of, or into any Harbour, Port or River, against Wind or Tides." This important discovery for some reason was never carried into execution by Hulls; hence this claim of England for priority in steam navigation fails.

In 1759, M. Genevois, minister of Berne, invented a species of steam propeller, which, like the foot of a duck, would expand and make a large surface to the water when moved against it, but would fold up into a small compass when moved in an opposite direction. This looked very plausible in theory, but practically it was a failure.

In 1774, Count d'Auxiron, a French nobleman, succeeded in the construction of a steamboat which was tried upon the Seine, near Paris. It moved against the stream very slowly. He was assisted by an ingenious countryman, Perier. After several very unsatisfactory experiments the boat was given up as a failure.

In 1782, Marquis de Jouffroy constructed a steamboat, 140 feet long and 15 feet wide, to ply on the Saone, at Lyons. The boat excited considerable attention and several experiments were made with it. The dreadful disturbance which shortly broke out in France put a stop to his efforts, and for several years he was an exile. On his return, in 1796, he found the principal part of his invention adopted by Des Blancs, who had gained his information from the experiments of the Marquis. The latter appealed to the government, but Des Blancs had obtained a patent during his absence, so that he was left without redress. Neither Des Blancs nor the Marquis ever succeeded in making a success of the enterprize.

We next come to one of our own countrymen, James Rumsey, who claimed to have used steam for propelling a boat in 1784. But from all the facts and testimony given, it appears that steam was an after consideration. General Washington, who was a friend of Rumsey, in his certificate, dated September 7, 1784, says: "That James Rumsey has discovered the art of working boats by mechanism, and small manual assistance against rapid currents." Rumsey petitioned the legislature of Pennsylvania, November 26, 1784, for what now is equivalent to a patent. (During the Confederation and before the adoption of the Federal Constitution, the States generally exercised the prerogative of passing laws for the encouragement of useful inventions.) This was granted him in March 25th, 1785. At that time there was no mention made, nor any idea held up to the committee of the Pennsylvania legislature, that his boat was to be propelled by steam. This is apparent from a letter from General Washington, dated "Mount Vernon, January 31st, 1786. Sir:—If you have no cause to change your opinions respecting your *mechanical* boat, and reasons unknown to me do not exist to delay the exhibition of it, I would advise you to give it to the public as soon as it can be prepared conveniently." This shows conclusively that the mechanical boat had not been tried at that time. This boat was propelled by hand labor, and by the force of the current in working the wheels and setting poles. From the testimony of twenty-one persons who knew positively regarding the time of building Rumsey's steamboat, it appears that work was not commenced on it until 1786. It was constructed on the plan of a common lifting pump, united with a forcing apparatus worked by steam. The funnel through which the water was ejected lay along the keel, discharging at the stern. The suction pipe was placed at the bow, and the engine midships, the reaction of the water being the impelling agent. (This same plan was invented by a Frenchman, named Bernoulli, in 1753, but never put to any practical use.) The first public exhibition of Rumsey's steamboat was made at Shepardstown, Va., December 3, 1787, as certified to by Major-General Horatio Gates, the Rev. Robert Stubbs, and others. It moved at the rate of three miles an hour. I have gone into particulars in this case, as Rumsey's friends claim that he was the first man who successfully moved a boat by the power of steam. Thus far steam navigation has been of no practical value; in fact it has no existence.

I now come to the first successful claimant, JOHN FITCH, of Windsor. (Windsor then embraced what is now several towns, both on the east and west sides of the Connecticut river; Fitch's birth-place was South Windsor, near the East Hartford line.) April 15, 1785, JOHN FITCH first conceived the idea of steam as a motive power for carriages, but soon turned his attention to its application in moving vessels, and says: "I was then altogether ignorant that a steam engine had ever been invented. The propelling of a boat by steam is as new as the rowing of a boat with angels, and I claim the first thought and invention of it." It was in Cobe Scout's log shop that Fitch made his first model of a steamboat with paddle-wheels. "The model was tried on a small stream on Joseph Longstreth's meadow, about half a mile from Davisville, in Southampton township, and it realized every expectation. The machinery was made of brass, with the exception of the paddle-wheels, which were made of wood." After spending some more time to perfect the model, he exhibited it to Dr. John Ewing, provost of the University of Pennsylvania, who gave Fitch the following letter to William C. Houston, formerly a member of Congress:

PHILADELPHIA, August 20, 1785.

Dr. Sir—I have examined Fitch's machine for rowing a boat by the alternate operation of steam and the atmosphere. The application of this force to turn a wheel in the water so as to answer the purpose of oars, seems easy and natural by the machine which he proposes, and of which he has shown me a rough model.

Fitch had numerous letters of recommendation from distinguished gentlemen, who had examined his model. August 29, 1785, Fitch presented the following letter to Congress:

August 29th, 1785. Sir:—The subscriber begs leave to lay at the feet of Congress an attempt he has made to facilitate the internal Navigation of the United States, adapted especially to the waters of the Mississippi. The machine he has invented for the purpose has been examined by several Gentlemen of Learning and Ingenuity, who have given it their approbation.

On the 27th of September, 1785, Fitch presented a drawing and models of his boat to the American Philosophical Society at Philadelphia. March 18th, 1786, the State of New Jersey passed a law, giving Fitch for fourteen years, "The sole and exclusive right of constructing, making, using, and employing, or navigating, all and every species or kinds of boats, or water craft, which might be urged or impelled by the force of fire or steam, in all the creeks, rivers, etc., within the territory or jurisdiction of this State." On the 20th of July, 1786, Fitch tried experiments on a skiff with a steam engine of three-inch cylinder, which moved a screw of paddles—the endless chain, and one or two other modes, which were not satisfactory. Disheartened by the failure, and provoked by the scoffs and insults of the spectators, he went to a tavern, and says "he used considerable West India produce that evening." The next day he felt very much ashamed of himself, and in the evening retired early. Says Fitch, "about 12 o'clock at night the idea struck me about cranks and paddles for rowing of a boat, and for fear that I should forget or lose the idea, I got up about 1 o'clock, struck a light, and drew a plan. I was so excited that it was impossible to sleep. At sunrise I sought the residence of Voight (an inventive genius whom Fitch often consulted), and showed him the draught. The plan was somewhat improved by a suggestion of Voight." The experiment was made in a skiff, July 27th, 1786, and worked to the satisfaction of the projectors. The next day he wrote to his friend, Mr. Tracy Potts:

Philadelphia, July 28, 1786.—My worthy friend. This may inform you that I completed my experiments yesterday, and find that they exceed my most sanguine expectations. We let out 7 knot of Log line and had not more than half of the purchase that we shall have on a Large Boat.

Fitch having exhausted all his resources in experiments on his machinery and boats, applied to the Pennsylvania legislature for a loan of £150, and failing of securing it by a vote of 28 to 32, he applied to General Thomas Mifflin, who was then speaker of the House, for individual aid. No prophet could have foretold the future of his discovery more accurately than did Fitch in that epistle:

Honored Sir:—I am of opinion that a vessel may be carried 6, 7, or 8 miles per hour by the force of steam; and the larger the vessel the better it will answer; and am strongly inclined to believe that it will answer for sea Voyages as well as for inland Navigation, which would not only make the Mississippi as navigable as Tide water, but would make our vast Territory on those waters an inconceivable fund in the Treasury of the United States. Perhaps I should not be thought more extravigent than I already have been * * *, when I assert, that six tons of Machinery will act with as much force as ten tons of men, and should I suggest that the navigation between this (country) and Europe may be made so easy as shortly to make us the most popular Empire on Earth, it probably, at this time, would make the whole very laughable.

The State of New York granted Fitch exclusive rights to her waters for fourteen years for the purpose of steam navigation, March 19, 1787.

The State of Delaware granted the same rights, February 3, 1787.

The State of Pennsylvania granted the same rights, March 28, 1787.

The State of Virginia granted the same rights, November 7, 1787.

Fitch's second boat was built in 1786, but the machinery was not perfected until 1787. This boat was forty-five feet long, and twelve feet beam. It had six oars or paddles on each side. The engine was a twelve-inch cylinder. The trial took place upon the Delaware, at Philadelphia, August 22d, 1787. The convention to frame the Federal Constitution was in session in that city at that time, and witnessed the success of the steamboat. Fitch, in his Journal, says that nearly all the members of the Convention were present, except General Washington. They were all pleased with the experiment, and letters of congratulation upon the success of the enterprise were given by the prominent gentlemen present—Governor Randolph and Dr. Johnson, of Virginia, David Rittenhouse, Dr. John Ewing, and Professor Andrew Ellicott, of Pennsylvania. Chief-Justice Oliver Ellsworth, of Connecticut, was on board of the steamer, and says the experiment was a success.

As the speed of the boat was not satisfactory, Fitch, after much trouble and anxiety, succeeded in raising the necessary funds to build a new steamboat, 60 feet long, and 8 feet beam. After many vexatious mishaps in perfecting the machinery, everything was ready for the trial trip about the last of July. Dr. Thornton, who was deeply interested in the success of the boat, writes to a friend, July 26, 1788: "Our boat will be tried this evening or to-morrow. Ours is moved by paddles placed at the stern, moved by a small steam engine." Fitch says in his journal, "We finally got it to work pretty well, and set out upon a journey to Burlington, twenty miles. Henry Voight, Richard Wells, Thomas Say, and several others were on board at this trial trip,"—the longest trip ever made by a steamboat at that time. At every town along the river banks they were greeted with cheers, and waving of handkerchiefs, and when within a few rods of their destination, the pipe boiler sprang a leak, and they came to anchor. The boiler was soon repaired, and the boat made several trips to Burlington and back without any accident. On the 12th of October, 1788, there were thirty passengers on board, and were taken from Philadelphia to Burlington (20 miles, up stream), in three hours and ten minutes, which fact was certified to, by Andrew Ellicott, Richard Chase, John Poor, and John Ely. This speed did not satisfy Fitch, or those who had a pecuniary interest in the enterprise. It was determined to build a new boat with larger machinery—the cylinder to be eighteen instead of twelve inches in diameter. Various alterations and improvements were made in the machinery before satisfactory speed was attained. On the 16th of April, 1790, a trial trip was made, and, says Fitch, "although the wind blew very fresh at the northeast, we reigned Lord High Admirals of the Delaware, and no boat in the river could hold its way with us, but all fell astern, although several sail-boats which were very light, and heavy sails that brought their gunnales well down to the water, came out to try us."

Several equally satisfactory trips were made with members of the company and invited guests; and Fitch elated with his success, exclaims, "Thus has been effected by little Johnny Fitch and Harry Voight, one of the greatest and most useful arts that has ever been introduced into the world; and although the world and my country does not thank me for it, yet it gives me heartfelt satisfaction."

On the 16th of June (1790) Governor Thomas Mifflin and the Supreme Executive Council were passengers on this boat, and were so highly pleased that they presented the steamboat company with a suit of flags, the cost of which was, £5 6s. 11d. The speed of the boat was eight miles an hour. It afterwards run ninety miles one day.

This boat was now run as a regular passenger boat between Philadelphia and Burlington. The two papers published in Philadelphia, the *Pennsylvania Packet* and the *Federal Gazette*, gave notices of the days and time of sailing:

The steamboat is now ready to take passengers, and is intended to set off from Arch street Ferry, in Philadelphia, every Monday, Wednesday and Friday, for Burlington, Bristol, Bordentown and Trenton, to return on Tuesday, Thursday, and Saturday.—*Pennsylvania Packet*, June 15, 1790.

The same notice was published in the Federal Gazette, June 14th, 17th, 19th, 22d, and 24th, 1790. In the New York Magazine is an extract from a letter dated August 13, 1790—Fitch's steamboat really performs to a charm.

It is estimated that the boat must have gone at least two or three thousand miles that summer carrying passengers. Was this not a success? The great problem of steam navigation was now practically demonstrated.

Wishing now a boat large enough to carry freight as well as passengers, the new company was consolidated with the old, and another boat was contracted for—the Perseverance—with the intention of sending it to New Orleans, for the navigation of the Mississippi. It was hoped that it would be finished in time to save the benefit of the Virginia law. (The legislature of Virginia November 7, 1787, passed a law securing Fitch's rights in the steamboat for fourteen years, conditioned, "that it should be void at the expiration of three years unless the said John Fitch shall then have in use on some river of this commonwealth, boats or craft of at least twenty tons burden, navigated by steam.") The great value of the Virginia law, was, that it gave Fitch the exclusive right of navigating the Ohio river and its tributaries with the steamboat. In this, the company were disappointed. The boat and machinery were nearly completed, when a violent storm arose, causing it to break from its moorings, and it was blown upon Petty's Island, in the Delaware, opposite of the upper part of Philadelphia. The tide being unusually high, the boat was driven so far upon the land that it was impossible to get it off in season to avail themselves of the benefits of the Virginia law. The stockholders became discouraged and refused to furnish any more funds, and Fitch having exhausted all his resources, the boat was abandoned and remained for four years without any change, and was advertised for sale at auction August 18, 1795. April 23, 1791, Fitch applied to the Federal Congress for a patent. August 26th, 1791: "Whereupon ordered, that letters patent be granted to the said John Fitch for his aforesaid inventions for the term of fourteen years."

This document is signed by General Washington, and by the Commissioners, Thomas Jefferson, General Henry Knox. and John Randolph.

In 1793, Fitch went to France, at the solicitation of our Consul at L'Orient, Aaron Vail, to build a steamboat. Arriving there at the time of the Revolutionary troubles he could not obtain any pecuniary assistance. Depositing his papers and specifications in the hands of Mr. Vail, he went to England, remaining in London for a time with his friend, Mr. Leslie, formerly of Philadelphia. In 1794, he returned to the United States, working his passage as a common sailor. He found his way to East Windsor, now South Windsor, to the house of his sister, Mrs. Timothy King, and to the house of his daughter Lucy, Mrs. Kilbourne. After remaining some two years with his sister, he starts off again on his steamboat enterprise. In 1796, he constructs a steamboat out of a ship's yawl. The boat was moved by a screw propeller on a large pond of fresh water in the city of New York, called the Collect. It was afterwards filled, and embraces the ground on which stand the Tombs and other adjacent buildings. In the spring of 1798, Fitch built a model steamboat three feet long, at Bardstown, Kentucky, which was tried upon a small stream near that town.

Some time between the 25th of June and 18th of July, this remarkable man, broken down with misfortunes, disappointments, and discouragements, committed suicide. (His will was made June 25th and admitted to probate July 18th.) His remains lie unhonored, in Bardstown, with a rough stone, without inscription, to mark his resting-place. I have only given the steamboat experience of John Fitch, but hope at no distant day to give his life history.

I will now examine the merits of later claimants. In 1788 Patrick Miller constructed a boat and William Symington made an engine for it, and on the 14th of October, 1788, it was moved by steam in the lake of Dalswinton, in the presence of several spectators. This did not answer their expectations, and the next year (1789) Mr. Miller had a twelve-horse engine made and fixed to his double-bottomed boat, which was tried on the Clyde and Forth canal, with success. This was England's first successful steamboat experiment. Symington continued his experiments, under the patronage of Lord Dundas, and in March, 1802, two vessels of 70 tons burden each were towed by the steamboat, Charlotte Dundas, 19½ miles in six hours, against very strong head wind. The English declare that this was the first practical steamboat experiment. Fitch, twelve years prior to that, was carrying passengers regularly, according to advertisements, eight miles an hour. Was not that practical?

A writer in the Boston Recorder of September 23, 1858, in an interesting article on steam navigation, gives Captain Samuel Morey, of Orford, N. H., the credit of being the first man to propel a boat by steam:

> The astonishing sight of this man ascending the Connecticut river between Orford and Fairlee, in a little boat just large enough to contain himself, the rude machinery connected with the steam-boiler, and a handful of wood for the fire was witnessed by the writer in his boyhood.

I have several times since the publication of the above article seen notices in other papers claiming priority for Morey. The writers evidently were not aware, that Fitch, several years prior to that, was making regular trips on the Delaware with his steamboat. Captain Morey was an original thinker and inventor, commencing his experiments with his little steamer on the Connecticut as early as 1790. After working three years in perfecting his machinery, he in the summer of 1794 propelled a small steamer from Hartford to New York at the rate of five miles an hour. Chancellor Livingston, Judge Livingston, Edward Livingston, and John Stevens went with him from New York to Greenwich. From this time to the time of Fulton's experiments there were many steamboats constructed by different individuals; prominent among them are, Oliver Evans, Nicholas I. Rooseveldt, and John Cox Stevens. To Stevens is due the credit of making the first maritime voyage. He went with his steamer, the Phœnix, from New York to Philadelphia in June, 1808. Rooseveldt built the first steamboat, the New Orleans, that navigated the Ohio and Mississippi, in 1811.

The next claimant, and one who is very generally accorded the honor of first practically demonstrating the application of steam for moving vessels, is Robert Fulton. Only a short time has elapsed (Febuary 26, 1883) since a statue of Robert Fulton was erected in the National Hall of Statuary in the Capitol by Pennsylvania, in honor of the discovery. It was not until 1803 that Fulton, with the assistance of Robert R. Livingston, our minister to France, made his experiment with a steamboat on the Seine, at Paris, which was not a success. Three years later, he commenced building the Claremont, at New York, in the shipyard of Charles Browne. It was not completed until August, 1807. This boat was a success, but did not equal the speed of Fitch's boat of 1790 by three miles an hour. Fulton lived in Philadelphia in 1785 and 1786, the time Fitch was making his steamboat experiments in that city, and when he was petitioning Congress for assistance, and the States of Virginia, Maryland, Pennsylvania, Delaware, and New Jersey for exclusive rights to their waters for steam navigation, and when it was in July, 1786, that Fitch made a successful public trial of his skiff steamboat on the Delaware, can it for a moment be doubted that Fulton, with his inquisitive mind, was not fully aware of Fitch's inventions? This was more than twenty years before Fulton made his experiments on the Hudson. Some time in 1786, Fulton went to England and spent several years in the family of Mr. West, perfecting himself in the art of painting. After leaving that family, he spent two years in Devonshire, as a painter, and while there became acquainted with the Duke of Bridgewater, famous for his canals, and Lord Stanhope, a lover of mechanics. Owing probably to their influence, Fulton first turned his attention to canals and steam navigation. He then went to France, and spent seven years in Paris. While there, he visited Mr. Vail, with whom Fitch had entrusted his drawings and specifications pertaining to his steamboat, and, Mr. Vail says, "*I lent Mr. Fulton of Paris all the specifications and drawings of Mr. Fitch, and they remained in his possession several months.*" According to the affidavits made by Robert Weir and Jacob Perkins, Mr. Fulton in 1801 visited England, and was on board Symington's boat, on the Forth and Clyde canal. To gratify him, the boat was propelled by steam four miles and back, at the rate of six miles an hour. *Fulton took drawings of the machinery.* Chancellor Livingston, who was aiding Fulton in his steamboat projects, was a passenger on Fitch's boat on the Collect, and was also a passenger on Morey's boat from New York to Greenwich, and no doubt had seen the steamboat experiments of Stevens and Rooseveldt on the Hudson. With the drawings and specifications of Fitch, with the drawings and observations on board of Symington's boat, with the observations of Livingston on Fitch's and Morey's boat, I would ask, to what discovery or invention pertaining to steamboats is Fulton entitled? One writer very justly remarks. "*If the inventions of others which Fulton has copied were removed from his boat nothing would be left but the hull.*" In 1817, the original patents, drafts, specifications, and models, of Fitch and Fulton were exhibited before a committee of the New York legislature, raised upon the petition of Governor Ogden of New Jersey. Witnesses were examined, and able counsel employed. Fulton and Livingston were represented by Cadwalader D. Colden and Thomas Addis Emmet, Fitch by Samuel A. Southard, Joseph Hopkinson, and Colonel Ogden. Certificates of Dr. Rittenhouse, Andrew Ellicott, Oliver Evans and John Ewing were produced, stating the performance of Fitch's steamboat. General Bloomfield testified, that he "had been a passenger on board Fitch's boat on the Delaware in 1787 and 1788, and regarded the experiment as successful." The committee after much deliberation reported to the legislature that "*The steamboats built by Livingston and Fulton were in substance the invention patented to John Fitch in* 1791, *and Fitch during the the term of his patent had the exclusive right to use the same in the United States.*" What stronger evidence can any one ask than the above, to substantiate the claim of Fitch over Fulton to priority in steam navigation?

Fulton, when he commenced his experiments, had the advantage of the models, specifications, drawings, and plans of Fitch—had made a successful trip on Symington's and Miller's steamboat and taken drawings of the machinery—had the benefit of Livingston's observations on Fitch's and Morey's boats—had his engine built in England by James Watts—had influential and wealthy friends to assist him. Fitch, when he commenced his experiments, was not aware that there was a steam-engine in the world—made his own engine with the assistance of common blacksmiths—had to experiment as he progressed to know the relative position and power of the parts—was poor, but by selling lands in Kentucky, which he acquired by surveying, and by limited assistance from friends, he surmounted incredible hardships, misfortunes, and discouragements, and overcame every obstacle, and demonstrated to the world the first successful steamboat enterprise. To-day Fulton's memory is honored by a statue in the Capitol, from Pennsylvania. Fitch lies in a lone grave at Bardstown, Kentucky, with a rough stone without inscription to mark his resting place. Let the nation honor the true inventor, John Fitch, by erecting some fitting monument to perpetuate the memory of one of her most useful inventors.

We are greatly indebted to Dr. Thornton, Whittlesey, and Wescott for the services they have rendered in bringing before the public the merits of John Fitch.

William Wood.

East Windsor Hill, March 12, 1883.

The Landed Proprietors of Great Britain.

It is a startling fact, and one which must fill the minds of reflecting Englishmen with grave concern, that more than one-half the land in the United Kingdom is held by one-twelve-thousandth of the population. That is to say, 2,238 individuals, out of a population of 28,000,000, monopolize forty millions out of the seventy-two millions acres, which comprise the territory of the two islands. It is still more startling that more than one-eighth of the territory, comprising 9,374,000 acres, is held by forty-four persons, not one of whom owns less than 100,000 acres, and two of whom—Lord Middleton and the Duke of Sutherland—possesses over a million acres each. The following table, prepared from the analysis of landholders in the "Financial Almanack," shows how this property is distributed and who are the great landed proprietors of the kingdom:

Proprietors.	Acres.	Proprietors.	Acres.
Duke of Argyll,	175,000	Marquis of Lansdowne,	135,000
Duke of Athole,	194,000	Lord Leconfield,	110,000
Evan Bailie,	165,000	Lord Lovat,	161,000
Rich. Berridge,	170,000	Lord Macdonald,	129,000
Marquis of Breadalbane,	438,000	A. E. MacIntosh,	124,000
Duke of Buccleugh,	459,000	Sir K. S. Mackenzie,	164,000
Marquis of Bute,	116,000	Norman Macleod,	143,000
Donald Cameron,	126,000	Alex. Matheson,	220,000
Earl of Cawdor,	101,000	Sir J. Matheson,	406,000
Jas. S. Chisholm,	113,000	Lord Middleton,	1,005,000
Duke of Cleveland,	102,000	Duke of Montrose,	103,000
Marquis of Conygham,	173,000	Duke of Northumberland,	186,000
Earl of Dalhousie,	138,000	Duke of Portland,	161,000
Duke of Devonshire,	193,000	Duke of Richmond,	286,000
Marquis of Downshire,	123,000	Sir C. W. A. Ross,	166,000
J. R. Farquharson,	109,000	Earl of Seafield,	305,000
Earl of Fife,	257,000	Marquis of Sligo,	122,000
Earl Fitzwilliam,	114,000	Duke of Sutherland,	1,208,000
J. Gordon,	112,000	Duchess of Sutherland,	149,000
Sir G. McP. Grant,	127,000	Marquis of Waterford,	109,000
Duke of Hamilton,	157,000	Lady Willoughby de Eresby,	132,000
Countess of Home,	103,000		
Lord Kenmare,	105,000	Forty-four persons,	9,374,000

In the House of Lords the property interest is, of course, paramount, 438 out of 505 peers being landowners to the extent of 14,250,000 acres; while in the House of Commons there are 194 proprietors, owning 2,121,000 acres, besides 66 sons and heirs of land-holding peers. Taking both houses together, the land-holding members of Parliament are in a majority of 120; and since they own nearly a quarter of all the land in the kingdom, it can hardly be expected that they will pass any legislation interfering materially with the existing land laws, or operating to their own disadvantage.—*N. Y. Observer*.

A German has invented a safe that, on its lock being tampered with, throws open its doors, seizes and drags and locks in the burglar, and handcuffs and holds him in readiness to be conducted to the police court in the morning. The Yankee is experimenting with a set of books for the use of county officers, which, as soon as a fraudulent entry is made in them, will, by means of a clever electrical contrivance, sound an alarm on the court-house bell.

The Locomotive.

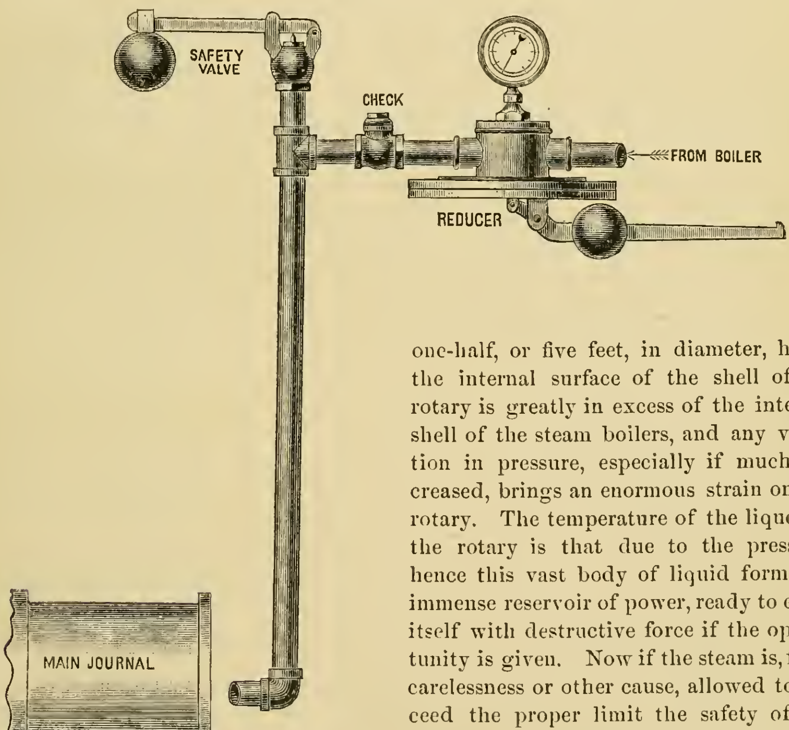
PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

NEW SERIES—VOL. IV. HARTFORD, CONN., JULY, 1883. No. 7.

How to Regulate the Pressure in a Rotary Bleach.

The explosion of a rotary bleach is usually attended with great destruction.

The inquiry arises why should such a boiler explode, making such havoc, when there is no fire used in connection with it? It will be understood that these boilers are filled with the material to be bleached or treated, and the liquor used in the process. This mass is heated by steam direct from the steam boilers. The bleach boilers are usually six or seven feet in diameter, while the boilers supplying the steam are only four and



one-half, or five feet, in diameter, hence the internal surface of the shell of the rotary is greatly in excess of the internal shell of the steam boilers, and any variation in pressure, especially if much increased, brings an enormous strain on the rotary. The temperature of the liquor in the rotary is that due to the pressure, hence this vast body of liquid forms an immense reservoir of power, ready to exert itself with destructive force if the opportunity is given. Now if the steam is, from carelessness or other cause, allowed to exceed the proper limit the safety of the rotary is endangered, and if rupture occurs, this immense reservoir of power becomes active and fearfully destructive. The steam connection between the steam boilers and the rotary should never be left open and free so as to subject the rotary to the strains due to the variations in pressure of the steam in the boilers; but there should be, intermediate, a regulating or reducing valve that will prevent the pressure on the rotary exceeding a safe and fixed limit. Such an appliance is illustrated by the diagram above. By examination it will be seen that the steam-pipe from the boiler connects first with a reducing valve or regulator, on which is a steam gauge. Following is a swing check valve, which prevents any liquor in the rotary from running back into the reducer. On the top of the vertical pipe is a safety valve to relieve the rotary of any excess of pressure should the reducer from any cause become inoperative. With the reducer and safety valve properly adjusted, any required and safe pressure can be maintained on the rotary, and the pressure to which the appliance is adjusted cannot be exceeded. We ask the careful attention of all paper manufacturers to this device. We believe it will overcome and prevent the danger attending the use of rotaries as usually fitted up. We prepared the device for a prominent paper manufacturer, who expresses great satisfaction with its operation. There is no patent on it; any steam fitter can put it up. Care however should be used in having the reducer properly adjusted to the rotary to which it is to be attached.

Inspectors' Reports.

MAY, 1883.

The summary of the work of the Inspectors for the month of May last shows a most satisfactory state of affairs, in a business sense, but a pretty unsatisfactory state from an engineering or mechanical standpoint. The whole number of inspection trips made foots up 2,463, during which 5,188 boilers were visited. Of this number 2,333 were thoroughly examined, both externally and internally, and 313 others were subjected to the hydrostatic test. The number of boilers condemned was 23. The total number of defects found which were considered of a sufficiently serious nature to be reported was 3,532, of which 507, or 14 per cent. were dangerous. The following table shows the defects in detail.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	499	35
Cases of incrustation and scale,	588	39
Cases of internal grooving,	22	10
Cases of internal corrosion,	92	25
Cases of external corrosion,	148	35
Broken and loose braces and stays,	50	12
Defective settings,	111	17
Furnaces out of shape,	156	15
Fractured plates,	108	40
Burned plates,	159	28
Blistered plates,	347	37
Cases of defective riveting,	268	72
Defective heads,	41	13
Leaky tubes,	469	15
Leaky seams,	174	24
Water gauges defective,	62	19
Blow-out defective,	18	4
Cases of deficiency of water,	5	3
Safety-valves overloaded,	25	7
Safety-valves defective in construction,	17	10
Pressure gauges defective,	168	42
Boilers without pressure gauges,	5	5
Total,	3,532	507

BOILER EXPLOSIONS.

MONTH OF MAY, 1883.

Oil Well (59.)—Harry Hope was instantly killed at 1 o'clock May 3d, by a boiler explosion on the Smith farm, one mile from Franklin, Pa. The boiler was a large stationary one of 40-horse power, and furnished steam for over twenty wells. Two derricks were torn down and property damaged on all sides. Hope's body was carried through the air for 250 feet over the tree tops.

Saw Mill (60.)—The boiler in Clapp & Lyttle's mill, Winamac, Ind., exploded on May 8th, instantly killing Joseph Lyttle, and fatally wounding Anderson Clapp.

Saw Mill (61.)—At 5.30 p. m., May 10th, a terrific boiler explosion occurred at the saw mill of A. W. Kent & Co., in Corry, Pa. The boiler was about forty-horse power, four-foot shell, twelve feet long, and has been in use nearly fifteen years. One half was blown four hundred feet away, and the other a distance of one hundred and fifty feet. Brick and rubbish was thrown for hundreds of feet around. Nelson Dimmick, the fireman, was scalded on the breast, stomach, and arms, besides being badly cut about the head. His little son, who was with him at the time, was slightly injured.

Saw Mill (62.)—A terrific saw mill boiler explosion occurred May 11th, on the farm of John Guyer, ten miles southwest of Goshen, Ind. Three men were killed, Levi Guyer, Henry Acker, and Willis Brundage. Henry Knizely, John and Joseph Guyer were so badly scalded that they cannot recover. The boiler had been considered unsafe for years, but the exact cause of the explosion is not known. The boiler was found 500 feet away.

Saw Mill (63.)—The boiler in Merrick's & Gibbs' saw mill, Green Bay, Mich., exploded May 14th. The rear part of the boiler house was demolished. A young man employed about the mill was severely but not fatally injured by the escaping steam.

Saw Mill (64.)—The boiler in the Bourbon, Ind., boat-oar factory exploded May 20th. Loss, $1,000. No one was injured.

Paper Mill (65.)—A terrific boiler explosion occurred May 21st, at the new Wolverine Paper Mill in the eastern part of Detroit, Mich. The walls of the building were blown down, and the shock of the explosion was felt many blocks away. William Thompson, engineer, a one-armed man, was undoubtedly instantly killed. Peter Frank, fireman, was fatally injured. The mill was new, erected only a few months ago by the Wolverine Car Roofing and Manufacturing Company, at a cost of $90,000. The loss is estimated at between $50,000 and $60,000. Insurance, $30,000.

Steamer (66.)—The steamer Pilot, running in opposition to the San Francisco and North Pacific railway, was blown up and destroyed near Petaluma Creek, May 24th. The captain, pilot, and five others are the only ones known to have been saved, and these were all injured. Eight persons are known to be killed, and the number of missing is unknown, as the names of passengers were not recorded at the place of departure. One family of twelve persons is reported to have been on board, and it is believed that many perished with the vessel. Later dispatches state that Mr. Matthews, late of Sonoma Mountain, on the way to Arizona, lost four children and another will die. H. Egler, who had just purchased property here, was killed. Mrs. G. P. McNear was found about a mile and a half from the scene of the explosion. She was standing in the mud, still alive, but unconscious. She was immediately removed to Lakeville, but died a few minutes after her arrival.

Brickyard (67.)—A boiler in the brickyard of Bly & Granbary, Bismarck, Dak., exploded, May 24th, instantly killing John Hasson, fireman, and James Oulette, carpenter;

fatally injuring James Oulette, and badly scalding Daniel Lyons. Two others were slightly injured. Damage, $10,000.

CHEMICAL WORKS (68.)—About 10.30 o'clock A. M., May 25th, the boiler in the Pan Handle Chemical Works, just opposite Steubenville, Ohio, exploded. Three sheets of iron were torn off, and the boiler lifted and thrown eastwardly forty feet, across the county road. The boiler house was badly wrecked. The engineer's dwelling, near by, was much damaged by steam and water and by fragments of the boiler house. One stick of timber struck and carried in the kitchen door, just missing a hired woman—a narrow escape from death. The loss is $1,500 to $2,000. No one hurt.

LOCOMOTIVE (69.)—On the morning of May 25th, the engine of a work train on the Chesapeake & Ohio road exploded its boiler while at work removing a wreck at Callahan, Va. The front end of the boiler was blown out, the engine completely wrecked, and six men of the wrecking gang injured. Some pieces of the boiler were thrown half a mile. The engine was 12 years old.

SAW MILL (70.)—The boiler in a saw mill at Waterford, Spencer county, Ky., exploded May 25th, fatally wounding several workmen, and instantly killing John Purcell, the owner of the mill.

SAW MILL (71.)—A terrible boiler explosion occurred one and one-half miles east of Leon station, Ohio, May 25th. From some unknown cause the boiler in the saw mill of E. C. Chandler exploded with terrific force and fatal effect. The building was torn to pieces. Nelson Johnson was instantly killed and M. Lewes and James Lewes were severely hurt, how seriously cannot now be told. The mill had been running only a little over three weeks. The loss will be in the neighborhood of $1,000.

SAW MILL (72.)—A boiler in Harris' mill, eight miles northwest of Mattoon, Ills., exploded May 26th, killing James Johnson, and probably fatally injuring Robert Davis and a man named Lomon. The boiler was split in two and the ends blown five hundred yards apart. Cause not known.

SAW MILL (73.)—The boiler of a saw mill at Champaign, Ills., exploded May 26th, killing two of the employes. The mill was reduced to kindling-wood.

FLOUR MILL (74.)—The boiler in the Royal Gem Flouring Mill at Staunton, Ill., exploded May 30th, and damaged the mill about $10,000. Engineer Davis was somewhat injured, but nobody else was hurt.

SAW MILL (75.)—A boiler exploded at the saw mill of Blackshear & Snyder, in the northwestern part of the parish of Opelousas, La., May 31st, killing two men, and badly wounding four.

The Hartford Steam Boiler Inspection and Insurance Company.

This company has now attained its seventeenth year, and its name and reputation are well established among the users of steam throughout the country. Its success has been due to the vigorous and intelligent manner in which its affairs have been managed and to its fidelity to the one business of the construction, care, and management of steam boilers, with a view to greater economy and safety in their use. Its advice is largely sought in the laying out of boiler houses, chimneys, and boiler plants. In connection with its office is a draughting room, chemical laboratory, and appliances and facilities for experimenting upon the strength and structure of iron and steel. It has some 18,000 boilers under its care, and employs forty-two (42) trained and experienced engineers, who are constantly engaged examining this large number of boilers. It is not hampered by the sale of any patent boiler or boiler attachments, and this particular feature has no doubt done much to establish it in the confidence of the manufacturing community. It is doing an important work and has well earned its present high standing among those who use steam power.—*Independent.*

The Locomotive.

HARTFORD, JULY, 1883.

Quality of Iron for Steam Boilers.

There is so much discussion and controversy in regard to the real value of the different grades of iron offered in the market for boiler plates, that we have felt compelled to investigate the subject in order to ascertain what the brands used at present mean, and what quality of iron is indicated by them. We find that the brands as formerly used were:

C. H. No. 1, flange,	C. No. 1,
C. H. No. 1, shell,	Tank.

Some manufacturers were not satisfied with these brands because they did not indicate the true character of the iron, and boiler users were often deceived by having an inferior iron palmed off upon them by boiler-makers, when they supposed they were securing a first-class article. The brands were subsequently changed, and the following are those used by most, if not all the prominent iron manufacturers in the country:

C. H. No. 1, flange,	Refined,
C. H. No. 1, fire-box,	Tank.
Shell,	

If these brands are honestly used the quality indicated is as follows, viz.: C. H. No. 1, FLANGE, and C. H. No. 1, FIRE-BOX, are strictly charcoal iron. SHELL has only a thin cover, or outer skin of charcoal iron. REFINED has no charcoal iron in it, but is simply refined from the pig. The pigs are selected with reference to the quantity of carbon which they contain. They are divided into *foundry* and *forge* pigs. Those containing the least carbon being selected for conversion into malleable, or wrought iron. The process of refining need not be described here. From the refinery the iron is usually run out into large moulds, and then broken up into what is technically distinguished as "*plate metal.*" Now the term "refined" iron is very indefinite, and means anything from "muck bar" to that which has been through several processes. The value of charcoal pig-iron, and charcoal blooms, is owing to their being produced with a fuel that is free from impurities, and while other irons can be purified it can only be done at expense and loss, and the danger is that in some cases at least it will be only purified sufficiently to "pass muster," and sell. The brand of "refined" iron in the market is often recommended as a superior article, because it is "refined," and the purchaser is led to believe that it is something unusually good.

Another test of quality is this; the price of refined iron at the time of our inquiry was 1¼ cents per pound less than the price of C. H. No. 1, Flange. The prices were, "*Refined*," 3¼ cents per pound; *C. H. No.* 1, *Flange*, 4½ cents per pound. Questions relative to the quality of boiler plate are frequently asked us, and we take this way of answering them. We believe in the best material for boilers and always recommend it. We know that there is sharp competition in the business and that the margin of profit is often very narrow. But the purchaser should know what he is buying and be willing to pay a fair price for a first-class article. The purchaser is often as much at fault as the boiler-maker, by trying to get a first-class article for less than its cost. We know all reputable boiler-makers would prefer to use the best material, and get a fair price for their work, and some will not make estimates if inferior material is called for.

Associations of Stationary Engineers.

Considerable interest is being manifested in various localities in organizing associations of stationary engineers.

This work has been encouraged and greatly advanced through the efforts of President Cozzens, of the National Association.

The object is to bring stationary engineers, in the various cities and manufacturing centers, together for mutual improvement.

Under proper management, these associations should be productive of great good, not only to the engineers themselves, but to their employers as well. It gives the members a good opportunity to compare notes and experiences. Each will ascertain what others are doing in the same field. It is the plan in these organizations to have a suitable room, well and conveniently furnished. The tables are to be supplied with mechanical papers, and such books will be gathered from time to time as bear upon mechanical matters.

Now all this is in the right direction. It is improving and elevating. It furnishes a pleasant retreat for the engineer when his daily work is done. It should be remembered that some of the most eminent mechanical engineers which the world has known have begun life at the foot of the ladder, and it is possible for any young engineer, by reading and studying, and giving careful attention to the details of his work, to become eminent.

Such organizations should set their standard high. Drinking and swearing should not for one moment be tolerated. Character has much to do with a man's success. Mechanical ability alone will not secure the best and highest results. Good moral character, combined with ability, will be rewarded sooner or later, and these organizations can be made very effective and influential in developing in their members the best results, mechanically and morally. They should not be degraded into *trade unions*, for that would invite the hostility of many whose influence and aid will be valuable.

With the right spirit in the leaders and managers, we can see incalculable good for every member; and we would encourage those engaged in organizing such associations with the hope and expectation that their influence will be elevating and improving.

Valuable Library Destroyed.

In his book, "The War between Peru and Chili," Clements Markham states that the work of ruin carried on by the Chilians in Peru, in accordance with the policy of their goverment, is continuous and most monstrous. The National Library, the best in South America, containing more than 300,000 volumes, and that of the University of St. Mark, in its different branches of jurisprudence, medicine, political economy, mineralogy, chemistry, and *belles-lettres*, have all been pillaged by Chilian officials to such an extent that not a single book remains, while the book-cases have been broken up for packing-cases. They also stole and shipped off for Chili the instruments belonging to the astronomical observatory; the machinery, laboratories, and apparatus of the Medical College, and those for teaching arts and industries; and, as if these disgraceful acts were not sufficiently scandalous, the buildings of the university, of the library, and of the colleges, are used for barracks and stables. But this is not all; there are other deeds which rival, if they do not surpass, the devastations of Alaric and of Tamerlane. The national archives contained numerous documents, some of them dating from the conquest of Peru, and the foundation of Lima by Pizarro. They have been pillaged, and these inestimable records have been sold by weight as waste paper. The gallery of portraits of distinguished historical personages, of the Incas, and of all the Spanish viceroys from Pizarro to Pezuela, has been destroyed. The pictures were torn down, and served as material of which the soldiers made tents in the barrack-yards. The promenades, public offices, museum, have been despoiled of all objects of art, and of every article intended for use or for amusement. Pictures, statues, bronzes, marble seats, fountains—in a word, whatever was movable has been stolen and carried off to Chili. A similar fate has overtaken the municipal schools of primary instruction, which the Chilians have closed in order to seize their endowments.

Weak Manholes.

The success of the horizontal tubular boiler in our large cities has led to its trial and successful employment in many other localities hitherto deemed unfitted for tubular boilers, owing to the nature of their feed waters. In the old style construction, with staggered tubes and as many of them as could possibly be crowded into the allotted space, there was but one way to remove scale properly, viz.: take out the tubes, which was objectionable on account of the loss of time required in work of removal, cleaning off, piecing out and replacing the tubes, with generally an additional outlay for some new tubes to replace those burned or worn out.

In the tubular boiler in its newer form, Fig. 1, specially adapted for bad waters, several of the lower rows of tubes are left out, which affords a clear space of some fifteen inches between bottom row of tubes and bottom shell of boiler at its deepest point. A manhole in front head underneath the tubes affords easy access to the interior of the boiler, facilitates the work of cleaning and removal of scale and deposit, and further adds to the boiler's efficiency by improving its circulation. The design in Fig. 1 is not shown nor recommended as the best disposition that may be made of the tubes to accomplish the object. Fig. 2 will be found a better illustration of our best practice.

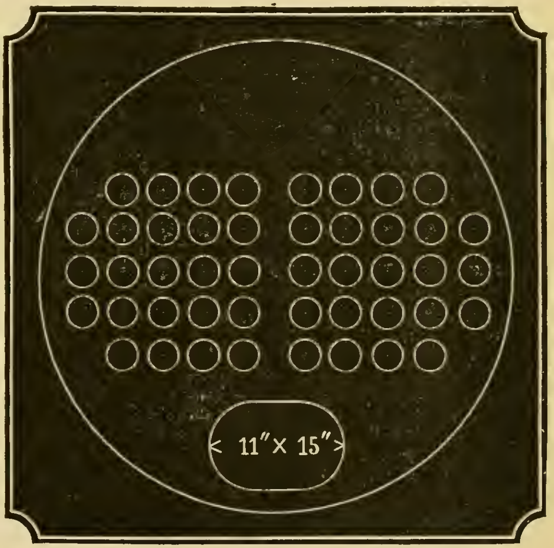


Fig. 1.

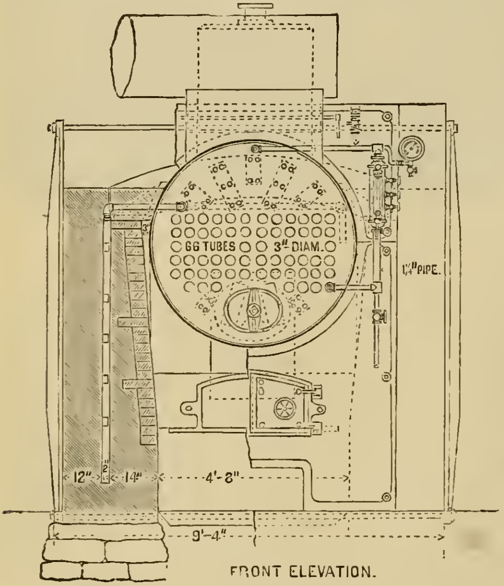
The tubular type of boiler is of course common property, in which each builder has his own ideas of what its construction should be, often adding some important kink of his devising. In the main these contributions have been valuable and have made it the successful boiler of to-day, but among the many thousands built annually, occasionally one may be found which, though of first-class construction generally, in some important particulars may be little else than a copy of the weaknesses and defects of twenty years ago. Sometimes this is due more to a want of thought than to a deliberate intention to palm off inferior work. Perhaps reproduced from the recollection of some old construction with which the builder was familiar. But we cannot disguise the fact that a determination to make a profit upon every piece of work, however low the price at which it was secured, and lack of skilled supervision in the interest of the purchaser during construction, accounts for much of the inferior work of other manufacturers.

It will we think be apparent that in cutting away so much of the material composing the front head as may be necessary for the manhole opening, usually eleven by fifteen (11 x 15) inches, we remove 11 x 15 x .7854=129.59 superficial square inches; assuming the head to be half an inch thick, this would be equal to 64.79 sectional square inches. In addition to this, the location of the manhole when fully available involves the loss of the lower tubes and their holding power in staying the heads—we are now simply considering the tube as a stay, not its evaporative efficiency. No doubt the advantage in having clean fire sheets more than compensates for the loss of these lower tubes, which, as has been repeatedly demonstrated, are of little importance and inappreciable in the boiler's performance.

But it is not alone the weakening effect of cutting away so much of the boiler head without providing reinforcement. Corrosion is sure to result from the springing of the weak unstayed section bordering the opening resulting in a leaky joint, followed by vain efforts to tighten the joint and so stop the leak, by excessive screwing up of the plate, causing successively distortion, fracture, and ultimate rupture. Boilers have failed under a hydrostatic test pressure from structural weakness of this kind, and it has been a fruitful cause of steam boiler explosions.

A case in point from our practice was that of two new boilers 60 inches in diameter, heads $\frac{7}{16}$ inch thick, containing 46 4-inch tubes having unstrengthened manholes under tubes in front head very similar to that shown in Fig. 1. This manhole opening was without an internal frame, strengthening ring, or stays of any description. Upon reporting this with a recommendation that this dangerously weak point should be properly reinforced, one report was enclosed to the builder of the boiler, who replied that reinforcement of a manhole of the description was not only unnecessary, but would weaken instead of strengthening the boiler!

The owners of the boiler were unfortunately persuaded to this view and declined to make the additions necessary to properly strengthen the manholes, which we deeply regretted, for they employ many persons who work within range of these dangerously constructed boilers. As for ourselves, we shall be careful when in that vicinity to pass by on the other side and give them the widest possible berth.



FRONT ELEVATION.

FIG. 2.

Fig. 2 is a front elevation of a 60-inch tubular boiler of the same type, being one of a number designed by the company for a prominent New England manufacturing company. The specification for these boilers provides for bracing underneath tubes on front and back head as follows: "Six (6) on rear head and two (2) on front head below the tubes as shown in drawing, none of which are to be less than three (3) feet long. Braces to be of best round iron of one (1) inch in diameter, and of single lengths."

In the matter of manholes it specifies "boilers, each to have two manholes each eleven (11) inches by fifteen (15) inches, with strong internal frames (as shown in drawing), and suitable plates, yokes, and bolts, the proportions of the whole such as will make them as strong as any other section of the shell of like area, one to be placed in front head underneath the tubes, and one to be placed on shell of boiler, as shown in drawing."

The Latest Concerning the Glacial Period in America.

In the columns of *The Independent* for March 4, 1880, and March 10, 1881, a somewhat detailed account was given of the investigations of the Rev. G. Frederick Wright, of Andover (now Professor in Oberlin), relating to the chronology of the glacial period. Since that time Mr. Wright has been busy collecting further information bearing upon the subject. In connection with Professor Lewis, of Philadelphia, he has accurately traced for the Pennsylvania Geological Survey the southern boundary of the glaciated region across that state, and during the year past, under the auspices of the Cleveland Historical Society, has followed it across Ohio and Kentucky to the Indiana line.

The southern boundary of the glaciated area of America crosses the Delaware River at Belvidere, a few miles above the mouth of the Lehigh River. Thence its course is through Northampton, Monroe, Luzerne, Sullivan, Lycoming, Tioga, and Potter counties, in Pennsylvania. It just touches the southwest corner of Alleghany County, N. Y., and reaches its northern limit in Cattaraugus County, a few miles north of Salamanca. Thence it turns southwest, running through Warren, Venango, Butler, Lawrence, and Beaver Counties, Pa., entering Ohio, in Columbiana County, a few miles north of the Ohio River. Thence its course leads through Stark and Holmes to Knox County, where it takes a sudden turn to the south through Licking, Perry, Fairfield, Ross, Highland, Adams, Brown, and Clermont Counties, crossing the Ohio River on the line between Campbell and Pendleton Counties, Ky., and re-crossing it near the southern boundary of Dearborn County, Ind.

Down to this line the whole country is covered with unmistakable signs of glacial action. Granite bowlders from the far North are numerous, both on the hill-tops and in the valleys; stones of various kinds are mingled together in the unstratified clay deposits, and are striated as in the ground moraine of Switzerland. South of this line these signs disappear. In the river valleys water has often transported bowlders much farther, but the action of water soon erases the peculiar marks of glaciation and leaves only stratified deposits.

This boundary line is remarkable, both for its indifference to latitude and to elevation above the sea. In Monroe County, Pa., it rises 2,000 feet above the sea without being much deflected from its general course. In like manner it descends 1,500 feet to cross the Susquehanna at Beach Haven, and ascends to 2,000 feet again in Lycoming County, and continues nearly at that elevation until it approaches Ohio. Its sudden turn to the southwest in New York, and to the south in Knox County, Ohio, is not due to any change in elevation. The highest land in Ohio (about 1,900 feet) is in Logan County, north of the point where the ice is extended farthest south. The gradual descent into the valley of the Mississippi may have had something to do with the extreme southern extension, but the sharpness of the flexures in Cattaraugus County, N. Y., and Knox County, Ohio, show that the southern boundary was determined largely by the irregularity of the force pushing from behind. If, for example, snows had fallen in excess over the region of the upper lakes so that the ice was a thousand feet deeper than to the east, the effect would be to push a lobe of ice in the line of the least resistance to the southward of the ordinary boundary.

South of New England, through Cape Cod, the Elizabeth Islands, Long Island, Staten Island, and across New Jersey the southern boundary of the glaciated region is marked by very large accumulations of glacial material, forming hills from fifty to two hundred feet in height along the whole line. West of this the terminal accumulation is not always so marked; but the boundary is everywhere sharply defined, and through a good portion of the distance the excessive marginal accumulation continues. Noteworthy points at which to observe this feature are in Pennsylvania, on Pocono Mt., Monroe County; in the valley of the Susquehanna at Beach Haven; of Conowango Creek, twelve miles north of Warren, and near French Creek, a few miles west of Franklin. Also in New York south of Randolph, and in Ohio near Canton, Stark County; Thornville, Perry County, and Adelphi, Ross County.

The distance to which bowlders found in Ohio and Kentucky have been transported is noteworthy. Ohio is covered throughout the larger part of its territory by the nearly horizontal strata of Carboniferous and Devonian formations. Not only are there no native granitic rocks within its borders, but none are to be found in place to the north short of the shores of Lake Huron. Yet a granite bowlder, 18x12x6 feet in dimensions, occurs near Lancaster, in Fairfield County, Ohio, which must have come from Northern Canada, nearly 400 miles away; and conglomerate bowlders containing pebbles of red jasper, characteristic of the hills about the eastern end of Lake Superior, are found in Boone County, Ky., ten miles south of Cincinnati and 550 feet above the Ohio River.

That the ice-sheet of the glacial period enveloped Cincinnati, crossed the Ohio River, and entered Kentucky a few miles, can no longer be questioned. This fact had been inferred by Dr. Sutton, of Aurora, Ind., and by Professor Shaler. Dr. Sutton, however, had not noticed scratched stones south of the Ohio, and Professor Shaler has not published his observation. But in a recent visit, Mr. Wright has both found deposits of genuine "till," containing granite pebbles and striated stones on the Kentucky hills south of Cincinnati, and has for a considerable distance traced the exact southern boundary of such accumulations in that State. That they are not water accumulations is shown both by the characteristics already described, and by the fact that they are not bounded by any barrier such as would obstruct a body of water. These deposits of transported material cease where the ice ended.

The effects of this extension of the ice-sheet into Kentucky are interesting. The Ohio River occupies throughout nearly all its course a narrow valley about one mile wide and from 300 to 500 feet deep, cut by pre-glacial erosion through the horizontal strata of the coal measures. The passage of the glacial ice across the river at Cincinnati must have formed a dam in its channel 500 or 600 feet in height. This would raise the water in the upper portion of the channel so as to submerge Pittsburg 250 or 300 feet and make both the Alleghany and the Monongahela for a long distance, arms of the interior lake. Very likely this may be the key to unlock the mystery of the extraordinary river terraces both above and below Pittsburg.

All this is preliminary to the question of the date of the close of the glacial epoch. We shall soon know the exact boundary of the glaciated area and shall be able to study at a great number of points the streams which break through this boundary. It will be strange if altogether the extent of the erosion of these various streams does not shed some light on the chronology of the glacial period, and serve as a wholesome check upon the speculative astronomical chronology now so much in favor. So far as calculations have been made they, with great uniformity, indicate a short chronology for the period since the glacial epoch. The post-glacial work done by the streams issuing from the glaciated area is extremely small. The rate at which they work is difficult to determine. Along nearly every stream there are extensive gravel terraces below the glacial limit, like those on the Delaware, at Trenton, N. J., in which Dr. Abbott has found paleolithic implements. Observers should be on the lookout for implements in all these gravel deposits.—*The Independent.*

Delta Metal—A New Alloy.

The great attention which has been given for some years past to the manufacture of alloys, says the *Iron Trade Circular*, has brought many of them into the market, which for durability and economy are unsurpassed when applied to the particular purpose for which they are made. An addition has now been made to the number by Alexander Dick of Cannon street, whose delta metal promises to replace ordinary brass in a large number of cases. Delta metal appears to be, practically speaking, a fine quality yellow metal, hardened and toughened with iron, the result being a fine gold-colored brass of really beautiful appearance. The copper and zinc alloys have always enjoyed a high reputation, but the introduction of iron into them, although successful enough experimentally, has always been wanting in uniformity and reliability when manufactured on the commercial scale. It is this obstacle which Mr. Dick has succeeded in overcoming by first alloying the iron in definite and known proportions with the zinc, and then adding the copper. When ordinary wrought iron is introduced into molten zinc, the latter readily dissolves or absorbs the former, and will take it up in proportions of about 5 per cent., or in some cases in somewhat larger proportions. The exact point of saturation or the proportion dissolved or absorbed is found to vary with the temperature at which the molten zinc is kept during the process; and unless the temperature be ascertained and controlled, the resulting products will be uncertain in their character. To secure the desired uniformity he uses gas or other furnaces that can be made to work at the same or uniform temperatures for heating the crucibles; and he finds that by keeping the crucibles at as high a temperature as possible without the volatilization of the zinc—that is to say, not exceeding about 1200 Fahr.—he is able to produce alloy containing a definite and known proportion of iron, and by adding the zinc and iron thus formed of ascertained and known character to the requisite amount of copper or copper and zinc, he is enabled to introduce any definite quantity of iron up to about 5 per cent. of the zinc contained in the alloy to be produced.

The results of experiments made by David Kirkaldy to ascertain the elastic and ultimate tensible strength of the delta metal were very satisfactory. Bar No. 1, of 1½ in. diameter, was tested as drawn; it was first turned 1.128 in. diameter, or one square inch area, and bore an elastic stress of 49,600 lb., or 22.1 tons per square inch, and an ultimate stress of 75,235 lb., or 33.6 tons per square inch, the ratio of the elastic to the ultimate strength being thus 65.9 per cent. The contraction of area of fracture, which was granular and silky in appearance, was 15 per cent., and the stress per square inch of fractured area was 88,511 lbs. At 50,000 lb., 60,000 lb., and 70,000 lb. per square inch, the extension set in 10 in. were 0.11, 0.82, and 3.73 per cent. respectively, the ultimate being 8.8 per cent. Bar No. 2 was of similar diameter, but annealed, and it was turned to similar area; it bore an elastic stress of 19,800 lb., or 8.8 tons per square inch, and an ultimate stress of 61,130 lb., or 27.2 tons per square inch, the ratio of the elastic to the ultimate strength being 32.3 per cent. The contraction of area at fracture, which was granular and silky in appearance, as in the other case, was 19.9 per cent., and the stress per square inch of fractured area was 76,317 lbs. At 50,000 and 60,000 lb. per square inch the extension set in 10 in. was 10.80 and 16.90 per cent. respectively, the ultimate being 17.5 per cent. Comparing the tensile strength of delta metal with that of iron, brass, and gun metal (taking the figures for the latter metals given in Molesworth's Pocket-book), the results were: Delta metal cast in sand (green), showed a breaking strain of 21.6 tons per square inch; ditto. rolled and annealed, 1½ in. bars, 27.2 tons; ditto. drawn into wire of No. 22 w. g., 62.5 tons; wrought iron, 22.0 tons; brass, cast, 8.0 tons; brass wire, 22.0 tons; and gun metal, cast, 16.1 tons per square inch; so that there can be no question as the superiority for many purposes of the new alloy.

The comparative cheapness of the new alloy will undoubtedly be one of its greatest recommendations; and Mr. Dick certainly appears to have full justification for claiming that although delta metal is an improved brass, it is as much superior to it as phosphor bronze is to ordinary gun metal, and as steel is to iron. It can be made as tough as wrought iron, and as strong and hard as mild steel; it can be forged and rolled hot, and will stand being worked and drawn into wire when cold. When melted delta metals runs very freely, and perfectly sound castings of fine close grain can be produced from it; its color resembles that of gold alloyed with silver, it takes a high polish, and when exposed to the atmosphere will tarnish less than brass. The prices of delta metal—ingots, sheets, rods, and wire—are but little in advance of those of the best brass, and vary slightly with the composition of the metal. The uses to which this new alloy can be applied are very numerous; its great strength, durability and hardness recommend it for various kinds of engineering work, whilst its fine rich color has already secured for it a market for cabinet work, harness, and carriage fittings, and in connection with other trades.—*Cotton, Wool, and Iron.*

[The composition of the above described alloy seems to be similar to that of Aitch metal, while its properties resemble those of Sterro metal.—ED. LOCOMOTIVE.]

The Properties of Oils.

M. Chevreul found metals to have, in certain cases, a remarkable influence on the oxidation of oils. Recently, the *Times* says, M. Livache has used, in this relation, finely-divided metal—such as is got by precipitation—instead of metallic plates, and the effect is greatly increased. He thus tried lead, copper, and tin, and found lead to have the strongest action. If precipitated lead, moistened with oil, be exposed in air, an increase in weight is very soon observed, and this is greater the more siccative—or drying—the oil. With linseed oil, the increase of weight reaches a maximum in 36 hours, whereas, exposed alone to air, the oil would take several months to reach this maximum. A solid and elastic product is obtained. With non-drying oils the increase of weight is much less, and takes much longer to be completed. The result in question, M. Livache points out, cannot be attributed to a simple division of the matter, allowing more active circulation of air, for the same experiment made with various other substances in fine division does not result in any like increase of weight; the effect here is merely like that in the case of a thin layer of oil exposed to air. The change in the other case must be attributed to a direct action of the metal. He suggests what industry may derive certain advantages from the facts observed. Thus a rapid method is indicated of distinguishing dry from non-drying oils. Further, the heating of oils might be advantageously replaced by a circulation in contact with air and in the cold state, over iron or fine plates having precipitated metallic lead on their surface. The oils so obtained would be always less colored, and would retain great fluidity, while the objectionable odors and the danger of fire which attend the present mode of treatment would be avoided.—*Cotton, Wool, and Iron.*

The oldest pieces of iron (wrought iron) now known are probably the sickle blade found by Belzoni under the base of a sphinx in Karnac, near Thebes; the blade found by Colonel Vyse, imbedded in the masonry of the great pyramids; the portion of a cross-cut saw exhumed near Nimroud by Layard—all of which are now in the British Museum. A wrought bar of Damascus steel was presented by King Porus to Alexander the Great, and the razor steel of China for many centuries has surpassed all European steel in temper and durability. The Hindoos appear to have made wrought iron directly from the ore, without passing it through the furnace, from time immemorial, and elaborately-wrought masses of iron are still found in India, which date from the early centuries of the Christian era.—*Cotton, Wool, and Iron.*

The Barber's Pole.

To the Editor.—While perusing an article in your last issue, in which you referred to the time when the barber did the work of the modern surgeon, it recalled to me what I once read in a very old work in the British Museum, London, relative to the "barber's pole." It seems that several centuries ago the village barber and the village surgeon were one and the same; and if an accident occurred by which a limb was broken or dislocated, the flesh torn, indeed anything that would call forth the services of a surgeon, the barber was the first summoned. But barber shops at that period were not nearly as numerous as they are now, and, in consequence, a difficulty often arose in finding them, especially as they had no sign to denote their whereabouts. The City Council of London at length made an order that barbers should extend from their shop front a sign, the shape of which should be that of a man's arm, and that it should be painted red to represent blood, while white bandages were to be placed around the arm. Soon it became a universal order, and in this way the barber's pole first originated. Though, of course, as years have rolled past and customs changed, the pole has assumed more varied and ornamental shapes.—*W. M. Hill, in "Steam."*

"Pure Liquors."

HOW SOME FAVORITE TIPPLES MAY BE CONCOCTED.

One of the gentlemen who has been engaged in the temperance work with Mr. Graham, under the auspices of the Episcopal church, has been investigating the matter of the adulteration of liquors. In the course of his inquiries he obtained a copy of a small pamphlet, giving directions, recipes, and processes for the production of various kinds and qualities of brandies, gins, whiskies, rums, bitters, cordials, and all other liquors, by the application and use of essential oils and essences, manufactured by —— of —— and ——, branch of —— & Co. of ——, Germany. This is printed, of course, for "the trade" and circulated privately. The preface of this curious little book reads:

"The manufacture and compounding of liquors, cordials, and other spirituous beverages by the use of essential oils or essences—without the more intricate and expensive process of distillation—has of late years assumed such vast proportions, as to necessitate their appliance by the majority of distillers and dealers in this country."

The evident object of the work is to induce liquor dealers to manufacture for themselves, and it is not at all unlikely that some may do so. That liquors as generally sold in the market are largely adulterated is not denied. As illustrations of the concoctions a buyer gets and his customer drinks, the following recipes are interesting:

"*Cognac Brandy*—(for 40 gallons)—Cognac oil, best genuine, 2 drachms; Jamaica rum essence, 4 ounces; glycerine, chemically pure, 1 pound; cologne spirit, proof, 40 gallons.

"*Jamaica Rum*—A very fine article, (for 40 gallons)—Jamaica rum essence, 12 ounces; old genuine Jamaica rum, 2 gallons; glycerine, chemically pure, 2 pounds; cologne spirit, proof, 38 gallons; color with sugar coloring.

"*Scotch Whisky*—(for 40 gallons)—Scotch whisky essence, 3 ounces; glycerine, chemically pure, 1 pound; cologne spirit, proof, 40 gallons."

The preparation of wines is consigned summarily to a few general remarks, towards the close of the pamphlet, which are quoted as follows:

"An almost annual return of diseases affecting the grape has not only reduced the quantity of the vintage, but also deteriorated the quality of the wines; from this the necessity has arisen to replace, by artificial means, that which nature has failed to produce. This has caused us to put upon the market the following Wine Bouquet essences: Catawba, Madeira, Port wine, Sherry wine, Medoc, Rhine wine, Moselle wine, Riesling, and Muscateller, which, by using ingredients, selected with a special care to health, have made them well known and extensively used in all principal wine marts of Europe, and already secured for them an extraordinary favorable reception by the trade here. Red wines are often deficient in tannic acid; this want has been especially provided for in our Medoc Bouquet essence."—*Hartford Courant.*

The Population of the Earth.

As an authority concerning the population of the different countries of the world, the publication called "Die Bevolkerung der Erde," published by Justus Perthes, of Gotha, occupies a high position. From the seventh issue of this work, which has recently appeared, we find the total population of the globe estimated at 1,433,887,500, an apparent decrease in the estimate of 1880 of about 22,000,000, while the recent censuses of all the great countries show an increase of over 30,000,000. This is, however, partly explained by a readjustment of the population of China, which, formerly given at 434,626,500, has now been carefully revised and estimated at 371,200,000. After this change of figures for China, Asia is set down as possessing a population of 795,591,000; this includes the 252,000,000 for British India, and the 14,500,000 of the territory of Russia in Asia. The results of recent censuses in Europe show an increase in the population, which is now stated at 327,743,400, as compared with 315,929,000 in 1880—an increase of about 12,000,000. Africa is set down as having a population of 205,823,260; America, 100,415,400, and Australia and Polynesia, 4,232,000. Before some of these vast numbers the total population of the United Kingdom at last census (35,000,000) does not bulk largely, but this is more than counter-balanced by the vast power and influence wielded by our country in every portion of the habitable globe.—*Chamber's Journal.*

MANUFACTURING STATISTICS.—Census Bulletin No. 302 embraces a table of statistics of manufactures in the United States, showing the capital invested, the number of hands employed, the amount of wages paid, the value of materials used, and the value of products for all the establishments of manufacturing industry, gas excepted, in each of the States and Territories, as returned at the census of 1880. The following are the totals: Number of establishments, 253,840; capital, $2,790,223,506; average number of hands employed, males above 16 years, 2,025,279; females above 15 years, 531,753; children and youths, 181,918; total amount paid in wages during the year, $947,919,674; value of materials, $3,394,340,029; value of products, $5,369,667,706.

New York is credited with 42,739 establishments; a capital of $514,246,575; value of materials, $679,578,650, and value of products, $1,080,638,696.

Pennsylvania is next, with 31,225 establishments; capital, $474,499,993; value of materials, $462,977,250; value of products, $744,748,045.

Massachusetts, with 14,352 establishments, employs a capital of $303,806,185, uses $386,952,650 worth of materials, and turns out products valued at $631,511,484.

Illinois, with 14,549 establishments, employs a capital of $140,652,066, uses material valued at $289,826,907, and turns out products valued at $414,864,673.

Ohio, with 20,699 establishments, employs a capital of $188,939,614, consumes material valued at $215,098,026, and turns out products valued at $348,305,390.

Next in order in value of products, but not in number of establishments, capital employed, or value of material, follow Connecticut, Missouri, Michigan, Indiana, Wisconsin, California, Maryland, and Rhode Island, showing products ranging from $185,680,211 for Connecticut, to $104,163,623 for Rhode Island.

The other States and Territories are all below $100,000,000 in value of products.

—*The Iron Age.*

Machinery for underground use of a higher class than has been employed before is now in course of adoption in South Staffordshire. There has been introduced at the Cannock and Rugeley collieries, Hednesford, an air-locomotive that gives very satisfactory results. The *Colliery Guardian* reports that the engine is one of Lishman & Young's, and has been made by the Grange Iron Company, near Durham. It has a pair of 4½ inch cylinders with 8 inch stroke, and is fitted with all the working parts of an ordinary steam locomotive. The receiver (the substitute for the boiler) is 6 feet 6 inches long by 3 feet 6 inches diameter, and is made of Siemens's steel plates. The engine is now working at a pressure of 300 pounds to the square inch, but will stand a pressure of 500 pounds. It is situated at a distance of 1,200 yards from the bottom of the shaft. It goes into the stalls and brings the coal directly from the face of work, a distance of 250 yards, delivering it to a station at the bottom of a trough vault. At this, a hauling rope takes hold of the trains and draws them up to where the main hauling engine takes them to the shaft. This main engine is stationed on the surface. It has a 32 inch cylinder, and besides hauling it compresses the air necessary for the smaller air-locomotive. The air cylinder of the main engine is 20 inches in diameter, with 5 foot stroke, and the air is compressed to 65 pounds per square inch. The air at this density is conveyed down the shaft in large receivers, and is taken along the mine a distance of 850 yards. Here a pair of 12 inch engines work a 5 inch compressor, and further compress the air up to 300 pounds per square inch. It is then led into a small receiver, and is taken to a point at which the air-locomotive can be charged,—an operation that occupies only half a minute.—*Engineering and Mining Journal.*

Improvements in Welding.—The *Mining and Scientific Press* says it seems almost probable that, just at the time when the chief difficulties in the way of welding disappear by reason of our better knowledge and skill in manipulation, the necessity for welding in large masses will be avoided by the use of cast metal. "Heavy hammers, furnaces with neutral or reducing flames, and increased facilities for handling masses of metals, have been making more and more difficult forgings possible, but the introduction of cast steel of almost any desired quality seems to be likely to render forging an art of the past. In smaller masses, like boiler plates, great progress is being made both in this country and abroad. Bottles, buoys, small boiler shells, fire-boxes, and, in fact, an immense variety of shapes, are now being made out of plate iron without seams or rivets. Very considerable advance is being made in the production of seamless tubes of large size, flat-welded, and cylinders with the head welded together seems to be an unanswered question, the only difficulty being the want of proper plant to manipulate the sheets. Hydraulic welding is making great advances, and some of our large locomotive works are doing very remarkable work in this way. It is notable, however, that in this large work, although an enormous pressure is necessary, the pressure must not be too great, for otherwise the metal which is sufficiently soft to form the weld will be squeezed out and the cooler metal only remain." —*Mechanics.*

Colors Made by the Human Voice.—The *Philadelphia Press* of June 2d says: An optical demonstration of the effect of sound on the colors and figures in soap bubbles was given at the Franklin Institute recently by Prof. Holeman. A film of soap was placed across the end of a phoneidoscope. To bring the sound in direct contact with the soap a tube was used. A reflection of the film was thrown on a canvass screen, where it first assumed a bluish-gray appearance. An intonation of the voice, with the lips close to the mouth of the tube, caused a number of black spots to appear on the reflection. When these passed away a beautiful light green, intermingled with pink, remained. These two appeared to be the principal colors caused by sound. It was noticeable, however, that while a certain tone would cause the same figure to reappear, it had no control over the color. A tone which, for instance, caused one solid color to appear, would bring out, perhaps, a dark blue at one time and a yellow at another. No difference was noticeable in the effect of the male and female voices.

The Locomotive.

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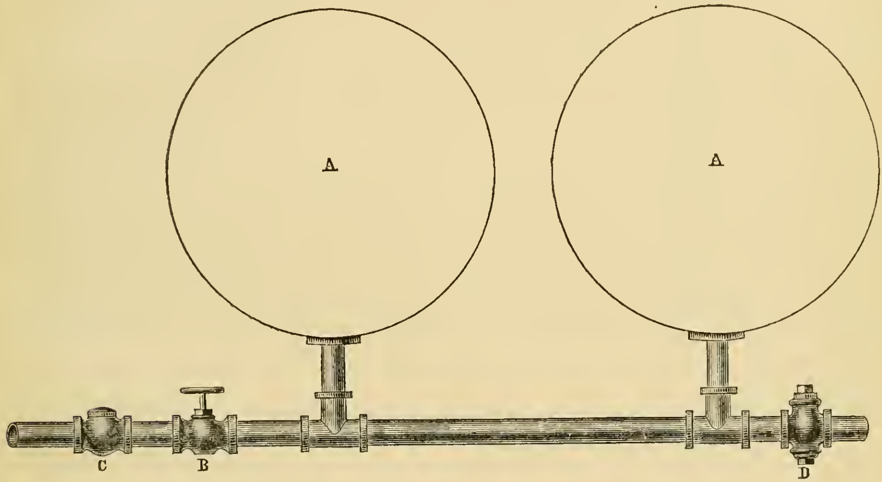
About Feed and Blow-off Attachments.

Figure 1 shows a very common form of making the feed water connection for a battery of boilers which prevails to an uncomfortable extent in many parts of the country. It may be described as follows:



A. A.—Cross sections of two cylinder boilers,
B.—Globe valve.
C.—Check valve.
D.—Blow-off cock.

It is a very ordinary occurrence in these localities for the interior boiler of a battery to become short of water; be overheated, bulged or collapsed, and oftentimes ruptured, doing more or less damage, according to circumstances and surroundings.

With such an arrangement of pipe connections, this is always possible, and may result from some one of the following causes: a more direct draft to the chimney or smoke-pipe; heavier firing, or cleaner boiler-sheets and tubes; allowing the fires in one furnace to become dirty and dull, while that of the adjacent furnace is clean and bright, etc.

In feeding boilers the feed-water will pass into the boiler through the connection offering the least resistance; therefore, under ordinary circumstances, the larger amount will go into the boiler nearest the supply, and I have always found it necessary in feeding several boilers upon the same line of feed-pipe to equalize the flow by partially closing the globe-valve upon the nearest boiler, and so graduating the lift of valves upon the other boilers as to make the feed uniform. But this cannot be done where boilers are connected as illustrated in Fig. 1, which is based apparently on the assumption that where the feed is on, each boiler is getting an equal amount of water. Practically this is rarely the case, and when some difficulty occurs by which one boiler loses its water, the true condition of affairs is not detected until too late.

At night, under banked fires, a dangerously common practice in some establishments during cold weather, there is great danger of the water being backed out of one boiler into that of the adjacent ones. A peculiar case of the kind occurred in Brooklyn some few years ago to some flue boilers under banked fires. A sudden change in the weather, from a dull, muggy atmosphere, to one bright, clear, and cold, accompanied by a brisk wind, which is supposed to have quickened the fire and set it aglow under one of the boilers—perhaps it had only been lightly covered up when banked—with all the steam-outlets closed from the upper part of boiler, it began to accumulate pressure and "kicked" its water into the adjoining boiler, which left its flues uncovered, causing overheating and collapse, with a considerable destruction of surrounding property.

This feed-connection has not only large possibilities in the way of danger from overheating, over-pressure, or collapse, but is also injurious because the difference in temperature between the entering feed-water and that of the bottom plate upon which it is emptied, is still very considerable under the most favorable circumstances, and is the cause of many fractured plates and leaky seams. And it is wasteful, for the production of steam is irregular, and the draft difficult to regulate.

Each boiler should have its feed and blow-off connection through separate pipes. The feed is best introduced at the front near the water line, for the valves are there within easy reach of the engineer, and continually under his observation. It should have suitable connections inside the boiler to ensure its delivery at the coolest place in the boiler where it will do the least damage, while the blow-off will be found most serviceable when attached to the boiler bottom near the back end. The location of feed, Fig. 1, at back end of boiler, is admirably adapted for a blow-off pipe, and steam-users who have their boilers connected in that manner will consult their best interests by making the change, putting in a blow-off cock or valve so that they may be blown off independently, and fitting up a separate feed connection, with suitably attached globe and check valve for each boiler.

To those who are wedded to the use of such a feed-connection as we have described, *i. e.* without check-valves, let us suggest making the pipe connections between the boilers of not less than eight inches internal diameter. This will equalize the pressure better than a smaller connection ; and to that extent lessen their danger. We would stipulate then they should not be used except once a common furnace, by which we mean one undivided furnace for the whole battery.

The use of mud drums is very general in parts of the country where mud and sediment contaminate the feed-water, the purpose of the mud-drum being to afford a separate vessel farthest removed from that part of the boiler in which the most violent ebullition occurs, into which mud and sediment will subside where it does the least damage, and from which it can easily be removed or blown out. But in nine-tenths of the cases of boilers so arranged that have come under the writer's attention, the feed-pipe is connected to the mud-drum, and feeds through it to the boiler, which, of course, must keep its contents in a state of agitation, thoroughly mixing up the mud and settlings, assuming that mud or sediment does subside within it during the time when there is no feed on. If so, when agitated by the feed it must be forced into the boiler again, thus defeating the very object of its use.

Inspectors' Reports.

JUNE, 1883.

Below is given the summary of the work of the Inspectors for the month of June last, with the exception of one of the large departments, the reports from which were not all in at the time of going to press. The reports, so far as received, show that 2,220 inspection trips were made, 4,172 boilers were examined, 1,676 of which were inspected internally, 341 were tested by hydrostatic pressure, and 51 were condemned. The total number of defects reported foots up 2,600, of which 399, or over fifteen per cent., were considered dangerous; as per the following detailed statement:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	271	24
Cases of incrustation and scale,	505	33
Cases of internal grooving,	26	10
Cases of internal corrosion,	69	16
Cases of external corrosion,	146	31
Broken and loose braces and stays,	34	14
Defective settings,	125	6
Furnaces out of shape,	69	4
Fractured plates,	87	48
Burned plates,	76	15
Blistered plates,	196	13
Cases of defective riveting,	127	43
Defective heads,	21	6
Leaky tubes,	316	50
Leaky seams,	187	19
Water gauges defective,	77	12
Blow-out defective,	29	4
Cases of deficiency of water,	15	6
Safety-valves overloaded,	32	7
Safety-valves defective in construction,	20	11
Pressure gauges defective,	171	26
Boilers without pressure gauges,	1	1
Total,	2,600	399

Leaky seams are sometimes one of the most troublesome defects to which steam boilers are subject. The causes of this defect are various. Sometimes it arises from defective construction of the boiler, the joint is not staunchly made originally, or the drift pin may have been used too severely, thus buckling the plates to such an extent that no amount of caulking will keep the seams tight under ordinary circumstances. If the plates do not come together truly when the lap is made, that is, if they are crooked, and buckled between the rivet holes, they cannot be drawn together by the process of riveting, and too much caulking is required to keep the joint tight. When this is the case, it is found that no amount of caulking will prevent leaking for any great length of time. The seams are always leaking and corroding, and in a short time patches have to be put on. If boiler makers would pay more attention to the matter of making good, smooth laps, with the rivet holes fair and true, they could dispense with about one-third of their rivets and have a stronger and better joint. It is now established beyond the shadow of a doubt, that a joint can be made perfectly tight for pressures up to 150 pounds per square inch, by pitching the rivets from 3 to $3\frac{1}{4}$ inches in a $\frac{3}{8}$-inch plate. We say it is established beyond the shadow of a doubt, because it is now regularly done by some of the best boiler makers, and they tell us that the seams hold better than they did when they put the rivets in as closely as they could conveniently drive them. They say that the staunchness of the joint depends more upon the nicety with which the plates fit together, than it does upon the pitch of the rivets.

BOILER EXPLOSIONS.

JUNE, 1883.

SAW-MILL (76).—The boiler of Blackburn & Snider's mill at St. Landry Parish, La., exploded this morning, June 1st, killing two men and wounding eight men and two boys. The mill was blown to atoms.

SHINGLE-MILL (77).—At 8.30 A. M. the boiler in the shingle-mill of G. V. Turner & Son, eight miles below East Saginaw, Mich., exploded with terrific force, shattering the mill building into fragments, which were scattered in every direction, and only a pile of brick, mortar, and remnants of the walls mark the spot where the boiler-house stood. Portions of the boiler were thrown in all directions. The steam-dome going into the air and descending passed through the roof of the salt shed and crushed into three tiers of salt barrels. The fire-front was blown several rods to the west and passed through a small house, fortunately empty. Another piece, in its flight through the air, carried off a portion of the smoke-stack on a drill-house that stood some distance away to the north, and another piece smashed in a corner of the drill-house. Still another piece fell into the bayou a long distance to the west. Three men were torn into pieces instantly. Their names were: William G. Turner, a son of the proprietor of the mill, who was also the engineer; Hiram Goulding, fireman, and John McDowell, night watchman. There were thirty men about the premises at the time of the explosion. The capacity of the mill was 70,000 shingles per day. The loss is $5,000.

PILE-DRIVER (78).—By the explosion of the boiler of a pile-driver engine on the Memphis & Charleston railroad yesterday, near Lagrange, Tenn., engineer Harry Roberts and fireman Lee Transcomb were killed outright, and Tom Farr Smith, an engineer, and a man named Tom Atkins, were seriously injured. Roberts was formerly an engineer on the river. He leaves a wife and three children living at Iuka, Miss.

SAW-MILL (79).—The boiler in the mill of Farnham & Lovejoy, Minneapolis, Minn., exploded June 6th. Matt Tierce, the fireman, had an arm and shoulder broken.

RUBBER-WORKS (80).—At College Point, L. I., last night, June 9th, a cast-iron vulcanizer weighing nearly five tons, in the factory of the Ansonia Rubber Works, burst. A piece of iron weighing several tons was blown through the roof of the factory, and fell into a vacant lot, nearly a block away. The roof and the larger part of the side of the main building of the factory were demolished. The damage will exceed $12,000. Jacob Jackson, an engineer, was shockingly scalded; Andrew Hoppe had both arms broken, his eyes put out, and the flesh upon his body was literally cooked; William Kelly was struck by a piece of the iron, and had his skull crushed. Two other workmen were fatally hurt.

STEAM-TUG (81).—The boiler of the tug Athlete exploded this morning near Fernandina, Fla. Captain Devette was blown through the wheel-house and killed. Two other men were fatally injured. The tug was wrecked.

Rubber-Works (82).—Thomas Culleton, aged sixty years, and Michael Hawk, aged thirty-five years, were instantly killed by the explosion of a rubber vulcanizer, or heater, of which they had charge, at the Trenton, N. J., Rubber Works, this morning. The men neglected to blow off the steam before they commenced to unscrew the bolts of the door. When a few bolts had been freed the strain came too heavily on the others, and the explosion followed. The door blew out, and the men were whirled with terrific force through a brick wall twenty feet away. The vulcanizer itself was thrown backward fifty feet, through two brick walls, into the car-spring shop, where a dozen men were employed. The escape of these men without injury seems almost miraculous.

Saw-Mill (83).—The boiler attached to a saw-mill belonging to Cottrill & Kennedy, and located near Fortville, Ind., exploded this evening with terrible effect. Mr. Cottrill was so severely scalded that he will die, and his partner, Kennedy, was instantly killed. The mill is almost completely wrecked.

Saw-Mill (84).—A dispatch stating that the boiler in the saw-mill of M. A. York, at Bernamwood, Wis., a place about seventy miles from Appleton, had exploded June 15th, completely wrecking the mill and killing the watchman. It was very early in the morning, before the men had come to work, otherwise the destruction of life would have been very great. The total loss is not known, but probably about $50,000.

Machine-Shop (85).—Just before noon, June 20th, the boiler in the engine room of H. E. Penney's machine-shop, on the alley back of No. 315 Third avenue south, Minneapolis, Minn., exploded with disastrous effects, the entire engine room being practically demolished. A young man named Willie Lunburn, who was employed at the shop, was knocked down and covered with the debris, and severely scalded by the escaping steam. Mr. Penney attributes the explosion to the rottenness of the iron in the boiler, and estimates his loss at between $1,000 and $1,200.

Saw-Mill (86).—The boiler in the mill of Behymer, Holbrook & Styles, seven miles from Shawneetown, Ill., on the Ohio and Mississippi road, exploded June 20th. Besides injuring the mill, a lot of lumber was destroyed, and a switch and a section of track were torn up. Loss, $15,000; no insurance. Eight men working about the mill escaped uninjured.

Paper-Mill (87).—About 9.30 o'clock on Wednesday evening, June —, an explosion occurred in the Ghent Paper Company's mill, located about one mile northeast of Ghent village, N. Y. The only employees in the mill at the time were William Watson, the engineer, and a lad named Lampman. The crash was heard by W. H. Sliter, the manager, at his house, about 300 feet distant, and he ran down to the mill. He discovered that three of the four cylindrical dryers had exploded. Fragments of the machinery were scattered in all directions and Watson lay on the floor in an unconscious condition. His skull had been fractured by a piece of the iron and the blood flowed in a stream from the wound. The damage to the machinery, etc., by the explosion, is estimated at between $3,000 and $4,000. The disaster was doubtless caused by an over pressure of steam on the cylindrical dryers, which were apparently defective in construction.

Threshing Machine (88).—Yesterday afternoon, June 21st, a steam engine attached to a threshing machine, at work eight miles from Greenville, S. C., exploded. The connecting band had broken, the engine had stopped, and a number of laborers had gathered to assist in repairing it, when the explosion occurred without warning, scattering the bystanders in every direction and throwing some of them thirty yards away.

Woolen-Mill (89).—The boiler at Gants' woolen-mills, near Boonville, Mo., exploded June 22d, wrecking the building and machinery. Several men were injured, but only one, the engineer, dangerously. The mills were valued at $50,000.

WELL (90).—A boiler exploded at a well on the Clapp farm, Kendall Creek, near Bradford, Pa., June 22d, killing the engineer and demolishing the rig.

MILL (91).—A boiler in the mill of Ives & Hale, at Whittlesey, six miles north of Medford, Wis., exploded June 28th, totally demolishing it, and killing the following persons: Donald Gerrish, engineer; John Spencer, fireman, colored; John Stoner. One was taken in the throes of death from beneath the boiler ruins, the second had his head blown off, and the third had his head crushed by falling timbers. Charles Stenhouser, Dan Moran, and C. Tuttle were badly scalded.

STAVE FACTORY (92).—At a stave-factory in Marshfield, Wis., recently, the man-hole plate blew out of a boiler, filling the fireman's pit with boiling water to the depth of eighteen inches. The engineer and assistant narrowly escaped being scalded to death.

FOREIGN.

STEAMER.—The steamer Iskatermburg, plying on the river Volga, Russia, exploded her boilers May 17th. Twenty-seven persons were wounded by the explosion.

TUG-BOAT.—An explosion occurred June 13th, on board a tug in the Rio Chuelo, South America, killing eight persons and seriously injuring nine others. Four were blown a great distance and horribly mutilated, and one was smashed to pieces against a house.

SAW-MILL.—The boiler in Grainger's steam saw-mill, on the fourth concession of the township of Gosfield, Essex County, Ont. [the county opposite Detroit], exploded June 2d. Richard Stewart, the fireman, was blown about four rods, and striking against a pile of lumber was instantly killed; Robert Hagan and Henry Grainger were badly scalded, and Grainger also had some of his teeth knocked out by being struck by fragments of the boiler. There were but sixty pounds of steam on at the time of the explosion.

An Old World Project.

Of the proposition elsewhere mentioned, to build a maritime canal through Palestine, the *London Railway News* says an English company, with the Duke of Marlborough at its head, has been formed for the purpose of making investigations and preliminary surveys. So far as at present proposed, the work will include, in the first instance, a canal twenty-five miles in length, from Haifa, in the Bay of Acre, through the plain of Asdraelon to the valley of the river Jordan. The depth of the proposed canal is to be forty feet, and its width two hundred feet. This will bring the Mediterranean into the heart of Palestine, and go far towards making a seaport of Jerusalem. It is further proposed to construct a canal twenty miles in length from the head of the Gulf of Akaboah to the Dead Sea, and thus unite the waters of the latter with the Red Sea. If these things were successfully performed it is expected that an inland sea about three hundred miles long, varying in width from three to ten miles, and deep enough to float vessels of the largest size, would extend from the Mediterranean to the Red Sea. There are some matters besides engineering difficulties which may hinder the execution of this project. The consent of the Porte is indispensable, and certain European powers would undoubtedly oppose the granting of a firman conferring upon England the exclusive right of way by water through Palestine. The Holy Land has also sacred associations for Christians throughout the world, and a wide-spread sentiment among all churches and sects would doubtless be raised in opposition to the innovation. Speaking of this particular subject the *London Times* says: "It is possible that the new enterprise may be proved to the satisfaction of many devout men and women to be the fulfillment of the prophecy of Ezekiel, to the effect that there is to be a broad sea in the desert, and that 'the fishers shall stand upon it from En-dedl even unto En-eglaim.'"

The Locomotive.

HARTFORD, AUGUST, 1883.

Dangerous Boiler Settings.

In setting a horizontal tubular boiler the brick-work of the furnace is so adjusted as to expose nearly or quite one-half of the exterior surface of the boiler to the direct action of the heat, but care is taken to close in the brick sides of the setting at a point below which the water never falls except through carelessness and neglect. It will be readily seen that if the fire and direct heat from the furnace is allowed to come in contact with portions of the boiler that are not protected by the water within, there will be danger of burning the iron and destroying its strength.

We call attention to this danger from the fact that we have found boilers so set that the fire line is above the water line of the boiler, and a strip of varying width, extending the whole length of the boiler is exposed to the action of the fire without the protection of water within. The evident object of this plan of setting is to get as much heating surface as possible, so as to secure great evaporative efficiency. But in the effort to secure this efficiency safety is forgotten. It should be borne in mind that "efficiency" at the expense of safety is not economy, and while a boiler may apparently do unusually good service at first by some such plan, it may prove very expensive in the end in repairs, and in greatly shortening the working age of the boiler. Any device that ignores sound principles is dangerous, and the effort to gain an advantage by such practices, where the party doing them is intelligent enough to know the danger, is inexcusable. It is introducing an element of trickery that should not for a moment be tolerated. A person setting a boiler may be ignorant of the danger of bringing the fires of the furnace in direct contact with unprotected iron, but with a full knowledge of the danger, there is no excuse.

Any circulars of patent boilers, or patent boiler attachments, or boiler "purgers," having endorsements signed or purporting to be signed by agents or inspectors of the Hartford Steam Boiler Inspection and Insurance Company are unauthorized, and will not be recognized. No one is authorized to sign such endorsements save the officers of the company.

Pneumatic Tramway Company.—Mr. James L. White, of New York, has favored us with photographs of the "Compressed Air Locomotive," which is said to be in successful operation on an ordinary surface road in Paterson, New Jersey. It is thought that with one charge of air it will draw a loaded car a distance of ten miles. On the road in Paterson there is quite a long incline of between 400 and 500 feet to the mile. This seems to be a practical demonstration of what has so long been needed, viz., some method by which street cars can be propelled by compressed air.

Mills' New England States Steam Users' Directory has just been issued in neat and attractive form. It contains a full list of the users of steam boilers in New England, with the number of boilers in each mill, together with many valuable hints for steam users. It can be obtained of the J. N. Mills Publishing Company, 145 Broadway, New York.

Henry Clay once owned the lot opposite the White House in Washington, and Commodore John Rodgers wanted it, but the old Whig persistently refused to dispose of it. On his return from the Mediterranean the Commodore brought in one of his vessels a fine Andalusian jackass, which Clay wanted for his Kentucky stock farm. All his offers were rejected, until one day the Commodore said: "You can have him for your lot opposite the White House." "Done," was Clay's reply, and the animal was shipped off to Kentucky. The Commodore built the now historic house which Secretary Seward occupied during the war. Here Payne endeavored to assassinate him on the night when President Lincoln was shot. The lot is now valued at $40,000.—*Pittsburgh Despatch.*

Cast Iron Boiler Fronts.

Cast iron boiler fronts, as used upon externally fired flush front boilers, are generally unattractive in appearance, ill-fitting, and destitute of all ornamentation. We can understand why this should have been so twenty years ago, when the darkest and dirtiest hole about an establishment that could not be used for any other purpose was generally selected as the fittest place to put the boiler; but of late years, there has been a change for the better, boilers being placed in well-lighted vaults in our cities, or in boiler-houses provided with a sufficient number of windows to afford ample light in other places where ground space is not so valuable, a change our boiler-makers have failed to properly recognized by designing an attractive boiler front, which would be a credit to themselves, and in keeping with the boiler's improved surroundings.

Cast iron work can be so easily and cheaply ornamented, there is no excuse for the ordinary flat-faced boiler fronts which disfigure nine-tenths of our boiler-rooms. Steam-users would be benefited could a huge bonfire be made of the old style patterns for boiler fronts, so we might start afresh with fronts of tasteful design, and adapted to the purposes of their use. The old front has long blocked the way of several modern reforms in boiler setting, chief among which is that of allowing a distance of from twenty to thirty inches between boiler bottom and grate, while that of the old construction rarely exceeded fourteen inches, for which castings might be had at many of our boiler-shops and iron-foundries,—while for the modern design with a few notable exceptions there was neither patterns nor castings.

Boiler-fronts are often kept very dirty and untidy in appearance, much more so than need be. In cleaning fires and dampening ashes, it is unavoidable that some dust shall be blown about and against the boiler fronts, but the quantity may be considerably lessened by exercising ordinary care.

I have found it a good plan to have a pile of wet ashes from a previous cleaning, which, when covered lightly over those just drawn, keeps down much of the usual cloud of dust which arises and envelops everything in the engine and boiler room, where hot clinkers and ashes are dampened with a hose. A pile of wet ashes is also a very handy thing to cover up a fire with in any sudden emergency, and is much safer, effective, and more comfortable to use, than an attempt to haul fires at such times.

Lamp black and oil are commonly used to paint boiler-fronts, which are kept presentable afterwards by frequent rubbing down with a piece of oily waste or rag. Asphaltum varnish is recommended for the same purpose, and has the advantage in appearance of giving a glossy coat or finish instead of the usual dead, lustreless hue. F. B. A.

Economy in Lubrication of Machinery.

By Geo. N. Comly, Edgemoor, Wilmington, Delaware.

[The following paper and discussion thereon at the Cleveland Meeting of the American Society of Mechanical Engineers, upon a subject of general interest to steam users, we reprint from the "American Machinist."]

In large manufacturing establishments the sum of money paid annually for lubricants is surprisingly great, and where oil is the lubricant the quantity wasted is a very large percentage of the total amount purchased.

Being convinced that such was the case, I endeavored to ascertain the actual quantity of lubricating material used in a given time on the various machines and in the various shops connected with the establishment at which I am engaged.

The result was startling, and the investigation proved that one of the most extravagant users of oil was the vertical engine used for driving the principal part of the works used for machine shop and bridge construction, etc.

The engine was nominally 60 horse power, with 16-inch cylinder and 18-inch stroke, with an 84-inch diameter pulley, making 106 revolutions per minute, but the indicator cards were evidence of the fact that frequently 83 horse-power were produced by the engine.

Owing to the fact that the engine was overloaded, the crank-shaft bearings and crank pin gave much trouble by heating, and occasionally it was necessary to stop the engine during working hours.

The expense for lubricating oils on this engine during the month of May, 1882, was at the rate of $\frac{53}{100}$ cents per hour of the time during which the engine was actually running. The oil used was cosmo-lubric No. 2, costing 65 cents per gallon, and the specific gravity of the oil was 26° Beaume.

During June the oil cost $3\frac{91}{100}$ cents per hour run, and the engine was running 120 hours per week, or an average of 20 hours per day.

About the 1st of July, I commenced using No. 10 lubricine-grease on the crank-shaft bearings *instead* of *oil*, and the result was the engine shaft bearings worked much cooler, gave no more trouble, and the cost of the lubricating material was reduced to $1\frac{15}{100}$ cents per hour run.

The crank-pin at this time was still using oil, and continued so doing until October 9th, when I had a copper box attached to the stub-end of the connecting rod close to the crank pin with a ½ inch tube connecting the box with the crank-pin bearing, and No. 4 lubricine-grease packed in it. No. 10 lubricine was also applied to the guides for the crosshead, the result being that the cost of lubrication was still further reduced to $\frac{78}{100}$ of 1 cent per hour run, and the guides and pin worked much cooler than they did previously when oil was used.

A mixture of palm-grease and beeswax in proper proportions will compare favorably in efficiency to the lubricine-grease.

I have also found mixtures of beeswax and tallow or beeswax and suet to work very well as lubricants for shafting. The relative proportions must, of course, be made to suit circumstances.

During the past eight months the line shafting has been running *without oil*, depending exclusively on the mixtures such as already described. The shafting is all provided with ball and socket hanger boxes, and the top half of the box has two cups cast in it, in which grease is packed, each having a cast-iron cover fitting closely over it to keep out the dust. This cover is chained fast by a very light chain, to prevent it from being lost or knocked down by ladders, etc.

The center oil hole, where a self-oiler is usually placed, should be stopped up with a cork to keep out dust at that point, and the use of oil is not allowed on any of the shaft-bearings where the grease can be applied.

By the regulations already described, the cost of lubricants has been reduced $44\frac{6}{10}\%$ in the cases noted above.

Means have been provided for using the grease on nearly all of the engines running at the works, and on several of the heavy machines, the result being a saving of lubricant and cool running of the journals.

It is better, when applying the grease, to make large holes in the caps of the bearings (perhaps $1\frac{1}{4}$ or $1\frac{1}{2}$ inches diameter, if allowable), and permit the grease to be packed directly on the journal surface. Where this cannot be done, a funnel-shaped cup is attached to the oil hole, in which is a copper-rod, one end of which presses against the shaft, while the other end passes through a spiral spring, which is tightened to the required tension by a screwed cap. The cup is filled with the grease, and the rod passsing though it melts the grease by the heat caused by the friction of the copper rod on the journal, the spring being tightened sufficiently to produce the necessary friction on the end of the rod.

Plain copper boxes, however, are frequently preferable, with lids to keep out dust. A piece of copper rod run through the center of the box touches the shaft, and the hole between box and shaft is made much larger than the size of the rod or copper, so that the grease can be well pushed down on to the shaft.

After reading the above paper, J. J. Grant said they (Grant & Bogert Machine Tool Works) were running their line shaft with similar lubrication. The bearings were always cold, and the cups required no attention. He considered it a great success.

Mr. Comly said, in explanation, that the boxes were originally of bronze; then they lined them with a composition of lead and antimony. But, although they run better, they always run hot till they used lubricine, when they had no further trouble.

C. J. H. Woodbury said his observations were that grease cost less, but that the friction was greater than with oil. He instanced a mill where the change had been made from oil to grease. It was thought that the friction was increased, so two shafts equally loaded, were tried—one with grease and the other with oil. He tested the matter, and found that where oil was used the temperature was increased but eight degrees; where grease was used the increase was thirty-eight degrees above the temperature in the room. The friction surface was 135 per minute; pressure, fourteen pounds per square inch. The friction was increased 33 per cent. by the use of grease. He thought the oil used by Mr. Comly was too light for heavy bearings. Cotton mills generally were using lighter oil. In one mill, where the power was limited, the output was increased five per cent. by the use of lighter oil. In another instance they could run with the gate partially closed. Where journals would not run cool, however, it was necessary to use heavier oil, or even grease, and submit to loss from increased friction.

ASPHALT AS FUEL.—The *Mexican Financier* says: "Inventors ought to find a good field in the study of some effective means to utilize asphalt as fuel. The solution of this question would be of great service to this country. It is said that many of what were thought to be coal mines, recently discovered in various parts of Mexico, are really deposits of bitumen. Now while asphalt is highly combustible, there seems to be at present no practicable method to utilize it as fuel, owing to its melting when subjected to heat. It is likely, however, that with the demand for cheap fuel now felt all over the country for railway, mining, and other industrial purposes, some effective method may be devised to make practical use of its heat-producing qualities; burning it, perhaps, after reducing it either to a liquid or vaporized form. The inventor of such a process could command a handsome fortune for the use of the right in this country. The products of the new oil wells in Vera Cruz, much of which are said to be too heavy for illuminating purposes, might also be utilized in the same manner."

A Buried City of Liliputians.

We clip the following from the New York *Observer:*

In the summer of 1839 I spent some two or three weeks on the Cumberland Mountains in Middle Tennessee. I had been engaged in teaching, and was in need of rest, and taking a good horse rode up to the Chalybeate Springs, in White county, some twelve miles from Sparta, the county seat. These springs were on the road across the mountains, from Nashville to Knoxville, East Tennessee, and about one hundred miles from the former city.

They were kept at that time by a New England man named Beckwith, and some thirty or forty persons were there.

We heard from our host that there was a buried city of liliputians some five miles distant, through the mountain passes, and a company of five gentlemen, with a colored man for a guide, started out to make an investigation. Our road was a mere bridle path, and would have been quite impossible to find without a guide. We reached the place about noon, and at once began our inquiries. The farm was owned by Thomas Wilson, a good Scotch name, and I have no doubt a man of truth. He said when he came there, some thirty years before, the ground was covered with the largest growth of trees, poplar, sugar-maple, black-walnut, and ash. It was what was familiarly called a cone in the mountains—the soil a rich, sandy loam, and the field was then in corn. The walls of the city were in the form of an octagon, or nearly so, and enclosed about six or eight acres. They were about three feet high, made of earth and loose stones thrown up, and bore the marks of the plow, and had evidently been very much higher. To show their great antiquity, a stump of a poplar was pointed out, standing directly on the wall, that measured six feet two inches across, and must have been five hundred years old—counting the rings in an inch, and estimating the whole number in the tree. No doubt it had stood there when Columbus discovered America, and was a good-sized tree then. Running through the center of the town were two rows of houses, on each side of a street. These were mere circles of earth, only a foot or eighteen inches high, and about twelve feet in diameter. Near the center were two such circles, about thirty feet in diameter, which had probably been their council houses. These could be distinctly traced, although evidently greatly reduced by time.

But the strangest part of the story is yet to be told. Mr. Wilson told us that on the highest part of this enclosure many graves had been opened, and skeletons found. They came upon them, in the first place, while plowing. The plow struck a flat stone, and on turning it up there was found a human skeleton, of a very diminutive size. He said that about a hundred had been exhumed up to that time. They were all buried in a sitting posture, with the knees drawn up near the chin, and the hands clasped on the top of the head. A flat stone was at the bottom and on the four sides and on top. By taking an iron crow-bar, and striking it down in the mellow soil, we soon found a grave. We opened two that afternoon. In each grave there was found a vessel of some kind, usually a bowl, about the size of an ordinary pint bowl, which had undoubtedly contained food. In one of the graves which we opened, there were found four vessels, all made of clay and muscle-shell and charcoal, well worked together, and either burnt or dried in the sun. The soil was remarkably dry, and the bones and the vessels were well preserved. We found in one of these graves, in addition to the bowl, a small-sized dinner-pot, with ears on the sides just like the dinner-pots of our grandmothers. It was not like them, of iron or copper, but of this same composition with the other vessels. It would hold about three pints or perhaps two quarts, and was made quite symmetrically and with an eye to beauty. In this pot was the bone of a deer's leg, charcoal, and a muscle-shell about one and a-half inches wide and three inches in length. This was no doubt put in for a spoon, and the piece of venison, and perhaps other perishable food, with fire, now only charcoal, for the supply of the departed, on his long journey to the happy hunting grounds, with provisions. In the same grave was a tray, about eighteen inches long, and nine inches wide, and two inches deep. Also, a small vessel that would hold, perhaps, a gill, for salt, most likely.

The bones were well preserved, and we got out the entire skeleton, even to the bones of the fingers and toes.

And now the most curious of all is to be told. The bones of the thigh and of the arm were not quite half the length of an ordinary man; so that they could not have been more than two and a half or three feet in height. They were not the bones of children, for they were hard, and children's bones of that size would have perished in a few years, being almost wholly cartilage. Beside, they had the wisdom teeth, which proved that they were adults. Then, all the graves which had been opened contained these small skeletons: not one exception. There could not have been so many infants buried in one place. In this same grave, which seemed to be that of a chief, we found on the neck two small ornaments about the size of an old-fashioned copper cent, carved out of muscle-shell, with holes through them for a string to tie them round the neck. At the head of the grave, inside of the stone casing, there was a piece of black slate about eighteen inches long and three inches wide, and three-quarters of an inch thick. We examined this slate very carefully for some hieroglyphics or letters, but found none. In the other grave which we opened we found only the ordinary bowl and the bones. Taking up our treasures in baskets, we carried them over to the hotel, and divided them among us as trophies. Mine were left in a box till called for, but I never got them. Returning by a different route through the Squeechy Valley, when I wrote for them to Mr. Beckwith. he said they had been carried away. I kept one of the mother-of-pearl ornaments in my pocket-book for many years, and I believe it is still in existence.

Why did I not write out some account of this wonderful discovery at the time? Simply because I thought it would be regarded as a hoax. E. P. PRATT.

PORTSMOUTH, OHIO, July 17, 1883.

East River Bridge.

The following facts and figures regarding the East River Bridge will be of interest to engineers throughout the world.

Length of river span, 1,595 feet 6 inches.

Length of each land span, 930 feet.

Length of Brooklyn approach, 971 feet.

Length of New York approach, 1,562 feet 6 inches.

Total length of bridge, 5,989 feet.

Width of bridge, 85 feet.

Number of cables, 4.

Diameter of each cable, $15\frac{3}{4}$ inches.

First wire was run out May 29, 1877.

Length of wire in four cables, exclusive of wrapping wire, 14,361 miles.

Length of each single wire in cables, 3,579 feet.

Weight of four cables inclusive of wrapping wire, $3.588\frac{1}{2}$ tons.

Depth of tower foundation below high water, Brooklyn, 45 feet.

Depth of tower foundation below high water, New York, 78 feet.

Total height of towers above high water, 278 feet.

Clear height of bridge in center of river span above high water, at 90 degrees Fahrenheit, 135 feet.

Height of floor of tower above high water, 119 feet 3 inches.

Size of caissons, 172 × 102 feet.

Grade of roadway, $3\frac{1}{4}$ feet in 100 feet.

Height of towers above roadway, 159 feet.

The weight of the whole suspended structure (central span), cables and all, is 6,740 tons, and the maximum weight with which the bridge can be crowded by freely moving passengers, vehicles, and cars, is estimated at 1,380 tons, making a total weight borne by the cables and stays of 8,120 tons, in the proportion of 6,920 tons by the cables, and 1,190 tons by the stays. The stress (or lengthwise pull) in the cables due to the load, becomes about 11,700 tons, and their ultimate strength is 49,200 tons.—*Van Nostrand's Record.*

"Groombridge 1830."

THE GREAT STAR THAT IS RUSHING THROUGH SPACE AT THE RATE OF TWO HUNDRED MILES A SECOND, OR THEREABOUTS.

[New York World, January 8, 1883.]

There is a star called Groombridge 1830, which is known to be flying through space at such a rate of speed that the attraction of all the bodies of the universe can never stop it. Newton's first law of motion is that "a body once set in motion and acted on by no force will move forward in a straight line and with a uniform velocity forever." Groombridge 1830 is a body which has come in at one part of the borders of the universe, and having found the attraction of all the vast masses of suns, among which our own is but as a mote in the light, to be practically "no force," speeds on its way with a velocity which, in Professor Simon Newcomb's words, will, within two or three million years, carry it beyond "the extreme limit to which the telescope has ever penetrated." By this it is meant not merely that it will pass beyond the stars, for the stars, many as they are, and at absolutely incalculable distances as by far the greater number of them are, are but a handful. All of them are within or close to the galaxy of which the solar system forms a part. The streak of light in the heavens which we call the Milky Way appears as it does only because the galactic region is a circular disk, the diameter of which is eight or ten times its thickness. The sun with the earth is near the center of this disk, so that when we look towards the circumference of it we see the stars crowded together, while, when we look towards the flat side of it, they are comparatively few and scattered. The Milky Way is what we see when our eyes turn towards the circumference. If the earth were a transparent ball a man at its center would see the galaxy, with the Milky Way as a belt running completely around it. The star Groombridge 1830 is not only on its way past all these visible stars, but it will go beyond them and pass among and through the region of nebulæ by which the disk is surrounded, for the nebulæ in all probability are but collections of glowing gas—the substance of which, according to a generally received theory, suns and world are made.

No other star is known to astronomers which has a proper motion so great as that which is bearing Groombridge 1830 on its way through infinite space and which is not less than two hundred miles per second, nor does science give any account of what produced it. As has already been said, an application of Newton's first law of motion shows that upon it the attraction of the whole universe of stars is absolutely "no force" to it. The star acts as if it had once been set in motion to go on at a uniform rate of velocity forever, either alone in space or from some other distant "universe" of which nothing is and nothing ever can be known, towards some other universe compared with which our own is not even as a cloud of dust. In such a matter as this an original *impetus* is out of the question. In the starry heavens masses *fall*—they are not driven; as the moon constantly falls towards the earth, so the planets constantly fall towards the sun. In other words, gravitation acts throughout the universe—wherever there is matter subject to this law, and therefore it is evident that this great star, wherever it came from and wherever it is going to, is doing its work in obedience to the law of attraction. A recent speculation may give an indication of what the giant star is on its way to accomplish, and this work is nothing more or less than the redistribution of the matter of some other universe than ours, which redistribution may have a serious effect upon the universe of which we are a part and parcel. The effect will be remote enough in time, and yet it is not by any means impossible that it may be felt long before the limit of years has elapsed which Professor Newcomb has assigned to the star for its disappearance from telescopic vision. Action and reaction are equal and in opposite directions. If Groombridge 1830 be moving towards some other great mass, the other is moving towards it, possibly with equal and possibly with greater velocity, and if the whole mass of the heaven of stars in our galaxy cannot arrest the path of the one it can hardly have any effect upon the other. In other words, our little universe need not be considered at all as a factor in the problem.

The speculation which has just been spoken of is founded on the Nebula theory, which is grounded solely in physics. The result of the theory is well known to be that suns will clash with suns, the heat resulting from the impact being sufficient to disperse the matter of which they consist through a space nearly, but not quite, equal to that which it occupied when the suns began to form. The process of condensation will then begin anew, and gradually form a body equal in mass to the sum of the suns which took part in the collison. The volume, of course, will be larger than any of the individual suns. Collision after collision and subsequent condensation after condensation will take place until, at a remote distance, two enormous bodies alone will remain, which will then begin to gravitate towards each other with constantly accelerating velocity, until they meet and sufficient heat results to make of the whole universe a nebula such as it is supposed to have been at first. And so, for one long swing of the pendulum of eternity, *actum est de homine.* The star Groombridge 1830, a runaway, a stranger to this poor universe of ours, is supposed to be in relation to some other star, one of two such great masses built up of the wrecks of the systems which once were a "universe" on its way to meet another of like proportions. And then the crash! If the tremendous cactaclysm take place near our system of stars it will certainly be involved in the ruin, and if remote, then such a nebula will blaze up in the heavens that we shall not have any need of sun or moon or stars forever.

A Discovery.

VALUE OF EUCALYPTUS LEAVES TO REMOVE SCALE FROM BOILERS.

It will be remembered that a few years ago there was a craze among land-owners in the counties bordering the bay of San Francisco for setting out Eucalyptus trees, and hundreds of thousands of them were planted. These trees have been found to contain qualities useful for a greater variety of purposes than probably any other natural product, but the supply has so far exceeded the demand that most of the groves have become burdens to their owners. The discovery lately of the use of the leaves as a steam boiler incrustant-preventive bids fair to largely increase the market for them. The greatest difficulty that engineers have ever found to contend with is the formation in their boilers of an incrustation from the solids contained in the water. Thousands of things have been used to prevent the formation of this "scale," as it is commonly called. Bran, potatoes, wood, cobblestones, sodium, chemical compounds, many and varied and numberless mechanical contrivances have been tried, many to no purpose, while some were found to mitigate the evil. None were found near perfect. The incrustation eats away the shell of boilers and is almost the sole cause of explosions. A greater evil, from an economical point of view, is the loss of fuel, caused by the fact that the incrustation is one of the poorest conductors of heat. Indeed, the consumption of fuel in boilers badly "scaled" is increased in many cases as much a hundred per cent. It is estimated that the increased cost of running locomotives in the Middle and Western States averages $750 per year for each boiler. George Downie of Salinas City several months since discovered that eucalyptus leaves removed scales from a boiler of his. He associated with himself Joseph McGillivray of Oakland, and they have since made extensive experiments and, it is claimed, with the most satisfactory results. So assured are they of the value of the discovery that they have secured patents in the United States, Great Britain, Germany, and other countries.—*Examiner.*

The Scorpion.

Dr. C. J. Wills, late one of the medical officers of Her Majesty's telegraph department in Persia, in his volume on Modern Persia says that he had heard from a Swedish physician at Shiraz, that scorpions, when they see no chance of escaping capture, commit suicide: "He told me, that when one was surrounded by a circle of live coals, it ran round three times and then stung itself to death. I did not credit this, supposing that the insect was probably scorched, and so died. I happened one day to catch an enormous scorpion of the black variety. In Persia they are of two kinds, black, and light-green, or greenish-yellow; the black variety being supposed to be much the more venomous. The full-grown scorpions generally are from two to three inches long; I have seen one five inches when extended from the tip of the claws to the sting, but he was phenomenal. The one I caught was very large, and to try the accuracy of what I supposed to be a popular superstition, I prepared in my courtyard a circle of live charcoal a yard in diameter. I cooled the bricks with water, so that the scorpion could not be scorched, and tilted him from the finger-glass in which he was imprisoned unhurt into the center of the open space; he stood still for a moment, and then, to my astonishment, ran rapidly round the circle three times, came back to the center, turned up his tail (where the sting is), and deliberately, by three blows, stabbed or stung himself in the head; he was dead in an instant. Of this curious scene I was an eye-witness, and I have seen it repeated by a friend in exactly the same way since, on my telling the thing, and with exactly the same result. For the truth of this statement I am prepared to vouch."

Salt in Lime Whitewash.

A correspondent of a German paper says that a few years ago it was decided to whitewash the walls and ceiling of a small cellar to make it lighter. For this purpose a suitable quantity of lime was slacked. A workman who had to carry a vessel of common salt for some other purpose stumbled over the lime cask and spilled some of his salt into it. To conceal all traces of his mishap he stirred in the salt as quickly as possible. The circumstance came to my knowledge afterward, and this unintentional addition of salt to the lime excited my liveliest curiosity, for the whitewash was not only blameless, but hard as cement, and would not wash off.

After this experience I employed a mixture of milk of lime and salt (about three parts of stone lime to one part of salt), for a court or light well. To save the trouble and expense of a scaffold to work on, I had it applied with a hand fire engine (garden syringe?) to the opposite walls. The results were most satisfactory. For four years the weather has had no effect upon it, and I have obtained a good and cheap means of lighting the court in this way.—*Ex.*

The Locomotive.

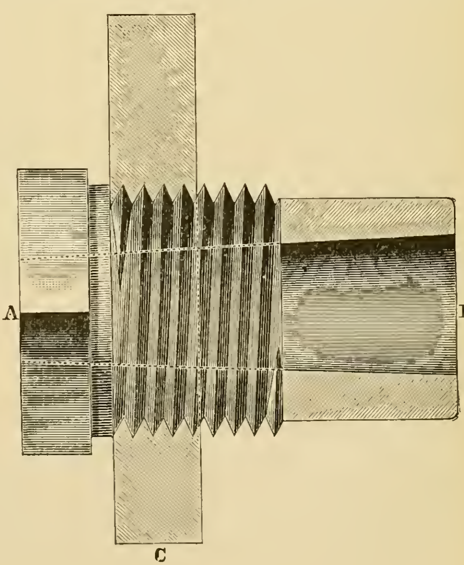
PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

New Series—Vol. IV. HARTFORD, CONN., SEPTEMBER, 1883. No. 9.

Fusible Plugs.*

A fusible plug is a composition shell filled with Banca tin, lead, or some suitable alloy, intended to be used as a safeguard against a class of disasters caused by low water. Fusible plugs are variously placed according to the type of boiler in which they are used; the idea being to place them upon the highest point of the fire line. Their operation is as follows: So long as water of ordinary temperature is in contact with the plug it remains intact, but if uncovered by a deficiency of water the filling melts before the boiler can be dangerously overheated, while the discharge of steam through the aperture of the plug gives a warning of impending danger, and slightly reduces the pressure within the boiler.

The shell for fusible plugs should be made of hard brass that will insure durability and admit of a proper finish with a clean cut thread; and substantial hexagonal head, made stout and strong, to withstand frequent removal and replacing for examination; and refilling when necessary. The cored holes for the fusible filling are variously made by different manufacturers, some being straight, others straight with a conical head, while others again are bell-mouthed.



The straight ones we think are insecure, with a constant liability to fuse in and out of season. Those with straight bore and conical head are better if the countersunk part forming conical head is properly done, while the bell-mouthed ones present a weak section about the head, so that if the plug is set fast in the boiler-head, as it is apt to be after one or two years' use, it will be almost impossible to get it out without such distortion as will prevent its further use. Therefore, while we would recommend every one who uses fusible plugs to have one or more extra ones on hand so there may be no delay in replacing a melted one, we would only advocate the use of such a formed plug as would promise sufficient durability to withstand several refillings. This we think may be accomplished if the cored hole for the fusible filling should be made about half an inch in diameter at the head end "A," tapering to say three-quarter inch at the opposite end, or point of the plug "B," as shown full size in Fig. 1, in which "A, B," is the conical shaped filling, and "C," a cross section of a portion of the boiler-head with the plug in position.

*Reprinted to correct errors noted in October Number, page 167.

The experience of the company causes it to favor a longer plug than is ordinarily used, one about two inches long exclusive of the head of the plug, with a projection not exceeding one and one-half inches, nor less than one inch into the interior of the boiler beyond the boiler-head. The external diameter of this plug should be about $1\frac{5}{16}$ inch, which corresponds to the size of an inch pipe-tap. The thread need only be cut upon half the length of the plug; the other half may be turned down to about $1\frac{3}{16}$ inch diameter and not threaded—as shown in figure. This pattern we have found more desirable than the short ones commonly provided; evidently because while surrounded by water it cannot be treated to a temperature sufficiently high to melt it.

Occasionally we find the filling of short fusible plugs badly honey-combed on the fire side for a distance nearly through the head of the boiler, the fusible part having apparently melted in the ordinary use of the boiler, there being no other indications of over-heating apparent, leaving but the dross and a light film of good material next to the water side. In some externally fired boilers, where the fusible plug is tapped into the back head of the boiler, they last for years without giving trouble. In internally fired boilers they are not generally so durable.

The National Boiler Insurance Company of England, who own a patent for what appears to be a very meritorious fusible plug, which they recommend for all boilers under their inspection, do not consider a plug reliable for a period exceeding two years without refilling. It is generelly believed by engineers that after a year's service the ordinary fusible plug cannot be depended upon to fuse at a low temperature, owing possibly to changes which occur in the character of the alloy.

Banca tin is the filling recommended by the United States Engineers, and we believe it to be as reliable as most of the alloys. Of course the purity of the article determines its usefulness for this purpose. We have a plug that melted inside of two weeks after being put in service, as also did several others of the same manufacture, under like circumstances previously, there being an ample quantity of water in every case, and no unusual disturbance noticed within the boiler. The melting was attributed to some peculiarity in the composition of the alloy—apparently such as to cause it to fuse at a much lower temperature than it should have done.

The law of Massachusetts requires a fusible plug upon all boilers, as also does the municipal law of several cities. The rules of the United States Steamboat Inspection service provide as follows:

"Rule 31. All steamers shall have inserted in their boilers plugs of Banca tin at least one-half inch in diameter at the smallest end of the internal opening, in the following manner, to wit: Cylinder boilers with flues shall have one plug inserted in one flue of each boiler, and also one plug inserted in the shell of each boiler from the inside, immediately before the fire line, and not less than four feet from the forward end of the boilers. All fire-box boilers shall have one plug inserted in the crown of the back connection, or in the highest fire-surface of the boiler. These plugs, in external diameter, must correspond in size to a one-inch gas or steam-pipe screw tap."

Inspectors' Reports.

JULY, 1883.

Below is given the usual summary, so far as the reports have been received, of the work done by the Inspectors of the Company for the month of July last. The number of inspection trips made foots up 2070, by which 4567 boilers were visited. Of this number 2171 were internal inspections, while 405 others were tested by hydrostatic pressure. The number of boilers condemned, or considered unfit for further service, was 41.

The total number of defects found which were considered sufficiently serious to be reported foots up 3563, of which 662 were considered dangerous. The usual tabular statement of defects is given below:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	474	65
Cases of incrustation and scale,	633	86
Cases of internal grooving,	16	5
Cases of internal corrosion,	91	29
Cases of external corrosion,	219	70
Broken and loose braces and stays,	46	24
Defective settings,	127	12
Furnaces out of shape,	136	18
Fractured plates,	193	76
Burned plates,	99	33
Blistered plates,	363	40
Cases of defective riveting,	234	50
Defective heads,	38	6
Leaky tubes,	306	48
Leaky seams,	196	34
Water gauges defective,	80	16
Blow-out defective,	33	6
Cases of deficiency of water,	7	3
Safety-valves overloaded,	22	5
Safety-valves defective in construction,	29	12
Pressure gauges defective,	221	24
Boilers without pressure gauges,	0	0
Total,	3,563	662

The *water-gauge* is one of the most important fixtures pertaining to a steam boiler, and upon its indications the safety of the boiler in a great measure depends. Therefore it behooves the engineer and steam-user to look sharply to its condition at all times, and see that it is in proper order, and that its indications show the true level of water in the boiler.

Probably the most reliable of all the different forms of apparatus that have been devised for showing the height of water in steam boilers is the ordinary gauge cock, properly located and kept clean. The glass gauge is a valuable adjunct in the hands of a careful man, but as ordinarily constructed is very apt to become stopped up, unless the water is more than ordinarily pure, and then, if too much reliance is placed upon it, its indications are not only useless, but absolutely dangerous. Many accidents that have occurred have undoubtedly been due to the passages to the glass having become filled up with sediment, so that the water-level indicated by the glass was not that of the water in the boiler. When a glass water-gauge is used, more especially when it is placed with the gauge cocks on a column, or "combination," as it is usually called, it should be thoroughly blown out at least three times every day. Merely opening the drip-cock at the bottom of the glass connection for a few seconds is not enough. Remember that there are *two* passages to the glass, *both* of which must be kept clean to give the glass any value as a water-gauge. When the glass is to be blown out, close the stop valve at its upper end, and blow out the water passage at lower end, then close the stop valve at lower end, and blow out the steam connections. When you have blown out the glass sufficiently, don't forget to open *both valves* and leave them open.

With a gauge cock it is different. The very act of "trying" them assists in keeping them clean. The best way to connect them to a boiler is to run each one separately into the boiler straight through the front head. No bends in the pipe should be admitted. If the pipes are straight they may be easily cleaned by running a wire through them, even when steam is on the boiler. The connections should be of good size, not less than $\frac{3}{4}$-inch pipe being used.

When the cocks are placed on a column, or combination, the pipes connecting this with the boiler should never be less than $1\frac{1}{4}$ inches in diameter. They are usually made one-half or three-fourths of an inch. Where bends occur in these pipes, tees or crosses should be used, instead of elbows. Then by simply removing the plugs from the tees, the pipes may be easily cleaned out without disconnecting them from the boiler. A half-inch pipe should be run from lower end of water column into the ash-pit. This pipe should be provided with a valve, by opening which the apparatus may be blown out once or twice daily.

When gauge cocks become worn so that they begin to leak, it is very poor policy to continue them in use. They should be at once repaired or new ones substituted. When it becomes impossible for an engineer or fireman to close a cock after "trying" the water, he is very apt to try it only when he is obliged to, and very naturally too. The possible risk thus incurred of letting the water get low in the boiler is one that no steam user can afford to take.

BOILER EXPLOSIONS.

JULY, 1883.

STEAMER (93).—The boilers of the steamboat Susquehanna blew up July 3d, at her dock in the Susquehanna river, at Wilkesbarre, Pa. The boat was torn to pieces. There were no passengers on board save the employees, who were injured as follows: John P. Delwiller, fireman, arm broken and concussion of the brain, and cannot recover; Perry Hughes, engineer, hand and face burned; Charles Nulley, the pilot, cut and bruised about the body. Edward Richardson, a traveling agent, of New York, had just stepped upon the gang-plank when the explosion occurred, and was hurled in the air several feet, landing on the shore uninjured.

SAW-MILL (94).—At 9 o'clock, A. M., July 5th, seven miles south of Huntsville, Texas, the boiler in J. F. Kelly's saw-mill exploded with fearful consequences. Dick Grant, the colored fireman, and his assistant, John Barkful, a convict, and two other convicts, named Slade and Jordon, were instantly killed. Four other convicts, named Nichols, Swarbe, Franklin, and Collard, were seriously injured, while Mr. Kelly, the proprietor, his partner, Henry Miner, and a man named Harrington were severely bruised and scalded. Burt Murray was slightly bruised by falling timbers. The mill was totally destroyed. The explosion is attributed to carelessness on the part of the engineer.

STEAM-TUG (95).—The steam-tug employed by the city of Baltimore exploded her steam drum while at the quarantine wharf, July 6th. Bentley, the engineer, and Anderson, the fireman, were terribly scalded. The tug was in the act of starting to board a steamer which was coming up the river.

SAW-MILL (96).—The boiler in a shingle-mill belonging to Hoogstraat & Cousins, near Custer Village, Mich., exploded July 12th, killing John McIntosh, the engineer, fatally scalding Tim and Pat Doyle, and slightly injuring several others working about the mill. The boiler was a new one, and, at the time of the explosion, the foreman says, contained two gauges of water. The damage to the mill will reach $3,000.

Saw-Mill (97).—A Millsboro, Wis., dispatch says: A boiler in Philip Hendricks' saw-mill exploded July 13th, doing damage to the extent of $2,500. Half the boiler was hurled three hundred feet, just over the heads of twenty men. An employee named Mead was slightly injured.

Paper-Mill (98).—The boiler in the Glens Falls paper-mill exploded July 16th, killing several people. The boiler was thrown a distance of 500 or 600 feet. The building is a complete wreck. The following is a list of the wounded: Christopher Yattan, fireman, Charles Miller, Charles Gower, machine-tender, E. J. Dickinson, Timothy Buckley, Michael Buckley, Stephen Lynch, Lee Parks, foreman, Edward Sweeney, the engineer, Patrick Sullivan, Charles Lee, and Miss Nellie Sullivan. The ruins were on fire within fifteen minutes after the explosion, and the flames spread with great rapidity. A small brick building, located forty feet from the boiler-room, was destroyed by the concussion.

Blast-Furnace (99).—A terrific furnace explosion occurred at Kutztown, twenty-six miles from Reading, Pa., early in the morning of the 17th, by which one man was killed and several others seriously injured. The eight boilers of the anthracite furnace, owned by the Philadelphia & Reading Railroad Company, and operated by William M. Kaufman & Co., exploded, reducing the furnace to a mass of ruins. Preparations had been made for casting, and the employees were outside the building taking a rest before tapping the furnace, when the explosion occurred. Large pieces of the boilers were hurled a great distance, and the debris of stone and shattered timbers were thrown about in great confusion. The engine and boiler house was entirely demolished. Frank Waltman, aged twenty-one years, of Topton, was instantly killed, being buried under the hot boiler, iron, and other debris. Solomon Waltman, his father, was injured in the legs and lower part of the body. Henry Waltman, aged forty years, was rescued from under the ruins. He was injured internally, and will die. Morris Good was severely scalded by escaping steam. Engineer Marstellar was also badly injured, and a number of other employees badly hurt. The force of the explosion shook the earth and aroused the people for miles around. Damage to the furnace will amount to many thousands of dollars.

Saw-Mill (100).—Noble & Benedict's saw-mill, six miles west of Sand Beach, Mich., was the scene of a boiler explosion July 17th. Charles Stover, of Fremont, the engineer, was instantly killed. The machinery and boiler were old.

Locomotive (101).—A locomotive on the Pacific division of the Chicago, Milwaukee & St. Paul railroad exploded near Forreston July 23d. The engineer and fireman were badly scalded.

Saw-Mill (102).—The boiler in J. D. Vick's saw-mill, near Russelville, Ark., exploded July 28th, killing William Hudson, and seriously wounding Payne Hudson. One other man was injured.

The following are the dimensions given for the proposed Messina Tunnel: Length, 44,443 feet, or $8\frac{4}{10}$ miles; fall from Sicily to datum line, 506.17 feet; length below the level of the sea on the Sicilian side, 15,382.69 feet; length under the strait, 14,107.4 feet; fall from Calabrian side to datum line, 502.56 feet; length below level of sea on Calabrian side, 14,979.24 feet; fall of straight parts, 35 in 100; fall in curves, 32 in 100; to cost $13,774,000.

The Locomotive.

HARTFORD, SEPTEMBER, 1883.

The Albatross and Deep Sea Dredging.

The United States Steamer "Albatross," built for the use of the United States Fish Commission, is a beautiful piece of naval architecture. It was designed especially for the service of the Commission, and is complete in all the appointments necessary for that service.

Prof. Spencer F. Baird, Secretary of the Smithsonian Institute, and under whose supervision the investigations of the Fish Commission are made, gave careful attention to all the details of fitting and furnishing the vessel with such apparatus and appointments as the service demanded. In this he was ably assisted by Lieut.-Commander Z. L. Tanner, of the United States Navy, who is commander of the Albatross. The Fish Commission Station for the New England coast is at Wood's Hole, Massachusetts, the connecting link between the waters of Vineyard Sound and Buzzard Bay. Here is a fine harbor, and on its shores are the laboratories where the "catch" is landed when the boats come from their dredging trips in the adjacent waters.

The Albatross is designed for deep sea work, and her trips often extend beyond the Gulf Stream into water two and three miles deep. The hull of this vessel is modeled to go astern with facility, which often becomes necessary in deep sea dredging. Her machinery is all of the most substantial character. Her length over all is 234 ft.; breadth of beam, 27 ft. 6 in.; depth, from top of floor to top of deck beams, 16 ft. 9 in.; displacement on 12 ft. draft, 1,000 tons. There are five transverse iron bulkheads and six water-tight compartments. The vessel is fitted with state-rooms, bath-rooms, cooking and mess-rooms for officers, civilian scientific staff, and assistants. Ample provision is made for the "catch" in and adjoining the work rooms and laboratories. Here will be found sinks with alcohol and water tanks attached, wall cases for books and apparatus, and the medical dispensary, and adjoining is the chart room. The vessel is propelled by twin screws 9 ft. in diameter and 14 ft. 10 in. mean pitch. They are driven by a double pair of compound condensing engines with cylinders 18 in. and 34 in. in diameter and 30 in. stroke of piston. There are two overhead return flue boilers, 8½ ft. in diameter, 21½ ft. long, with 93 square feet grate surface. A steam chimney or superheater 7 ft. 4 in. in diameter and 14 ft. high above shell. Among the interesting pieces of apparatus aboard are the Sigsbee Deep Sea Sounding Machine, the sounding rods, water cups, and gravitating trap for collecting specimens at known intermediate depths. There are also dredge nets, rake dredges, deep sea thermometers, etc., etc. The vessel is lighted at night with the Edison incandescent system. An arc lamp of great power serves to illuminate the surrounding surface of the sea. A powerful submarine lamp is also provided which can be lowered to any depth not exceeding 1,000 ft. for deep sea explorations. There probably never was a ship so well equipped for such service as this. The Albatross has been on its station at Wood's Hole the past summer and has done some very important work. She was caught out in the great August storm, which was so destructive to shipping on the "Banks" as well as along the whole coast. During this storm she was on or near George's Bank, and considerable anxiety was felt for her safety. But a few days after she steamed into the harbor of Wood's Hole in perfect order, to the great delight of the whole scientific corps and citizens as well. It was the privilege of the writer to be at the harbor when she arrived. Commander Tanner reported very rough weather and high seas, but said there was little time when the dredges were not out. The dredging in some instances was in water 12,000 and 15,000 feet deep. Many rare specimens of the denizens of the deep seas were secured, of which much might be said, but our space forbids.

We congratulate Prof. Baird and his associates on the accomplishment of a long cherished desire, and shall expect interesting and valuable reports from the work of the Albatross.

The Inspector's Story.

"The Union Manufacturing Company have applied to us to inspect their boilers, so you will go there to-morrow morning, Mr. Right," said the Chief Inspector as we were leaving the office one evening, and he added, the boiler in the old mill is about fifteen years old, and I don't know how well it has been cared for during the past three years; look very carefully over it, and see if it is in fit condition for their pressure of 80 lbs.

When I arrived at the "Union" at an early hour the next morning, the superintendent told me they had all their boilers open and ready for our inspection. "If you will take the battery of new boilers first,—they are in first-class condition, and probably won't require anything. As soon as they are inspected we will start up, while the old mill won't be started until next week, and you can take your time there.

I found the new boilers, as they were called, they having been in use something more than a year, not nearly as good as they were assumed to be, for they had a considerable accumulation of sediment and scale upon the bottom sheets, while in two boilers of the battery the girth seams had been leaking for a time unobserved and corroded the adjacent sheets, that all the boilers required a thorough cleaning out before starting up, and periodically afterwards. I also recommended that the blow-off should be removed from the front head of the boiler, and be properly attached to the bottom of the shell near the back end, where it would more effectually drain the boiler and serve the purpose of its use. These defects, with some needed repairs, and pointing up upon the brick setting, when reported to the superintendent surprised him. "I thought these boilers were in tip-top order," he said, "from the reports which reached me; however, it is better to know the truth, and I will put on a force of men to make the repairs immediately."

The boiler at the old mill I found in a most dangerous condition from a heavy deposit of mud and scale, which had been there a considerable time, many of the tul es being solidly imbedded and burned out, while others were dangerously thin. It did not appear that this boiler could have been properly cleaned for a considerable time, for the handhole plate at the back end could not be got out, being banked in firmly by the accumulation behind it. Is certainly seemed that it had not been taken off during the preceding two years.

The boiler had evidently been well built, and had it been properly cared for might have done good service for some years longer, I thought. As I stopped for a breathing spell, laid down my tools, and looked about me at so many evidences of neglect, I felt indignant, and involuntary exclaimed:

"The man who has charge of this boiler out to be kicked out of the place and never allowed to go near another one."

"You may well say that," was the reply, which seemed to come from towards the front head of the boiler.

"Hallo!" I said, raising my candle above my head to better penetrate the darkness in that direction. "Who are you?" thinking perhaps the fireman whom I had last seen working about the fire-room had heard my exclamation and answered it. "I am the old boiler, Mr. Inspector, and you see how outrageously I have been treated and abused. I can't keep still any longer."

I scratched my head, the usual habit of a man in a dilemma, rubbed my eyes again, and looked about me. This is a strange experience, I thought, but said aloud, "Go ahead, tell me how you have been abused."

THE OLD BOILER'S LAMENT.

"I was built by Mr. Worthy of the Vulcan Works, fifteen years ago. You know something of his works?" I nodded "yes."

"Well, the job was an honest one, for he was a man who took pride in his work. He sent one of his best men, Mr. Goodman, here to put up the work covered by his contract, which was for boiler, engine, and shafting. When the job was finished and tried it gave complete satisfaction, and the superintendent of the mill was so well pleased he hired Goodman as engineer to take charge of it. For twelve years everything run like clock-work here. Goodman gave orders to the fireman to sweep me off and wash me out carefully, and remove all scale and mud every two weeks, and he made it his business to see that the fireman done his work properly. He used to say that next to his wife and children he thought more of that old boiler and engine than anything else in the world—and you may be sure I steamed my prettiest for him. We never had any break downs. You might have tried me at any hour of the day and found two solid gauges of water, with a bright clean fire upon the grate. The engine was started and stopped regularly from Monday morning to Saturday night for years, and never had to be shut down during working hours for anything in his department.

"Mr. Goodman died three years ago, and the company hired Mr. Slouch, the present Chief Engineer. Slouch is a good talker, and he made the company believe they had been burning too much coal, that Goodman was an old fogy, and that they should wait and see what he could do for them; they probably won't have to wait much longer after they get your report. He set the valves upon the engine to suit himself, and afterwards had to increase the pressure on the boilers twenty pounds to do the work. Modern practice was in the direction of higher pressures, he said, by way of explaining that. As for washing out the boiler every two weeks, he would stop that, for it was unnecessary, besides being a great waste of fuel, for the boiler and brick work had to be cooled down and heated up again. When it required cleaning, he would have it done in a better way. I guess it never has, according to his notion, for it has never been done since he came here.

"Pat, the fireman, says he can't keep steam, nor please anybody, and the men in the dye house bother the life out of him because they don't get enough steam to do their work; while he, poor devil, fires as hard as he can. He burns a great deal more coal than he used to, and says he don't know where it all goes to. Slouch says the proper way to clean a boiler is to get up a good head of steam and blow it out—ugh! the brute,—that's the way he has always done. Wonder how he would like to hang here suspended by his head and heels, covered with red-hot brick-work, racked at every joint, and distorted out of all shape?

"Blow me out under a big head of steam! Ugh! how my old joints ache! My curse upon him! Ugh! ugh!! ugh!!!"

Here there came a blast of wind that nearly blew my candle out, and in endeavoring to shift my position, I found my shoulder quite lame where it had rested against a brace as I listened to the wail of the old boiler. Straightening myself as soon as I could, and gathering up my tools, I began working my way out, meeting Pat, the fireman, who said "I didn't hear the tap of your hammer this long time, and was coming to look for you." "Pat, you have a strong draft here?" "Oh, yes, its a fine old chimney, but it makes queer noises sometimes, when the north wind blows over the hills. It howls worse now than it used to do."

The old boiler was condemned as unfit for further use, and although there was some talk of selling it to a second-hand dealer in the neighborhood who made an offering for it when he heard it was to be taken out, probably intending to rejuvenate it with his paint pot; however, I succeeded in saving it that degradation and saw it decently cut up and sent to the scrap heap. The boys laugh when I tell them my story, but to me it has always seemed a real adventure. F. B. A.

Comparison of Decimal with the Binary and other Scales.

The following Table has been prepared for the use of machinists and other mechanics who have occasion to use ordinary steel scales as found in the market at the present time. These scales are usually divided into eighths, sixteenths, thirty-seconds, sixty-fourths, tenths, twentieths, fiftieths, hundredths, twelfths, twenty-fourths, etc. The Table shows at a glance the relative value of these divisions, and their decimal equivalents.

8ths.	16ths.	32ds.	64ths.	Decimals.	48ths.	24ths.	12ths.	6ths.	40ths.	20ths.	10ths.
			1	.015625							
				.020833	1						
				.025					1		
		1	2	.03125							
				.041667	2	1					
			3	.046875							
				.05					2	1	
	1	2	4	.0625	3						
				.075					3		
			5	.078125							
				.083333	4	2	1				
		3	6	.09375							
				1					4	2	1
				.104167	5						
			7	.109375							
1	2	4	8	.125	6	3			5		
			9	.140 25							
				.145833	7						
				.150					6	3	
		5	10	.15625							
				.166667	8	4	2	1			
			11	.171875							
				.175					7		
	3	6	12	.1875	9						
				.2=1-5					8	4	2
			13	.203125							
				.208333	10	5					
		7	14	.21875							
				.225					9		
				.229167	11						
			15	.234 75							
2	4	8	16	$.25=\frac{1}{4}$	12	6	3		10	5	
			17	.265625							
				.270833	13						
				.275					11		
		9	18	.28125							
				.291667	14	7					
			19	.296875							
				.3					12	6	3
	5	10	20	.3125	15						
				.325					13		
			21	.328125							
				$.333=\frac{1}{3}$	16	8	4	2			
		11	22	.34375							
				.35					14	7	
				.354167	17						
			23	.359375							
3	6	12	24	.375	18	9			15		
			25	.39 625							
				.395833	19						
				.4=2-5					16	8	4
		13	26	.40625							
				.416667	20	10	5				
			27	.421875							
				.425					17		
	7	14	28	.4375	21						
				.45					18	9	
			29	.453125							
				.458333	22	11					
		15	30	.46875							
				.475					19		
				.479167	23						
			31	.484375							
4	8	16	32	$.5=\frac{1}{2}$	24	12	6	3	20	10	5

8ths.	16ths.	32ds.	64ths.	Decimals.	48ths.	24ths.	12ths.	6ths.	40ths.	20ths.	10ths.
			33	.515625							
				.520833	25						
				.525					21		
		17	34	.53125							
				.541667	26	13					
			35	.546825							
				.55					22	11	
	9	18	36	.5625	27						
				.575					23		
			37	.578125							
				.583333	28	14	7				
		19	38	.59375							
				.6=3-5					24	12	6
				.604167	29						
			39	.609375							
5	10	20	40	.625	30	15			25		
			41	.640625							
				.645833	31						
				.65					26	13	
		21	42	.65625							
				$.6667=\frac{2}{3}$	32	16	8	4			
			43	.671875							
				.675					27		
	11	22	44	.6875	33						
				.7					28	14	7
			45	.703125							
				.708333	34	17					
		23	46	.71875							
				.725					29		
				.729167	35						
			47	.734375							
6	12	24	48	$.75=\frac{3}{4}$	36	18	9		30	15	
			49	.765625							
				.770833	37						
				.775					31		
		25	50	.78125							
				.791667	38	19					
			51	.796875							
				.8=4-5					32	16	8
	13	26	52	.8125	39						
				.825					33		
			53	.828125							
				.833333	40	20	10	5			
		27	54	.84375							
				.85					34	17	
				.854167	41						
			55	.859375							
7	14	28	56	.875	42	21			35		
			57	.890625							
				.895833	43						
				.9					36	18	9
		29	58	.90 25							
				.916667	44	22	11				
			59	.921875							
				.925					37		
	15	30	60	.9375	45						
				.95					38	19	
			61	.953125							
				.958333	46	23					
		31	62	.96875							
				.975					39		
				.979167	47						
			63	.984375							
8	16	32	64	1.=one	48	24	12	6	40	20	10

Useful Notes for Rapid Approximate Calculations.

To find the weight of water in a rectangular vessel at ordinary temperatures:
Length in inches × breadth in inches × depth in inches, divided by 28 = *pounds.*
To find the amount in gallons, divide by 231, *instead of* 28.

To find the weight of water in a cylindrical vessel at ordinary temperatures:
Diam. in inches × diam. in inches × depth in inches, divided by 35 = *pounds.*
To find the contents in gallons, divide by 294, *instead of* 35.

The U. S. liquid barrel = $31\frac{1}{2}$ gallons.

The ordinary flour barrel (196 lbs. flour) will hold about 28 gallons, or 234 pounds of water.

The basis of U. S. liquid measures is the gallon of 231 cubic inches.
" " British " " " " " " $277\frac{27}{100}$ "

A cubic foot of ice at 32° weighs about $57\frac{1}{2}$ pounds.
" inch " " " " " $\frac{1}{30}$ "

Water in freezing expands about $\frac{1}{12}$, or $8\frac{1}{2}$ per cent., that is 12 cubic feet of water will make about 13 cubic feet of ice.

The expansive force of freezing water is probably not less than 30,000 pounds per square inch. (Trautwine, p. 516.)

Trials by Trautwine (*Pocket Book*, p. 519) showed the weight of freshly fallen snow to vary from 5 to 12 pounds per cubic foot. On one occasion, when a very dry and incoherent mixture of snow and hail had fallen to a depth of 6 inches, he found its weight to be 31 pounds per cubic foot. A cubic foot of snow may, by a gentle sprinkling of water, be converted into about half a cubic foot of slush, weighing 20 pounds.

"An inch of rain amounts to 3,630 cubic feet, or 27,155 U. S. gallons, or 101.3 tons per acre." (Trautwine, p. 519.)

To reduce bushels to cubic feet, multiply by 1.244.
" cubic feet to bushels, divide by 1.244.

A ton (2,000 lbs.) of anthracite coal, market sizes, occupies about $37\frac{1}{2}$ cubic feet, and will just fill a cubical box whose sides are 3′ $4\frac{1}{4}$″.

A ton (2,000 lbs.) of bituminous coal, market sizes, occupies about 41 cubic feet, and will just fill a cubical box whose sides are 3′ $5\frac{3}{8}$″.

A ton of coke (2,000 lbs.) occupies 71.4 cubic feet, and will just fill a cubical box whose sides are 4′ $1\frac{3}{4}$″.

The specific gravity of the cotton fiber is 1.95, or nearly double that of water.

The specific gravity of the woolen fiber is 1.61, or about $1\frac{6}{10}$ times heavier than water.

The specific gravity of the flax fiber is 1.79, or about $1\frac{8}{10}$ times heavier than water.

The wood of the pomegranate is the heaviest known, being about $\frac{1}{3}$ heavier than water. (Clark's *Manual*, pp. 199–212.)

The Influence of our Forests upon the Water Supply.

There has been in the past few years a considerable amount of discussion, especially among those using water as a motive power for manufacturing purposes, of the effect upon our annual rain-fall due to clearing up large tracts of our forest trees. Some maintain that the effect is to directly diminish the amount of rain which falls annually upon any given area of land which has been cleared up, thus causing severe droughts and an insufficiency of water for motive power where there formerly was an abundance. With respect to this latter state of affairs, we think it would be much easier to show that it is brought about by an increase in the amount of power required, rather than by a diminished water supply. But this is not the question. Does the clearing up of our forests diminish the annual rain-fall? We do not think it does. At any rate, it has not sensibly affected the amount falling in the Eastern States during the last sixty years, as is absolutely proved by the records kept by the various water-power companies during that time. At Lowell, Mass., the proprietors of the locks and canals have kept a record of the annual rain-fall since the year 1826, and no material change has been shown. According to these records, the average for the whole period has been 41.94 inches yearly. In the year 1882 it amounted to 40.91 inches. In 1876, '78, '79, and 1881 it exceeded this amount, being 56.63 inches in 1878; and the average for the ten years from 1826 to 1836 is almost precisely the same as the average for the last ten years, although very large tracts of forest have been cleared away in the Merrimac valley during that time.

The real effect produced by cutting down and clearing away the forests would seem to be this: It allows the water which falls to run off more rapidly to the ocean. In a heavily-timbered region, it will readily be seen that the presence of the trees will tend to equalize and prolong the flow and evaporation of the surface water, while in a region bare of trees it will quickly find its way to the various streams, and thence to the ocean, and the evaporation will also be more rapid, owing to the absence of the shade, etc. Thus it may reasonably be inferred that land which was reasonably moist while covered with trees may, after being cleared up, be subject to periods of drought. The writer personally knows of several cases where "living" springs of water existed on land which was covered with trees, and the dryest seasons did not perceptibly diminish the amount of their flow. After the trees were cut away, these springs wholly dried up in a year or so, and the hardest rains would make them flow but a day or two.

The presence of forests seems not to *increase* the rain-fall, but to *temper* and equalize its effects after it has fallen. H. F. S.

The Preservation of Exposed Iron.

(FROM COTTON, WOOL, AND IRON.)

In reference to the corrosion of iron work, more particularly that which occurs in bridge work, Theodore Cooper, M. Am. Soc. C. E., recently made the following remarks in the course of a paper read before the American Society of Civil Engineers:

"The rusting or corrosion of wrought iron at ordinary temperatures is a very important matter of consideration. The corrosion of an iron rod set in sulphur is not uncommon. The explanation, to the writer's mind, is a simple one. There is no chemical action between pure sulphur and iron at ordinary temperatures, these two elements only uniting at high temperatures—above red heat. But ordinary commercial sulphur generally contains sulphuric and sulphurous acids, produced by the oxidation of the sulphur during its process of sublimation. These acids are the immediate corroding agents when the impure sulphur and iron are in contact. Such sulphur should be thoroughly washed before being used. In general, the rusting or corrosion of iron only takes place in the presence of an acid and moisture. In dry air at common temperatures, or under pure water free from air and carbonic acid, iron does not oxidize. Neither does it oxidize in dry carbonic acid gas, nor to any great extent, if at all, in damp oxygen. But in the presence of moisture and many acids the corrosion takes place readily and continuously. The most common agent toward corrosion is carbonic acid gas. Professor Calvert found that damp air with a slight addition of carbonic acid produced a rapid oxidation, the process being, first, a production of protoxide of iron, changing to the carbonate, and then passing to the hydrated oxide, or ordinary rust. Though the carbonic acid was the active agent in bringing about the combination, the carbonate of iron remained in small quantity,—an apparent process of transfer or disposing influence. As our atmosphere contains carbonic acid gas and aqueous vapor, and as all natural waters contain air, and generally carbonic acid in solution, the rusting of iron is universal. It varies, however, in the degree of rapidity according to the conditions of the special location, the dryness of the air in certain regions making the action an exceedingly slow one, while in others the excess of moisture and gaseous acids produce an exceedingly rapid corroding action. In tubular bridges, tunnels covered with iron girders, and the overhead parts of bridges, the ironwork is especially subject to corrosion, due to the excessive amount of moisture (condensed steam), carbonic acid, and frequently sulphurous acid discharged upon the exposed surfaces from the locomotives.

"While the sulphurous acid, if present, is a very active agent in promoting corrosion, the greatest factor is undoubtedly the carbonic acid gas. An analysis of a sample of rust taken from the Conway bridge gave:

	Per cent.		Per cent.
Sesquioxide of iron	93.094	Carbonate of iron	0.900
Protoxide of iron	5.810	Silica	0 196

"William Kent found in rust taken from a Pennsylvania railroad bridge, where it was exposed to the action of escaping gases, carbonic acid in considerable quantities, but only traces of sulphuric and sulphurous acids. Under fresh or under salt water the corrosion of iron is largely influenced by the presence and amount of air and carbonic acid gas. The action generally appears to be greater where the iron is alternately wet and dry. The caustic alkalies and alkaline earths prevent the oxidation of iron by neutralizing the acids. Iron, therefore, does not corrode in alkaline solutions, or when embedded in lime. The testimony in regard to the action of a thin coating of lime whitewash upon iron is contradictory. The writer has seen many cases where whitewash has corroded iron rapidly; others testify to its thorough preservative qualities. The difference may consist in the addition of other ingredients to the solution. For example, it is often customary for whitewashers to add common salt to the lime solution to increase the hardness of the coating. Again, others add glue, or similar material, to the lime to increase its adhesive qualities. The one containing salt would undoubtedly corrode the iron, and the other with the glue would not do so. Whether a thin layer of lime only, after the lime had taken up its full equivalent of carbonic acid, would continue to act as a preservative is doubtful, for, from its hygroscopic character. it would readily convey moisture charged with the destructive acid into the surfaces of the metal. As to hydraulic cement, the evidence is not so positive. Thos. C. Clarke, M. Am. Soc. C. E., says in his report upon the Niagara bridge, that, on uncovering the anchorage links, he found the iron as perfect as when put there, without the slightest sign of rust, though the mortar was saturated with moisture, and the whole foundation evidently surrounded by water-bearing strata of rock. Gen. M. C. Meigs says he found a wrought-iron pipe, laid in cement concrete, honeycombed and leaky after twelve-years' time, and he learns from plumbers that, in their experience, American cements corrode iron. This different testimony in regard to the action of cements may possibly be explained by the different circumstances of each case—such as the relative compactness and depth of the cement in which the iron is embedded. There is a possibility, however, that in certain cements the silicates may be soluble in water, and thus furnish the acid agent toward corrosion. Mineral wool made from furnace slag, very closely approximating the composition of hydraulic cements, has been found, in certain cases, to corrode iron very rapidly. It was claimed that this was entirely due to the hygroscopic character of this material, but recent instances reported to me would appear to lead to the belief that the wool in the presence of water not only corrodes the iron, but also disintegrates and hardens into a solid mass. Wet coal ashes corrode iron very rapidly. William Metcalfe, M. Am. Soc. C. E., states that a wrought-iron pipe buried in coal ashes was completely eaten away in one year's time.

"As a curious instance of the slight causes which promote oxidation, the experience of a manufacturer of fine cutlery was related to me. He found at one time a large portion of his goods being returned to him as in damaged condition. Instead of the bright, clean surfaces for which such articles are noted, he found rusty, deeply oxidized blades. After much anxiety and watching to determine the cause, whether it was damp paper, the ill-will of some of his agents, or other cause, it was located upon the man who sorted and wrapped the knives into packages. Everything he touched was found to rust, from the peculiar acid character of his skin exhalations. Similarly, it is well known that some persons cannot carry pocket-knives or bright iron articles, as keys, etc., about their person without their becoming very rusty. The rusting of iron proceeds with great rapidity after it has once commenced, because the rust of iron is a ready absorber of moisture and gases, and it thus constantly conveys new elements of destruction into the yet unchanged metal. It is to this fact that the great difference in the rusting of used and unused rails, machinery, and tools is due. The jars and vibrations to which the one is subjected keep the surfaces clear of accumulated rust, that would act as storage reservoirs for the corroding elements. There is often much misconception in regard to the amount of iron contained in a certain thickness of rust. Dense, compact rust may contain enough iron to equal one-fourth or one-fifth of its thickness, but the looser and more common kind of rust will not contain over one-eighth of its thickness in pure iron. In other words, rust one-quarter of an inch in thickness will contain from one-sixteenth to one-thirty-second of an inch of iron, according to the density of the rust.

"The preservation of iron from corrosion is a subject of vast importance, and has given rise to many expedients, more or less effective, such as alloying iron with other metals, as chromium, tin, or copper, arsenic, etc., to obtain a less corrodible metal; plating the surfaces with other less oxidizable metals, as nickel, tin, copper, silver, or gold; coating with zinc, a metal that is readily oxidized upon the surface, but whose oxide, when formed, becomes a protection to any further oxidation (when not subject to other acids than carbonic acid gas); coating with fused mineral enamels; covering with lacquers; coating with magnetic oxide of iron by the processes of Barff or Bower, by subjecting to high temperatures and the presence of moisture; and lastly, the use of paints of innumerable characters. For general engineering structures the coating given to iron surfaces for their protection against corrosion must be not only moderate in cost, but of such a character as to be readily renewed when removed by accident or design. It must also differ from zinc in being able to resist the corroding action of sulphurous acid gas and the chlorides in locations where these may occur. This practically reduces us to the use of paints (using this term to include not only the paints proper, but varnishes, oils, and other materials applied in a liquid form). The relative merits of the paints depend upon their durability, adhesiveness, and imperviousness. The cracking of the paint and want of adhesion produced by too rapid drying of the paint, and the want of adhesion due to the presence of rust upon the surfaces of the iron, are the most frequent causes of failure in the better classes of paints. All rust should be carefully removed from the surfaces of the iron before painting; a coat of raw linseed oil then makes an excellent covering for the surface—elastic, perfectly adherent, and a good, durable substratum for future coverings. In order to get our ironwork out of the shops quickly and in a condition to be handled, we resort too often to quick-drying paints, to the future injury of the work. As to the pigment to be used for the covering of this substratum, red lead, oxide of iron, etc., each have their own advocates.

Successful Labor.

The following, which we clip from a recent number of *Mechanics*, seems to "strike the nail so squarely on the head" that we reproduce it here, and commend it to the careful consideration of our readers.

"To labor successfully is what most persons desire. At the same time, very few understand what are the conditions of successful labor. This is why there is so much hard work performed to little purpose. The first requisite would appear to be the love of work. Probably there is nobody who has made the most he could of his opportunities who has not put his heart into his undertaking. It was evidently the Divine intention that all men should work. Else why are they given brains and bodies that seem so eminently planned for that particular purpose? Why else is it that work is surrounded with incentives and delights? Lazy men and women never accomplish great results. They go to their labor 'like quarry slaves.' Work becomes drudgery. Their lives are too often an ignoble failure.

"Another cause of failure is that persons have not chosen the sort of work in accordance with their capacities. The youth who would have made an excellent farmer or mechanic fondly imagines that his talents will enable him to shine in the field of literature or art; and he whose ideality is largely developed too often falls into a similar error, and plods along in life's weary way in an utterly distasteful rut, seemingly without the power to rid himself of an occupation which is to him as an incubus. These are what might be properly called the misfits of life. The world is full of them. As poets are born, not made, so, we believe, are farmers, and ship-builders, and lawyers. There are other persons whose vanity and self-love stand in the way to their success. Their interest in their occupation is dissipated by their fondness for amusement and physical enjoyment. The best success can never be achieved by this class.

"Another important adjunct to success is method. To lay out one's work systematically is a great help. Let those who have been in the habit of doing their work just as it happens try this plan. Our word for it, they will be surprised that so much more can be accomplished in a given time than by the old helter-skelter way. Of course, it is not possible for one to work always, and the time for recreation should be as systematically observed as the time for labor. Promptness is another condition to success. Half the value of anything to be done consists in doing it promptly. A large class of persons are always behind time. As a consequence, their work is always in advance of them. They are forever in a hurry. These folk waste time for themselves, and waste it for others, and thus fail of the success they might have achieved by habitual punctuality. But, possessing all the other elements, a firm grasp of success can never be attained without thoroughness. Whatever is worth doing at all is worth doing well. No matter how humble the work, it should be done thoroughly and entirely. Fidelity to details is important; combined with love of labor, fitness of occupation, method, and promptness, it forms a royal road to the most joyful thing in life—successful labor."

A Struggle of the Giants.

The Early Peach came to a place where four roads met. He slapped his chest with his stem and looked to the east and the south.

"Bismillah!" he cried, "I am the boss, and I drive the ambulance."

The little Green Apple came down the long road from the west and heard him. He bowed to the north and he bowed to the west.

"I am the son of the cyclone," he shouted, "and I travel with my own private coroner."

"By the camel of Mahomet," said the Early Peach, "I am the friend of the sexton, and I can knock you out in four rounds, Marquis of Tewksbury rules."

"Come to the wake," said the little Green Apple, "and you may call me the harmless paw-paw of the wilderness if I can't double up the man who planted you."

Then they looked down the four long roads and waited for some one to practice on. From the east came a fair young girl from Vassar College, and up from the south came a gray-haired African.

"Take you the fair student," said the Early Peach.

"Not I," said the little Green Apple, "I didn't come here to attempt impossibilities. For nearly four years this little girl has sat at surreptitious midnight lunches; she has broken up a score of young men with her ice cream bills, and still she is hungry. But I will stand aside and give you a chance at the African."

"I am not on the suicide lay this morning," said the Early Peach. "I know him, and already since yester-even's sun there have reposed beneath his untroubled vest a peck and a half of my brethren, and he is even now famished. He is known as the destroyer of watermelons, and all my tribe fear him. Allah is great, but some things are impossible."

So they let many people pass by unharmed, the old, the tough, the wary, and the well-seasoned. But when the day was far spent, coming down the long road from the west, they saw a ruddy boy, the pride and joy of his home, and the torment of his teacher. Whistling a merry roundelay he came, his face as rosy as the glowing west, his heart as light as thistle down.

He was their meat.

The Early Peach and the little Green Apple set their teeth and breathed hard as he came near.

"Now!" they shrieked, and, livid with hate, they fiercely sprung upon him.

In two short minutes that boy had both of them down, and as he cracked the peach pit to get at the "goody," he said:

"Jiminy jinks, I wisht I knowed where I could find a bushel of them fellers."

The Early Peach, with a dying gasp, turned and said:

"We were taken in."

With a hollow groan, the little Green Apple replied:

"Of course."

But the boy slept soundly all that night, and came back the next day to look for more.—*Burlington Hawkeye.*

A Balloon for Service Under the Sea.

The international exhibition at Nice is reserving some wonders for the foreigners who may propose to pass a portion of the winter of 1883–84 upon the borders of the Mediterranean. One of these wonders is a balloon, which its inventor, M. Toselli, calls "the observatory under the sea." It is made of steel and bronze to enable it to resist the pressure which the water produces at the depth of 120 meters. This "observatory under the sea" has a height of eight meters and is divided into three compartments. The upper apartment is reserved for the commander, to enable him to direct and to watch the working of the observatory, and to give to the passengers the explanations necessary as to the depth of the descent and what they will see in the depths of the sea. The second apartment, in the center of the machine, is comfortably furnished for passengers to the number of eight, who are so placed that they can see a long distance from the machine.

They have under their feet a glass which enables them to examine at their ease the bottom of the sea, with its fishes, its plants, and its rocks. The obscurity being almost complete at 70 meters of depth, the observatory will be provided with a powerful electric sun, which sheds light to a great distance in lighting these depths. The passengers have at their disposal a telephone, which allows them to converse with their friends who have stopped on the steamboat which transports the voyagers to such places as are known as the most curious in the neighborhood. They have also handy a telegraph machine. Beneath the passengers an apartment is reserved for the machine, which is constructed on natural principles—that is to say, as the bladder of a fish, becoming heavier or lighter at command, so as to enable the machine to sink or rise at the wish of the operator.—*London News.*

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

New Series—Vol. IV. HARTFORD, CONN., OCTOBER, 1883. No. 10.

Accidents resulting from Bad Construction and Management.

Our illustrations this month afford us a more than usually instructive lesson in boiler construction and management.

The first cut shows the result of putting a double riveted seam in thick plates where it will be exposed to the direct heat of the furnace. The plates were one-half of an inch thick, and the illustration shows a piece cut from the bottom of a new boiler after it had run but a few weeks. It is from the outside lap of the first girth seam from the front end, and consequently was directly over the grates.

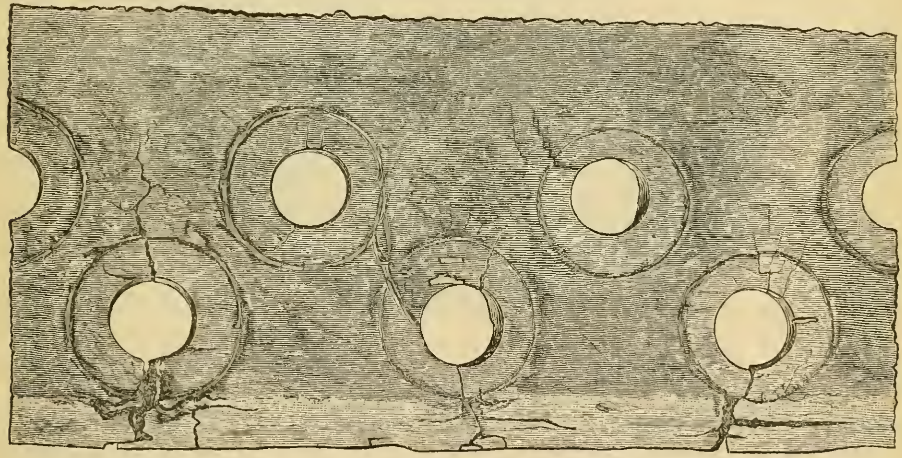


Fig. 1.

Now it is evident that a seam at this point will be exposed to great and sudden variation of temperature, which will occur whenever the furnace doors are opened for any reason, as firing, cleaning fires, etc. It is also evident that these variations of temperature will cause corresponding expansion and contraction of the plates at this point. It will also be seen that when a lap joint occurs at this place the outer plate of the lap will be exposed to greater variations of temperature and consequently will expand and contract more than the inner lap, which is not exposed to the fire but is in contact with the water in the boiler, which will keep it at a comparatively even temperature.

Now, by the double row of rivets the two plates where they overlap are bound rigidly together at two points dependent upon the distance apart of the two rows of rivets. If their temperature was always uniform, or even varied the same, all would be well, for then they would expand and contract alike and no harm would result; but, as we have shown, the outer lap, especially if the plates are thick as in this case, will expand and contract much more than the inner one, and the inevitable result will be, that that portion of the plates between the two rows of rivets must either be stretched, compressed, or buckled. The force of the expansion and contraction is limited only by the strength of the iron of the plates.

It will readily be seen that this constant strain on the joint will very soon loosen the rivets and injure the plates. In this case the outer plate gave away by cracking from the rivet holes to the outside of the plate as seen in Fig. 1. This became so bad that it was necessary to cut out a piece of the plate forming the outer lap (from this piece our cut was photographed) and put on a patch. The inner lap was injured very little.

Single riveted joints should always be used in parts of a boiler which are exposed to the fire; for then, the plates being confined at but one point are free to expand and contract at will, and no strain is brought upon the joint.

It should be said in justice to the boilermaker that in the above mentioned case he strenously objected to double riveting the girth seams, but the owner of the boiler would have them made so, and took the responsibility.

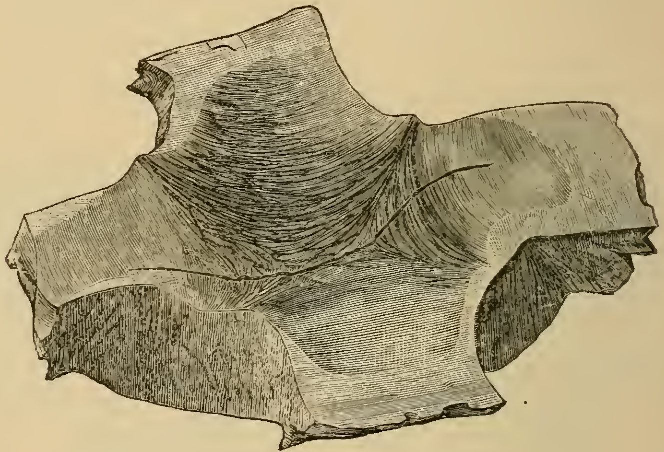


FIG. 2.

Figs. 2 and 3 show the result of allowing sediment to collect on the lower tube sheet of an upright tubular boiler. It is a very remarkable case.

The head was one-half inch thick, the material, steel. In consequence of an accumulation of sediment between four adjacent tubes, the head at this point became highly overheated, almost melted in fact, so that it bagged down over three-eighths of an inch

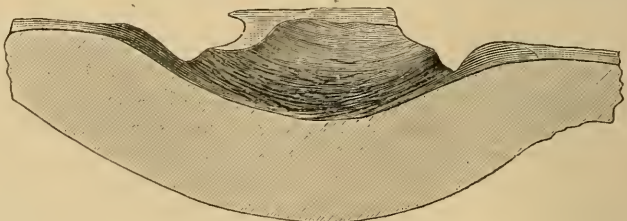


FIG. 3.

in the small area between the tubes. It was so hot that its condition was plastic; it was nearly melted in fact. It seems almost impossible that such a small isolated part of a plate could become so hot, surrounded as it was by the large mass of cooler metal in contact with water, but such was the fact in this case. Fig. 2 shows a view full size of the piece after it was cut out of the head. Fig. 3 shows a section through the center.

Upright boilers should always have four hand holes in the shell just above the lower tube sheet, and the plates should be frequently removed and the sheet examined and thoroughly cleaned if necessary. With proper care, the above accident, which necessitated an entire new tube sheet, would not have occurred.

Inspectors' Reports.

August, 1883.

The usual summary of the work done by the inspectors of the Company is given below. The whole number of inspection trips made foots up 2,467, the number of boilers visited 4,939, the number thoroughly inspected both internally and externally 1,957, while 414 others were tested by hydrostatic pressure. The number of defects found which were considered of so serious a nature as to be reported was 3,311, of which 739 were dangerous, and led to the condemnation of 33 boilers.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	382	41
Cases of incrustation and scale,	554	57
Cases of internal grooving,	8	3
Cases of internal corrosion,	87	14
Cases of external corrosion,	183	40
Broken and loose braces and stays,	26	12
Settings defective,	119	12
Furnaces out of shape,	84	20
Fractured plates,	147	103
Burned plates,	114	44
Blistered plates,	245	27
Cases of defective riveting,	486	116
Defective heads,	30	13
Serious leakage around tube ends,	291	95
Serious leakage at seams,	200	50
Defective water-gauges,	81	12
Defective blow-offs,	29	7
Cases of deficiency of water,	11	7
Safety-valves overloaded,	35	22
Safety-valves defective in construction,	33	14
Pressure-gauges defective,	164	28
Boilers without pressure-gauges,	2	2
Total,	3,311	739

We also give with this issue the complete summaries for the months of June and July, which were incomplete at the time we went to press in the months in which they should have appeared.

Month of June.

Inspection trips,	2,463
Total boilers examined,	4,618
Total boilers examined internally,	1,899
Boilers tested by hydrostatic pressure,	402
Boilers condemned,	55

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	297	24
Cases of incrustation and scale,	534	33
Cases of internal grooving,	26	10
Cases of internal corrosion,	80	18
Cases of external corrosion,	153	32
Broken braces and stays,	34	14
Defective settings,	134	6
Furnaces out of shape,	82	4
Fractured plates,	88	48
Burned plates,	79	15
Blistered plates,	200	13
Cases of defective riveting,	132	43
Defective heads,	22	6
Serious leakage around tube ends,	328	50
Serious leakage at seams,	190	19
Defective water-gauges,	77	12
Defective blow-offs,	30	4
Cases of deficiency of water,	15	6
Safety-valves overloaded,	34	7
Safety-valves defective in construction,	20	11
Pressure-gauges defective,	188	26
Boilers without pressure-gauges,	1	1
Total,	2,744	402

MONTH OF JULY.

Inspection trips,	2,387
Total number of boilers examined,	5,362
Total number inspected internally,	2,819
Number tested by hydraulic pressure,	409
Boilers condemned,	43

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	595	65
Cases of incrustation and scale,	759	86
Cases of internal grooving,	20	6
Cases of internal corrosion,	107	30
Cases of external corrosion,	242	74
Broken braces and stays,	59	24
Defective settings,	164	13
Furnaces out of shape,	156	20
Fractured plates,	201	80
Burned plates,	116	33
Blistered plates,	428	42
Cases of defective riveting,	254	50
Defective heads,	56	10
Serious leakage around tubes,	372	49
Serious leakage at seams,	261	36
Defective water-gauges,	89	19
Defective blow-offs,	44	6
Cases of deficiency of water,	8	4

Safety-valves overloaded,	26	5
Safety-valves defective in construction,	39	14
Pressure-gauges defective,	252	30
Total,	4,248	696

Making the steam connections to boilers, and the running of steam pipes generally, is a matter of great consequence to the proper working of any system, whether designed for heating or power purposes. Many elaborate systems have been designed and erected which have either utterly failed to work or have given very indifferent and unsatisfactory results. In nine cases out of ten the trouble arises from the fact that the laws governing the flow of the water of condensation have been altogether ignored. In some cases which have come under our notice, the fact seems to have been unknown that such a thing as condensation of steam exists in pipes.

Steam pipes, whether used to convey steam for heating or power purposes, should always pitch downward from the boiler, so that the steam and water shall flow in the same direction. When pipes are arranged to drip back toward the boiler, there is always trouble unless the pipes are very short, or very large. Vertical pipes or risers must, of course, drip in this manner, but when they rise from the end of a horizontal section of pipe they should always have a relief or drip pipe at their lower end. This relief should connect with the main return, if it is a gravity heating system, below the water line. If it is any other system the drip may be discharged by means of a trap, or through a valve, or any suitable arrangement.

When pipes are reduced in size, a drip or relief pipe should always be put in, or the larger pipe will fill with water up to the level of the lower side of the smaller pipe. The same remarks apply here as in the above case.

Common globe-valves should be put into pipes with their stems or spindles nearly horizontal, otherwise the pipe will be trapped half full of water, which will cause hammering. Open way valves may have their spindles vertical.

BOILER EXPLOSIONS.

AUGUST, 1883.

Brick-yard (103).—A terrible boiler explosion occurred at the brick-yard of Mr. R. T. K. Bain, Norfolk, Va., Aug. 1st, by which the buildings were demolished, and the engineer, David C. Bain, was instantly killed. Judson Hoffler, Lewis Davis, and H. B. Wilkins were severely injured.

Locomotive (104).—On the morning of the 3d a freight engine on the Chicago, Rock Island & Pacific road exploded its boiler while standing on the track in Peoria, Ill. A strip several feet long was torn out of the boiler at its forward end and on top of the barrel, and the dome was torn off. The force of the explosion was upward.

Saw-Mill (105).—On Saturday, Aug. 4th, the boiler of a portable engine employed to cut fuel for the locomotives of the A. W. Wright Lumber Company's logging railroad in Roscommon county, Mich., exploded, killing Philip Breard, Abe Cole, and Fred. Oulette. Low water in the boiler was given as the cause. The bodies of the dead were conveyed to East Saginaw for burial.

Laundry (106).—The boiler of Allen's shirt factory and laundry exploded at Des Moines, Iowa, Aug. 6th. The boiler was carried entire into the second story of the adjoining building and landed in the recitation-room of the Iowa Law School. Engineer J. A. Motley, who was opening the furnace door, was seriously burned on the arms and face, but not otherwise injured. The boiler was full of water and was making steam preparatory to starting the machinery. It had been cleaned Saturday evening and was filled cold by hand. The cause of the explosion is inexplicable.

—— Mill (107).—P. Caldwell was killed and L. Harwick fatally scalded by the explosion of a boiler at St. Williams, Ont., Aug. 10th.

Oil-Well (108).—The boiler at the well of L. J. Sherman, near Tarport, Pa., exploded Aug. 16th. The fragments were scattered in all directions. Samuel Parish, who was standing within six feet of it when the explosion occurred, got off with a few bruises. His escape from instant death was miraculous.

Brewery (109).—A boiler at the Falls City Brewery, situated outside the city limits, Louisville, Ky., exploded at 11 o'clock, Aug. 16th, tore out the boiler-house, passed through a shed adjoining, and went 200 feet in the air, and descending struck a slaughter-house, crushing through the roof and floor, and bringing up in the cellar. Though several persons were about the boiler not one was injured.

Threshing Machine (110).—A terrible explosion occurred at Rockwell, Ind., Saturday evening, Aug. 18th. The boiler of Henry Burford's threshing-machine exploded, scalding Tom Overman, the engineer, Joseph Glosson, Henry Burford, and Newkirk. It is thought that Overman and Glosson will die.

Locomotive (111).—By the collapse of a flue in the boiler of a locomotive on the Northern Central Railroad, about twenty miles from Baltimore, Md., Aug. 20th, the engineer and fireman were fatally scalded.

Flour-Mill (112).—There was an explosion in a flouring-mill situated at Oakdale, a small place twelve miles southwest of Nashville, Ill., Aug. 21, which instantly killed the fireman, named Wilson, who was in charge of the engine at the time.

Paper-Mill (113).—The large paper-mill of J. Howard Lewis, in Springfield township, six miles from Chester, Pa., was destroyed by fire, Aug. 22d. While the fire was burning a boiler in the mill exploded, killing one man, John Morrison, and seriously injuring two or three others, including Mr. Lewis, the proprietor. Loss $80,000.

Steamer (114).—The boiler of the steamer Mary exploded at Detroit, Mich., Aug. 24th, while the boat was at the wharf. George Cunningham, fireman, was severely scalded about the hands and face. The steamer was not damaged.

Saw-Mill (115).—The boiler of M. B. Paxton's saw-mill and gin, situated twelve miles north of Memphis, Tenn., exploded with disastrous results to life and property, Aug. 27th. A. J. Pike, a laborer, was instantly killed; W. J. Garvin, an employee, was severely injured; a colored man had an arm broken, and Mr. Paxton, the proprietor, who was acting engineer at the time, received painful wounds. The loss will not fall short of $2,000.

Saw-Mill (116).—The boiler in the mill of Barnes & Jones, at Durango, Colo., exploded Aug. 28th, killing two employees named Ballard and Cook, and injuring James Deming, the fireman.

Saw-Mill (117).—The boiler of a portable mill, operated by Irwin & West, and located near Cincinnati, Ohio, exploded Aug. 29th, instantly killing Newton Irwin and fatally injuring Joseph West. Two employees, George Mooreland and Dick Steele, were injured, the former fatally. The explosion was caused by the use of muddy water in the boiler.

Lead Works (118).—An explosion in the Collier Lead Works at St. Louis, Aug. 30th, did $15,000 damage and killed Louis Schaff.

——— (119).—A boiler exploded at Alexandria, Va., Aug. —. Particulars not given.

The Locomotive.

HARTFORD, OCTOBER, 1883.

We are sometimes very much annoyed by the want of good faith in boiler construction. There seems to be a feeling, certainly on the part of some, that a little departure from the correct thing is of little account if it will only pass. One of the tricks is to use thinner iron for the construction of the shell in places where the lap of the sheet is inside. For instance, if a boiler shell is constructed of three sheets in length the outer sheets will overlap the center sheet and prevent the edges being seen unless one gets into the boiler. Now it is not unfrequently the case that this center sheet is of thinner iron than the other sheets. An inspector discovers this when making the internal examination. In casting up the safe working pressure of a boiler, the strength of the weakest point must be the highest limit allowed for bursting pressure, and the factor of safety must simply reduce the pressure which would burst the boiler to a safe working pressure. Now the thinner the iron the less resistance it affords, and if the thin sheet is the weakest point, it must be made the basis for calculating the safe working pressure, which would be lower than would be allowed if the sheets in the boiler were of uniform maximum thickness. We call attention to this fact because the discovery of such practice has made serious trouble between the boiler-maker and the steam-user. This business is sometimes carried so far that the edges of the plates are "upset" so as to appear thicker and heavier than they really are. We would not believe that there were men so blind to the duties and obligations which rest upon them as to resort to such practice, but the careful inspector finds all such defects, and in time we come to know whose work is carefully and honestly done, and whose is open to suspicion. In States and cities where inspection laws are in force that give the methods and rules by which the safe working pressure of a boiler is calculated, there is no alternative except to follow the rules, and if certain requirements regarding construction are a part of the law, there is no authority or right to depart from it, and yet there are boiler-makers who try to force their boilers into such localities when their work is not up to the requirements of the law. Now this boiler making is pretty serious business, and inasmuch as some one must be blamed when accident occurs, it is important that all who have to do with boilers, from their construction to their care and use, shall be honest in all their work. There are other weak and defective points in construction which we shall allude to from time to time.

Errata:—Several annoying typographical errors crept into our last issue which we would call attention to here.

Page 145, first line, *for* "brass, tin, lead," &c., *read* "banca tin, lead," &c.
" " end of fourth line, *for* "aperture" *read* "operation."
" " twenty-fourth line, *for* "countersink" *read* "countersunk."
" " third line from bottom, *for* "b" *read* "B."
" " fourth " " " " "a" " "A" *and omit* "Fig. 1."
" 146, tenth line from top, *for* "that" *read* "short," *and for* "plug" *read* "plugs."
" 151, tenth line from bottom, *for* "out" *read* "ought."
" 153, second line, *omit* "however."

The engraver also showed a left hand thread in the cut of fusible plug, but that will probably cause no inconvenience to anyone.

A SERIOUS accident happened at Middlesborough, England, on the 19th ult., by which several members of the Iron and Steel Institute were seriously burned, one fatally. It well illustrates the dangers attending a visit to iron works. We clip the following account of it from *Engineering:* "Mr. Cooper, the manager of the Northeastern Steel works . . . stated that in moving a ladleful of metal it had been upset, and that Mr. Davison, of the Horbury Foundry Iron Works, had been most seriously injured, as had also two of the workmen, while others had also suffered, but less seriously. Mr. Cooper was himself standing close by when the accident occurred, and his clothes were burnt by the splashing of the metal, as were also those of several of the visitors. At the time of our writing, the details of the accident are not fully and clearly available, but it appears that the ladle containing 10 tons of molten metal was being moved by a locomotive along a raised stage, and that for some reason the engine driver, after being brought to a stand, took a run at it to get it past a certain point, the result of the jerking being to throw out the clutch securing the ladle and cause it to tip over on its carriage, emptying out the metal. Mr. Davison, who was on the stage, and was unable to get out of the way in time, received most serious injuries, which terminated fatally at 11 o'clock on Wednesday night. Seven workmen were also injured, one of them—Edward Rawden, the cupola tenter—seriously. One of the visitors, Mr. T. D. Ridley, of Redcar, was also severely burnt, and many of those present had narrow escapes."

THE old locomotive "Arabian," after nearly fifty years of faithful service, was at last destroyed in the burning of the Pittsburgh Exposition building. The "Arabian" was not the first locomotive, but it was among the first which did practical service in hauling trains on a railroad, and the excellence of its construction is attested by the fact that it was still at work after so many years of rough service and hard knocks. One or two older engines survived, but they were laid up and carefully preserved as curiosities, while the "Arabian" could claim without contradiction that it had been steadily at work longer than any other engine in the world, and could be considered as the still active grandfather of the numerous family of its kind now running in this country. It was exhibited in Chicago, and on its return the Baltimore & Ohio Company allowed it to remain in Pittsburgh during the local exhibition there. Its destruction will be heard of with regret by the thousands who saw it in Chicago, and by our readers, who had its history told them in the letter written by the late Mr. Latrobe some ten years ago.—*The Railroad Gazette.*

Russian Basic Steel.

Mr. Sergius Kern of St. Petersburg, writes as follows to the *Chemical News:* It was a very interesting object for the writer to test the qualities of the basic steel of Russian manufacture. Near St. Petersburg, the Alexandrovsky Steel Works are commercially working the basic process in Siemens-Martin furnaces.

The plate steel welds quite like iron; in fact, the Nevsky Works, St. Petersburg, rolling the ingots, make, out of the remaining scrap, piles which, heated to a welding heat, are rolled into capital plates for different purposes. The following are the results of trials of the steel plates:

UNANNEALED PLATE.—Thickness in inches, ½; breaking weight, tons per square inch, 26; elongation in 8 inches, per cent., 26.

ANNEALED PLATE.—Thickness in inches, ½; breaking weight, tons per square inch, 22; elongation in 8 inches, per cent., 36.25.

The chemical composition of the steel runs as follows:

	Per cent.		Per cent.
Carbon	0.10	Sulphur	0.02
Manganese	0.43	Silicon	traces.
Phosphorus	0.02	Copper	none.

I am informed that the raw materials charged into the furnace contain, on the average, 0.75 per cent of phosphorus. I am very happy to state that the great invention of Messrs. Thomas and Gilchrist is worked in Russia in such a satisfactory way.—*Exchange.*

Some specimens of basic steel made by the Pennsylvania Steel Company, which were recently shown us had a tensile strength of 54,790 pounds per square inch, an elastic limit of 44,000 pounds per square inch, an elongation of 23⅓ per cent. in 8 inches, and a reduction of area at point of fracture of 70 per cent. The company are making boilers for their own use from this plate, and have recently begun its manufacture on an extensive scale. (Ed. Loco.)

Notes on Mill Shafting.

The close observer cannot help noticing the fact that the development of the construction and arrangement of the machinery of transmission, such as shafting, hangers, pulleys, etc., has never kept pace with that of the mechanism for the generation of power, or of that by which the power is utilized. This is somewhat surprising when we consider the extreme simplicity of the principles involved; but perhaps this very simplicity is what has caused the subject to be overlooked and unduly neglected, aspiring mechanics preferring to exercise their ingenuity in some more difficult branch of the profession. For the past few years, however, the question has received the attention that its importance demands, and consequently great advances have been made in the right direction.

Comparatively few years ago our shops were fitted up with cumbrous, slow moving shafting of wood or cast-iron, relics of which still remain in many localities. A favorite form of shaft consisted of a wooden drum about twelve inches in diameter, having cast-iron journals running in the clumsiest imaginable hangers. From this drum, belts were run to drive the various machines. When the requirements of any machine rendered it absolutely necessary to have a higher belt speed than could be obtained from the drum, it was "built up" to the required size. This job was generally done in the most original and startling manner, and thus in the course of time the line usually became pretty well filled up, or covered, with a collection of "scabs" whose "wobbling" presented a frightful appearance when the shaft was in motion. If a belt run off one of these improvised pulleys, which they did very often, it generally made about one "flop" and then began to wind up on the drum or body of the shaft. About that time everybody in the vicinity took to their heels. When the "slack" in the belt was all taken up, there was a moment of suspense, which generally lasted about one-tenth of a second, and then something had to "let go." Whether it was the belt or countershaft hangers depended entirely upon their relative strength. If the hangers or their fastenings proved the weaker, the countershaft, with its pulleys, were generally "fired" clean across the shop, and the man who happened to be in its path was considered unlucky. During the melée, the belt generally became detached from the countershaft and calmly proceeded to wind the remainder of itself about the main shaft—all but about two feet, which in consequence of its centrifugal force, resolutely refused to wind, but stuck straight out, and at every revolution of the shaft "brought up" against the floor above with a "ker-slap" which made the dust fly, and had a strong tendency to upset the nerves and cause profanity on the part of any one who happened to be at work on the floor above. Gradually, however, certain correct principles of tranmission of power began to be recognized, and it was felt that the above state of things, like the Chinese in California, " must go," and it went. Turned shafts of wrought iron were substituted for the wooden or cast-iron ones. This rendered higher speed possible, and for several years past progress has been quite rapid.

But the grand fight in what may be called the shafting revolution, has been upon the question of speeds for main lines, and diameters of the same. One general rule may be given to cover the whole ground, and that is: make your shaft as small as you can, and run it as fast as you can. Different ideas as to what this limit is, however, is what has caused the fight, and the difference in practice in different localities.

Too much attention cannot be paid to see that line shafts are properly lined up and kept so. The influence of improper alignment is greater than is generally supposed. It not only causes great waste of power, but in many cases is the immediate cause of breakage, which is too apt to be attributed to insufficient size of the shaft. The writer has a vivid recollection of being called upon five years ago to investigate the cause of the periodical failure of a line of 2½ inch shafting about 75 feet in length. It had acquired the inconvenient habit of breaking at about the middle of its length every few months. The owners thought it was too small for the work it had to do, and wished to put in a new one of larger size. We thought it was amply large, and suggested that possibly it was out of line. The master mechanic at once " got on his ear " and declared that it was all right; he had personally superintended putting it up about two years before, and he ought to know, etc. So he ought, but he didn't. Fifteen minutes work with the transit showed it to be *five and one-half inches* out of line at and near the place where it usually broke. The hangers were then properly lined up, and the shaft has never broken since, and is now running with a much greater load than it ever had during its breaking days. In this case the deviation of 5½ inches was in a lateral direction, showing that the shaft must have been originally put up in the condition in which it was found. This is very probably an exceptional case, still it shows what is possible. Shafting is much more apt to be out of line vertically than horizontally, as in the above case. Unequal setting of the foundations of walls and piers, as well as any changes which may be made in the location or amount of machinery on the different floors of a mill or shop, all tend to bring about this result; therefore it is well to periodically test the alignment of all the principal lines of shafting. It should always be done when changes in location of machinery are made, or additional machinery is put in. By far the cheapest, most accurate, and most expeditious method of doing it is to call in an engineer with his transit and level. Carpenters' tools and methods cannot be relied upon to indicate the true condition of a long line of shafting, especially when it is covered with a multitude of pulleys, with belts leading off in all directions.

Coupling the different lengths of a long line of shafting is a most important matter. The closest attention should always be given to it. Numberless forms of coupling have been tried, nearly everybody connected with a mill or shop having, at some time or other, " had an idea for a coupling," which was to revolutionize the world. Most of these devices have been designed with the object in view of facilitating the removal of the coupling when pulleys are to be added to or removed from the main line. So far as the writer knows, but three really good ones have ever been designed, and these are too well known in this country to need special mention. For heavy prime movers, the ordinary plate coupling, well fitted, is the best thing that has ever been devised, and will probably continue to be. For ordinary line shafts, the three couplings mentioned above answer very well, but the advantages they possess over the plate coupling are not sufficient to justify one in paying more for them than the plate coupling costs.

When the plate coupling is used, the bolt holes should always be countersunk so as to bring the bolt heads and nuts flush with the outside surface of the flange. If this is not done, the coupling becomes, especially if there are any belts in its neighborhood, as dangerous an article as the toy pistol on the Fourth of July. This remark may seem superfluous, still we think it is justified by the fact that many machinists to-day are fitting up couplings with the bolt heads and nuts projecting their full thickness from the face of the flange. We have seen several men get caught by these projecting bolts and carried over the shaft, and in two instances they were killed. We always approach them with fear and trembling, and make our stay as short as possible. Any one who is obliged to work in the vicinity of such a coupling will confer a boon on suffering humanity by "kicking" to the full extent of his powers.

The hangers used in a system of shafting is one of the most important parts of it, for upon their construction and adjustment depends, in great measure, the efficiency of the whole arrangement. Certain elementary principles which should govern their design may be summed up thus: no open hanger should be tolerated; the parts which take the strain resulting from the weight of the shaft and the pull of the belts should be of wrought iron; the bearing should admit of convenient adjustment in a vertical direction. So far as we know there is but one hanger in the market which fulfills these three simple conditions, and this is used to a very limited extent. A large proportion of the hangers in use are open hangers, and several bad accidents have resulted from their use. A few years ago a whole line of shafting in a cotton mill fell, badly smashing the machinery. Open hangers were used, and from some cause which we were unable to learn, the shaft was thrown out of one of the bearings, and the whole line followed. The use of properly constructed bale hangers would have prevented the accident. But bale hangers, as usually made of cast-iron, are easily broken by shocks which would not injure a wrought iron one.

The material for the bearings or boxes of shafts has always been a favorite theme for discussion among mechanics. Some contend that cast-iron is the best material, others prefer boxes lined with babbit metal. The argument in favor of cast-iron is: that it is cheaper, runs easier, and will wear longer if it is kept properly lubricated. This may be so, but we prefer a well babbited box to anything else. The trouble is in keeping the boxes properly lubricated. Accidents happen in the best regulated families, and boxes will occasionally run dry in the best lubricated shops, and the risk of cutting the shaft is one that no one can afford to take. With the best lubrication it is practical to give a shaft, the odds, in the long run, will be found to be decidedly in favor of the box lined with the soft metal.

For genuine curiosities in mechanical practice, commend us to the pulleys of a few years ago. The wonderful and complex forms that so simple a thing as a pulley arm should be, has assumed in the hands of different men is quite startling, to say the least. It would seem at the first glance that some makers of pulleys (we will not call them designers or mechanics), expended incredible amounts of ingenuity in devising strange and unheard-of shapes for the arms of their patterns. The horse shoe bend and the double ogee have been as wax in their hands. We have seen pulleys only 24 inches in diameter with 3-inch face, that had no less than *fifteen arms;* each arm was the full width of the face of the pulley, and about $\frac{5}{16}$ of an inch thick, and described almost a semicircle in getting from the hub to the rim. The apology for this and kindred shapes is, that fewer of them break in casting. We don't wonder at it. When iron is tortured into such shapes, it ought to resolutely refuse to break or be broken, and should always stand as a monument to the man who designed them. If a founder can't cast a pulley without recourse to such horrible expedients, he should be liberally dusted with *parting sand.*

H. F. S.

Standard Time.

The subject of standard time for the world has of late received much attention, and the sooner it becomes an accomplished fact the better it will be for every body. A hundred years ago the present system of time notation was good enough for all purposes, but since then the invention and wonderful development of the telegraph, and railroad and steamship lines, has brought people in distant parts of the world into such close business relations that the need is sorely felt for something better than the old local standards, and the arbitrary and unphilosophical division of a day into the two parts, A. M. and P. M. By all means let us fix upon some meridian, reckon time from it, and it alone, and count the hours from the beginning of one day to the beginning of the next. This is the only sensible way of doing it. A correspondent of the *Railway World* has the following to say upon the subject:

"Anything more crude, uncertain, and insufficient than the style now in use cannot well be imagined. It is a relic of the Dark Ages, adopted centuries before a railroad or telegraph was thought of. Modern progress demands something better adapted to the wants of our present advanced civilization. Whatever change is made will doubtless be initiated by the railroads of this country, and, if it proves satisfactory, will eventually extend throughout the world; for which reason it is to be hoped that whatever action they may take in the matter will have so broad and catholic a basis as to admit of its universal adoption. In the discussions which have arisen in considering this problem, it has been conceded that the remedy lies in establishing a standard or standards, of time of universal or local application. It must, I take it, be assumed that any plan or reformation which may be decided upon by the railroads of the country will encounter a strong opposition from the mass of the general public. The conservative feeling which makes people reluctant to surrender an established custom and adopt something different in its place would, I apprehend, prevent any legislation on the subject for some time to come. But, fortunately, it is not necessary that the laws of the country should be invoked in the matter. The question is one which primarily affects nothing but railroad schedules and railroad time-pieces, and is entirely within the control of each company or companies, respectively or collectively. Due regard, however, should be had for the public interests and convenience, and any change that is made should, so far as is possible, be in accord with the existing condition of things. It would seem as if the problem might be solved by adopting the recommendation which has been made, and ably advocated, of taking as the standard the astronomical time of Greenwich, England, according to which the day begins at noon and is divided into 24 hours, numbered from 1 to 24.

"The Observatory at Greenwich furnishes the best known time that exists. It is exact, constant, and known (or ascertainable) everywhere. It is used in astronomical observations and calculations, as the basis of tables used in navigation, and for mathematical and scientific purposes generally, so that its adoption by railroads would bring them into harmony with the other cosmopolitan pursuits of the world. I can foresee the objections likely to be urged against the adoption of Greenwich time. It would probably be contended, as it has been, that inasmuch as the hours of the day would run from 1 to 24 instead of the day being divided into halves of 12 hours each, as is the present civil day, great inconvenience would result to the public. And, further, that inasmuch as the clocks and watches throughout the country would all register the time at Greenwich, people would be going about their avocations at strange and unnatural hours. Now let us see what these objections amount to. I would, however, premise by saying that there is no use in ameliorating an evil if it can be as easily eradicated, and that any reform that is attempted cannot be too thorough if the best results are to be obtained. Some inconvenience will necessarily follow any change, and the compensating benefits should be made as great as possible. A clock is merely an instrument designed to measure the flight of time, generally having 12 grand divisions shown on a dial, covering the time from midnight to noon, and the converse. The particular names by which its several divisions or indicated periods are known is of but minor importance in comparison with the exactness of the information derived therefrom. Should Greenwich astronomical time be taken as the standard, 12 o'clock midnight would become the end of the twelfth and the beginning of the thirteenth hour. Two o'clock A. M. (present style) the beginning of the fifteenth hour; 6 o'clock A. M. (present style) the beginning of the nineteenth hour, and so on around the circle. In a short time the people would become accustomed to speaking of the hours of the day in this way and the novelty of it would soon wear off.

"According to the system proposed, if the sun set at Greenwich at the beginning of the seventh hour (6 P. M., present style,) 15° west on the same parallel of latitude it would set one hour later, or at 7 P. M., present style; 30° west, two hours later; 75° west, five hours later, and so on to 90° *east*, where it would set 18 hours later, and simultaneously become visible at Greenwich six hours before the beginning of the next day. From this it will be seen that the hour of the day bears no conventional relation whatever, as at present, to the rising and the setting of the sun. To demonstrate the disadvantages attending the present style it is only necessary to instance the familiar illustration of a ship sailing around the world. If going west, the ship's log contains a record of a blank day—interpolated, in fact—while if sailing to the east a day has to be added, thus occasioning, to say the least, what should be an uncalled-for absurdity. Again, it daily occurs in the United States that we receive the morning intelligence of events which have taken place in Europe and Asia in the afternoon of the same day. If we read in the papers that something has transpired in even such well-known cities as London, Paris, or Berlin, at a given hour, how many persons know exactly when it did occur? The advantages which would result from the proposed change would be certainty and uniformity. There would no longer be any question about New York, Philadelphia, Washington, Pittsburgh, Chicago, and 50 or more other standards of time now in use by the railroads of the United States. By getting rid of A. M. and P. M. it would no longer be necessary to print railroad time-tables with such devices as are now adopted to distinguish between night and day trains. Such notations as "the time between 12 o'clock noon and 12 o'clock midnight is indicated by heavy-faced type," and "heavy rules on left hand of columns indicate trains between 6 P. M. and 6 A. M.," would no longer mystify and distract the average traveler.

"In making the change suggested, it should be done simply in the interests of railroads, and care should be taken to make no attempt to force its acceptance upon the public by legislative enactment or otherwise. If the people throughout the land have local time which suits them, let them have the undisturbed enjoyment of it. Experience has fully demonstrated that railroad time is the standard which is in general use along the respective railroads of the country, and it would not be long before Greenwich time, if used by the railroads, would be used universally, to the exclusion of any other."

Fireproof Walls and Self-Binding Mortar.

In the construction of fire-proof, or more properly speaking, fire-resisting walls, the mortar hitherto used has been either refractory clay or else a mixture of the latter with finely ground firebrick. Herr Fritz Lürmann, in a short paper which has recently appeared in *Stahl und Eisen* deals with this question principally as it affects the construction of blast furnaces, coke-ovens, generators, etc.; but as his observations apply to other structures intended to resist the effects of fire, we quote them. The author says that so-called fireproof mortars are neither self-binding nor do they combine with the refractory bricks employed. Fireproof brickwork, consequently, does not hold together well, as is the case with ordinary brickwork constructed with hardening lime or cement. Now, fire-resisting brickwork, such as is employed in blast furnaces for instance, is exposed to great pressure, like ordinary brickwork; but it is at the same time expanded by the physical effect of heat, and chemically changed and melted off, through the combined operation of heat and the substances contained in the space enclosed, such as slag, glass, etc. Thus, even during drying, preliminary heating, and starting of structures, consisting of refractory material, a shifting of the bricks takes place if mortar has been employed which does not bind well. The joints open, the mortar drops out, and, even before work proper is commenced, the cohesion of the supposed fire-resisting brickwork is destroyed. It need not be pointed out here how such disturbing causes hinder successful working. In order to give the required cohesion to walls of refractory bricks at once, enabling them to resist the preliminary heating and starting, Herr Lürmann proposes to construct them, contrary to the present practice, not with so-called fireproof mortar, but with a self-binding mortar of lime, dolomite, cement, slag, glass, etc., with the addition of sand, clay, firebrick, etc., which frits at high temperatures. This self-binding mortar, ground very fine, is mixed with water to the consistency permitting of the use of very thin joints. Walls thus constructed are stated to form a compact whole, which expands equally, without shifting of bricks or dropping out of the mortar from between the joints. As soon as very high temperatures are reached, the mortar sinters either partially or wholly, and frits with the refractory bricks. It is best to use small bricks, for larger bricks are generally not thoroughly burnt through, and might give rise to shifting. It is only with small bricks that an equally expanding wall can be constructed, and, through the employment of self-binding mortar, converted into a solid fire-resisting mass. The latter, from the same cause, will also contract equally during cooling.—*Cotton, Wool, and Iron.*

Oil on Rough Water.

The report of B. C. Sparrow, superintendent of the Second Life Saving District, under whose direction experiments have recently been made in the use of oil for calming a rough sea, has been presented to the president of the Board on Life Saving Appliances, and by him forwarded to Superintendent Kimball, of the Life Saving Service. The experiments were made with a view to determining to what extent oil could be used as an auxiliary agent by the Life Saving Service, and were in the line of individual experiments made in Scotland which had been commended to the attention of the Life Saving Bureau by the press and by private suggestions. In the introduction to his report Mr. Sparrow says: "The nature of the phenomena presented by a rough sea, the relative influence of the different agencies concerned in its action, and just how far this action can be controlled, can only be determined by carefully compared experiments, which would require an expenditure of time and funds not at our disposal. Therefore the subject is herein treated only as a matter of practical observation and not of exhaustive scientific inquiry." His experiments included the list of apparatus designed for distributing the oil on the water at a distance from the object to be protected from the force of the waves, and a description of several of the inventions, the manner of operating them, and the effect which it was hoped they would have, accompany his report.

Preliminary to recording the results of his experiments he describes the conditions of the sea under the influence of certain winds, in order to establish the circumstances under which oil might be advantageously used if it possessed properties such as had been claimed for it. Among these conditions he notes the dangerous sea produced by rapidly increasing wind in deep waters, the surf as it breaks on shore, heavy on-shore swells rolling in against off-shore winds, and swells breaking upon a shore in the absence of wind. He says that at present it is thought sufficient to present such facts as have been gathered relating to the calming effect of oil upon the sea where it breaks in deep water, and the evidence that it has no controlling effect whatever upon the sea where it breaks upon the shore. On the first point he says: "When a boat or vessel is lying to in the open ocean, exposed to a dangerous sea, and by means of a drogue or otherwise makes a dead drift directly before the wind, the pouring of oil upon the water is an effective means of safety, as under such conditions the craft keeps in the calm surface over which the oil prevents the sea from breaking, but when lying under 'ranging sail' no benefit is derived from the use of oil, since the craft will continually range ahead from the oiled surface into rough water."

He concludes that for many reasons the instances will not be numerous in which a vessel will make a "dead drift," and in that condition dispense oil in order to avoid the ordinary dangers of the sea, and thinks that most master mariners will continue hereafter, as in the past, to hold their course at the risk of shipping a sea. He does not think that any of the appliances yet invented for distributing oil in advance of a vessel while under ranging sail, several of which he describes, can be successfully used, and with this conclusion dismisses the question as far as it relates to the use of oil on deep water.

He describes a series of experiments made at the house of the Massachusetts Humane Society on Nanset Beach in January and March of this year, with oil carrying and distributing projectiles designed for use in calming the water on shore and reducing the danger of the surf. These projectiles were reservoirs of oil discharged from a gun, which it was intended should, on falling into the water, distribute their contents on its surface. As the result of these experiments he concludes that the several devices of the inventors in their present form dispense oil faster than is necessary, and are not adapted to being thrown to windward; that they are of no use for the purpose of the life-saving service in the immediate vicinity of the shore, and that their use from boats remote from land is, on account of the size of the guns necessary to discharge them, impossible. He recommends, however, that careful attention be given to any additional or improved devices under this plan that may be offered in the future.

He reports other experiments with oil when it was poured on the water from on board a vessel during the prevalence of a strong northeast wind. An oiled surface of one acre in extent was obtained, but, although the process of pouring oil on the water was kept up for a considerable length of time, the sea continued to break as before the oil was applied. Another experiment was made on a pond 400 yards from shore to shore, a large part of which was covered with oil, on an occasion when the wind had roughened it until it had broken into "white caps." The oil obliterated the "white caps" as it advanced from the windward, but the waves broke on the lee shore and threw up the surf with as much energy as if no oil had been cast upon them. After reciting these experiments, he says: "The conclusion deduced from our experiments is that oil exerts no influence upon a sea that breaks on the shore. The result, when an inrolling, undulating wave from the ocean throws thousands of tons of water upon the shore, cannot be prevented by a thin film of oil." He adds: "The majority of the printed statements, together with all the verbal statements made by mariners who have used it, furnish conclusive evidence that in deep water oil has a calming effect upon a rough sea, but there is nothing in either source of information which yet answers the question whether or not there is in the force exerted by the wind a point beyond which oil cannot counteract its influence in causing the sea to break."—*The Iron Age.*

The Locomotive.

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About Steam-Gauge Connections.

It is a very simple matter to properly connect a steam-gauge to a boiler, but in nine cases out of ten it is not correctly done for some reason or other which it would be difficult to assign.

The chief points to be considered in connecting steam-gauges are: To locate them so that they cannot be injured by the heat radiated from the boiler front or uptake; to provide an inverted siphon or other arrangement which shall insure the spring or diaphragm always being filled or covered with a body of water while the boiler is under steam; and to so make the connections that the pipe may be blown out at any time without removing or disturbing the gauge.—The gauge should also admit of easy removal while the boiler is under steam for the purpose of testing and correction.

Some engineers, when erecting boilers, attach the steam-gauge directly to the uptake, or to the portion of the cast iron front which covers the end of the boiler and forms the front connection. This should never be done, as under such circumstances the heat will inevitably injure the spring, and the gauge will in a short time indicate anything but the correct pressure. Much trouble has been caused boiler owners by this practice. The gauge should be carried to one side and secured to the brick work; or, if for any reason this is undesirable or impossible, it should be brought out

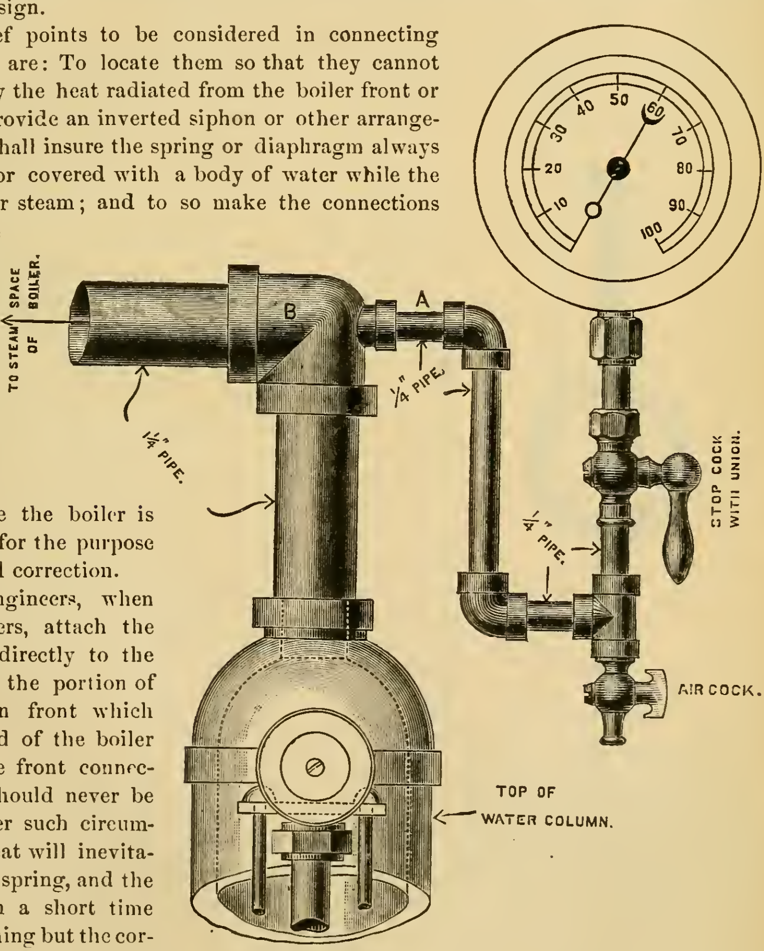

Fig. 1.

far enough from the boiler front to allow a good thickness of some non-conducting material to be placed between it and the boiler, sufficient to effectually prevent injury.

The second of the above objects is generally accomplished by attaching the gauge to a pipe bent into the form shown in Fig. 2. This form of siphon, while it accomplishes perfectly what it is designed to do, namely, the keeping of a body of water on the spring, possesses the disadvantage of not allowing the pipe to be cleared of sediment without removing the gauge and causing great inconvenience. Moreover, whenever a pipe bent into this form becomes filled up with a solid deposit, which sometimes happens, it is peculiarly difficult to clean out, owing to the impossibility of driving a rod or wire through it. It is also impossible to clear a siphon of this type of water when it is necessary to do so, which occurs when a boiler is stopped for any cause in cold weather. In such cases, unless the gauge is disconnected, and it and the pipes cleared of water, they are very apt to freeze up, and when they do the spring is generally burst open. The number of gauges which we are called upon every winter to test and "solder up," whose springs have been split from this cause, is quite surprising.

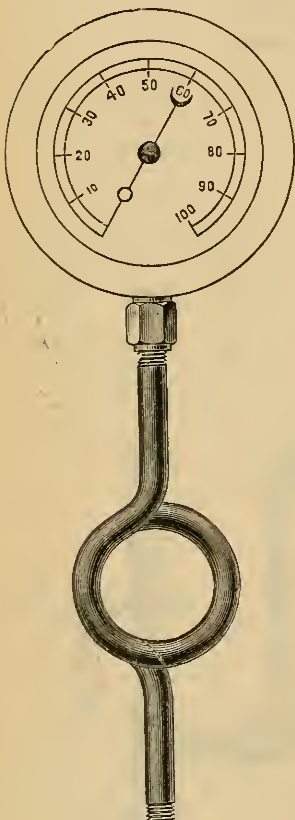

Fig. 2.

The form of steam-gauge connection shown in Fig. 1 is what we have found to best serve all purposes. The cut shows the details so clearly that no explanation is necessary. Where no combination or water column is used, the nipple shown at A extends to the boiler and enters it at any convenient point in the steam space. When a water column is used, as shown in the cut, it screws into the reducing tee on top of the column, as shown. The air cock shown permits of easy and thorough cleaning of the pipe, by simply opening it when steam is on the boiler and blowing through for a few seconds. When this is done the stop-cock between it and the gauge should be closed, or the gauge may be injured.

The stop-cock, with union, should always be used, as it admits of the removal of the gauge for testing, adjustment, or repairs while the boiler is under steam. Care should be exercised that this cock be put on *right end up*, or it will be useless for the purpose intended. In many places where they are used we find them put on, strange as it may appear, with the union *below* the cock. This, with most of the arrangements of pipe which we find in use, renders it impossible to disconnect the gauge without considerable trouble.

We would add a word of caution to engineers who have charge of vertical boilers. Where such boilers are used, the pipe to the steam-guage is generally taken from the boiler near the top, and then dropped down several feet to bring the gauge where it can be conveniently read. Engineers should recollect that the pipe in such cases fills with water, and that its weight will cause the gauge to indicate a higher pressure than that actually due to the steam pressure. The excess of this pressure over and above the actual steam pressure will be one pound for every $27\frac{3}{4}$ inches in height of water column standing on the gauge. While this is of no consequence in ordinary running, it should always be taken into account when indicating an engine or making a test. The indicator will, of course, show nothing above the actual steam pressure at the top of the boiler, and unless the weight of the water column is taken into account there will be an undue difference betwen the boiler pressure, as shown by the guage, and that realized in the cylinder.

Inspectors' Reports.

SEPTEMBER, 1883.

The two hundred and fourth monthly summary of the work of the inspectors is given below. It appears that the whole number of visits of inspection made foots up 2,509, while the whole number of boilers visited was 4,791, of which number 2,122 were thoroughly inspected, both externally and internally; 285 boilers were tested by hydrostatic pressure, and 53 were condemned.

The number of defects found which were considered of sufficient gravity to be reported was 2,835, of which 422 were regarded as dangerous. The defects in detail were as follows:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	302	25
Cases of incrustation and scale,	446	34
Cases of internal grooving,	12	4
Cases of internal corrosion,	99	18
Cases of external corrosion,	161	40
Broken and loose braces and stays,	44	14
Settings defective,	125	23
Furnaces out of shape,	74	10
Fractured plates,	122	50
Burned plates,	88	21
Blistered plates,	250	13
Cases of defective riveting,	229	14
Defective heads,	44	9
Serious leakage around tube ends,	286	56
Serious leakage at seams,	193	36
Defective water-gauges,	73	7
Defective blow-offs,	37	9
Cases of deficiency of water,	18	3
Safety-valves overloaded,	30	6
Safety-valves defective in construction,	22	7
Pressure-gauges defective,	179	23
Boilers without pressure-gauges,	1	0
Total,	2,835	422

Defective settings are one of the chief sources of loss and waste of fuel in boilers of the externally fired type. The reasons for this are various; the chief ones are faulty design and faulty construction; faulty design preventing the perfect combustion of the fuel, and faulty construction being responsible for cracks, leaks, and air holes in the walls of the setting, flues, and chimney, whereby cold air is drawn into the furnaces at the wrong places, thereby lowering the temperature of the products of combustion; and into the flues and chimney, impairing the draft, and very greatly reducing the efficiency of the whole arrangement.

Too much care cannot be taken with the brick work of boiler settings. The brick should be carefully laid, the joints should not be too thick, the mortar should be of good quality. A hollow wall should always be built for the side and rear end walls, with a two-inch space between them. Some engineers recommend a solid wall, for the reason that two inches of brick work is a better non-conductor than two inches of air. This may be true if we take simply a brick wall two inches thick, and compare it with a film of air two inches thick. But the air space between two walls is a different thing. It breaks the *continuity* of the wall, and is consequently of greater value than at first sight appears. But its greatest value consists in the fact that it gives us two walls (which, of course, should always be laid up independently, or at least *not* tied rigidly together), the inner one exposed to the fierce heat of the furnace, takes any distortion or cracking which may result, while the outer wall remains comparatively cool and intact, and consequently prevents the sucking in of cold air through the cracks, which *will* occur in the inner wall, and *will* extend entirely through the whole wall if it is solid, whatever practicable thickness may be given to it. A small crack in the setting of a boiler, which gives the air a chance to draw in through the joints into the furnace or flues, results in a greater loss of efficiency than most people are aware of. One of the most fruitful sources of loss from this cause occurs when boilers are set with a "flush front" setting. The walls always expand and force the front away from the end of the boiler. When the front becomes bulged out, the entering air, instead of all going through the fuel, takes a short cut up between the front and the brickwork, directly into the smoke connection. It is surprising how much effect half an inch of space between front and wall at this place will produce. We have found many cases where it was impossible to make steam from this cause, and the source of the trouble was entirely unsuspected until it was pointed out by an inspector. Boilers set with a "projecting front" are not subject to this defect.

BOILER EXPLOSIONS.

SEPTEMBER, 1883.

THRESHING MACHINE (120).—The boiler of a straw-thresher engine exploded on the farm of B. F. Taylor, nine miles east of Ashton, Dak., Sept. 1st, killing four persons and seriously injuring five others. Fragments of the boiler were blown three hundred yards. One large traction-wheel was blown eighty yards. The cause of the explosion was the water running low and pumping cold water into the boiler. Loss about $250.

SAW-MILL (121).—The saw-mill of Mr. Dallas Crawford, on the Six-Mile Creek, a few miles from Erie, Pa., was set on fire by tramps Sept. 1st. While the mill was burning the boiler exploded, and several persons narrowly escaped death.

FLOUR-MILL (122).—A boiler in the Shawnee Mills, Topeka, Kansas, exploded Sept. 3d, killing the engineer and doing $10,000 damage.

THRESHING MACHINE (123).—The boiler of a steam thresher on the farm of Abraham Overholtzer, in Dauphin county, Pa., exploded Sept. 5th, instantly killing Simon Brinser, the engineer, and Jacob J. Kline, both of Elizabethtown. The explosion was due to a lack of water in the boiler.

SAW-MILL (124).—The boiler in a portable saw-mill a few miles west of Marietta, Ohio, exploded Sept. 7th, killing Charles Palmer and Martin Ellison, and severely injuring two other men.

PORTABLE ENGINE (125).—A boiler used by contractors who are building a bridge at Herr's Island, a short distance from Allegheny City, Pa., exploded with terrific force Sept. 10th, scattering débris and hot water in all directions. Five men, three of them Hungarians and two Irish, who were at work at the time, were all more or less injured by being scalded or hit with flying débris. One of them, whose name could not be learned, was injured so badly that he will die. The others will recover. The cause of the explosion is not known.

Iron Works (126).—A terrific boiler explosion occurred about 5 o'clock p. m., Sept. 11th, at the blast furnace of the Cleveland Rolling Mill Company, Cleveland, Ohio. The boiler was blown into many fragments, and caused considerable damage. Four men, whose names could not be learned, were injured, none of them seriously.

Saw-Mill (127).—One of the largest boilers on the Trinity & Sabine Railroad at Fowler & Saunders' mill, Trinity, Texas, exploded Sept. 12th, killing the fireman, J. C. Lutton, badly scalding another man and boy, and slightly injuring Mr. Fowler. Cause of explosion unknown. The boiler was blown fifteen feet high and thirty-five back, reversing the ends.

Locomotive (128).—At 3 o'clock on the morning of Sept. 14th, as a south-bound freight train on the International & Great Northern Railway reached the trestlework about one mile north of Riverside, Texas, the engineer shut off steam, preparatory to slowing up to cross the trestlework, when the engine No. 178 exploded, blowing the top of the boiler to pieces. The fireman, H. P. Ellis, jumped to the ground, about fifteen feet, striking on his head and shoulders, rendering him unconscious. The engineer remained on his engine and was not hurt.

Iron Works (129).—Between 1 and 2 o'clock p. m., Sept. 20th, a large boiler in the flanging department of the Sligo Iron Works, Pittsburgh, Pa., exploded with fearful violence, scattering fragments in every direction, and setting fire to the Lake Erie railroad shops and a number of dwelling-houses in the vicinity. The boiler department, a brick structure, was completely wrecked, as were also a number of passenger and freight cars and the shops of the Lake Erie Railroad, while a row of dwellings on the opposite side of the street were set on fire. At the time of the explosion twenty men were at work. Of these, three were killed and eight badly injured, four fatally, while four children who lived across the way were also badly hurt. The boiler was an upright one, and was six feet in diameter. It was split into four pieces, the largest one being blown a distance of 200 feet, landing in the middle of the Monongahela river. It is not known what caused the explosion.

Steam Yacht (130).—William Gutcliffe, a Paterson machinist, recently built a steam-engine, and for a boiler used an ale-cask, which he said would stand a pressure of 350 pounds to the square inch. He fitted up a small boat with his engine and wooden boiler. Sept. 21st, he steamed up the Passaic river half a mile to Lincoln bridge and back to near the falls, where he made fast about 7 o'clock and dumped out the fire, as he thought. Soon after he left the fire started up again, and in time generated such a pressure of steam as even an ale-cask could not sustain, and with a terrific roar the boiler gave way, hurling the staves and engine far into the air above trees on the adjacent hill. Boat and all disappeared in the completest of wrecks. Luckily no one was in range of the flying fragments.

Saw-Mill. (131).—The boiler of the engine running the saws at the bridge now being constructed over the Red River at Shreveport, La., for the Vicksburg, Shreveport & Pacific Railway, exploded with terrible force Sept. 22d, killing five men and wounding five others.

Tannery (132).—A large tubular boiler in Shaw Brothers' tannery, at Grand Lake Stream, Me., exploded Sept. 23d, tearing out the side of the building and throwing the fire-box of the boiler a distance of 600 feet. There were four men in the building at the time of the explosion, but all escaped uninjured.

Kitchen Range Boiler (133).—The Scovill House in Waterbury, Conn., narrowly escaped destruction by the explosion of a range Monday morning, Sept. 24th, at 6 o'clock.

The cause was the shutting off of the city water. Several employees narrowly escaped death. The building was fired in several places, but the flames were extinguished.

THRESHING MACHINE (134).—A terrible steam threshing machine accident occurred on the Kreger place, about eight miles south of Osakis, Minn., Sept. 26th. The machine was owned and run by the Ives Brothers. The pump was not working satisfactorily and the engine was stopped for a few minutes. The men gathered around the engine, when the explosion occurred. The killed are Albert Garlock, Peter Billedaux, and Matthew Joyce. Those dangerously wounded are "Frank" Ives and Charles Ives. The slightly wounded are "Mike" Riley, Samuel Porter, and Chester Gilbert. All are scalded and bruised. Gilbert was blown thirty feet from the engine. Albert Garlock was thrown nearly 300 feet and Billedaux nearly 150 feet from the engine. Both bodies when picked up were literally stripped of clothing and the flesh and skin scalded off. They were pierced full of holes from the flying pieces of iron. Matthew Joyce and "Frank" and Charles Ives were blown down a few feet in front of the engine. The engine was blown fifty feet directly over the top of the separator and wheat stacks.

STEAMER (135).—The boiler of the steamer J. S. Robinson, which lay at the foot of Westerlos street, Albany, N. Y., exploded Sept. 28th, instantly killing the captain. George S. Warner, and the fireman, William Cleary, and seriously injuring Frederick Winslow, the engineer, who was blown into the water and narrowly escaped drowning, and Willard Durand and Melville Ryan, deck hands. Richardson VanZandt, a son of Captain VanZandt of the tug-boat Cora, from New Baltimore, which was lying alongside the Robinson, was also injured. Captain Robinson, of the Hattie M. Betts, was blown from the pilot-house on to the wharf and severely injured. The Betts, which lay at the stern of the Robinson, was damaged to the extent of $1,000. The Cora, which lay alongside, is a total wreck, and the C. P. Grout, lying ahead of the Robinson, had her joiner work carried away and her machinery damaged. The Robinson sank immediately, carrying with it the body of Cleary, the fireman. One section of the boiler, weighing two or three tons, was hurled 400 feet against the top story of a three-story building, crushing in a portion of the wall. Another section, weighing nearly a ton, crushed in the roof of the coal-barge E. M. Downing, and still another section was hurled to the rear, grazing the cabin of the coal-boat Apollo, and tearing away the roof before it fell into the river. Buildings were shaken, windows shattered, and general consternation prevailed in the vicinity.

STEAMER (136).—The freight steamer Colorado left Buffalo, Sept. 29th, for Chicago. At about 9 o'clock, when five miles out, the starboard boiler exploded with a terrific shock. There were no passengers aboard, but eight or ten of the crew were more or less injured. Henry Allen, a deck hand, died in a short time. The boiler was thrown up into the air and toward the stern of the steamer, and turned around so that when it came down it had changed ends. The Colorado was towed back to the harbor by tugs which went to her relief, and the injured men were taken to the hospital.

THE *Iron Age* says: The report of the committee of the Geodetic Association, presented at the general meeting of the conference at Rome. Italy, on the 24th ult., favors the universal adoption of the Greenwich meridan, and also recommends as the point of departure of the universal hour and cosmopolitan dates the mean noon of Greenwich. Part of the scheme of the conference contemplates that each town of importance shall have a public time-signal station electrically connected with a central observatory, for the purpose of receiving and disseminating standard time with precision. Another feature is that all railway and public clocks should be connected electrically from the public time-signal stations.

The Locomotive.

HARTFORD, NOVEMBER, 1883.

The "Gaffney & Company" Boiler Explosion Law Suit.

Our readers will remember that on June 1, 1881, one of the three steam boilers of Messrs. Gaffney & Company, Philadelphia, Pa., exploded, killing three persons and injuring others. The boiler was new, having been run but a few months. The exploded boiler was of the plain cylinder type, 30 feet long and 36 inches in diameter, the heads were of the pattern known as "flat cast iron," one and seven-eighths inches thick, filleted at the flange, and strengthened by a boss surrounding the man-hole. The front head—the one in which was the man-hole—blew out, which was mainly the cause of the destruction which followed. A full account of this explosion, with illustrations, will be found in *The Locomotive* of July, 1881. The boiler was insured in the *Hartford Steam Boiler Inspection and Insurance Company*, and by its certificate was allowed a pressure of eighty (80) pounds. A coroner's jury was summoned, and, after examining the ruins, they rendered a verdict condemning the use of flat cast iron heads, and wound up by saying that the "Hartford Company" was entitled to the sevest censure, etc. No reason was given why this Company should be censured, save that it certified to the safety of a boiler that had flat cast iron heads. It was well known at the time that such heads were in common use in Philadelphia and vicinity. It struck mechanical engineers throughout the country as a very strange verdict, inasmuch as there was no law or ordinance criticising or condemning such heads.

In due time the Company was notified that a suit had been commenced against it by the parents of a little boy who was struck and killed by a piece of iron from the exploding boiler. Damages were laid at $50,000; suit was brought in the City Common Pleas Court, but, on petition of the Company, was at once transferrd to the *United States Circuit Court*. The case was tried in the October term, 1883. A very labored effort was made by attorney and experts for plaintiffs to place liability upon the Company, and some of the familiar faces that figured in the Deitel case a few years before were conspicuous. An effort was made by plaintiffs to run the case after the fashion of the Deitel case. But they soon found out that the United States Court had its own methods, and that it tried its cases on the basis of strict justice, and was not influenced by sympathy or prejudice. In charging the jury Judge Butler said in closing: "*I deem it my duty to say to you that the plaintiff's case in my judgment is weak, as respects both these points,—so weak as hardly to justify a verdict in their favor. This question, however, is submitted to you to be determined according to your judgment. In submitting it I caution you against all suggestions of sympathy or prejudice. They have no proper place in a court of justice.*"

The jury were out but a few minutes, and, returning, rendered a verdict in favor of the defendants.

In the Deitel suit against the Hartford Steam Boiler Inspection and Insurance Company for damages for the death of the engineer, caused by the explosion of an insured boiler in the city of Philadelphia, the jury rendered a verdict for the plaintiffs which in our judgment was not in accordance with the evidence, and which we believe would have been set aside in a higher court. The case was tried in the Court of Common Pleas No. 3. The damages were adjusted and paid by the Company. In the division of the spoils one of the experts (?) thought his share was not commensurate with his services, and failing to secure more by persuasion, we understand he has brought suit against the lawyer for an increased allowance, and further, we have been informed that the suit is brought in the same Court of Common Pleas that the Deitel case was tried in. It would be interesting to know how much the widow Deitel received as her share of the amount of damages under the verdict. We hope when the case comes to trial it will be before the same judge that presided at the Deitel case; he will be familiar with all the facts, and it would no doubt be refreshing to him to review the points in the case. It will also serve to give him some impression of the "expert" talent that is encouraged by such verdicts.

The *Spectator* for November 1st has an interesting article on driven wells in Brooklyn, N. Y., as a source of water supply for the city. The article is illustrated with diagrams, and the reader will be amply rewarded for the time spent in studying it.

The *Travelers Record* for October has on the first page an article entitled "Java, the Queen of the Tropics." The island is projected upon an outline of the Northern States of the Union, thus giving the reader an idea of its great area. Its government, inhabitants, and products are described, as well as its terrible enemies, earthquakes and volcanoes.

The cable announces the sudden death of Dr. C. W. Siemens of London, from rupture of the heart. Dr. Siemens was born on the 4th of April, 1823. He was one of the most distinguished scientific men living. His researches in theoretical science were deep and profound, while his contributions to practical science, in the form of inventions and improvements in industrial processes were many and varied. He was the inventor of the regenerative gas furnace, the open hearth process of making steel, constructed most of the Atlantic cables, designed the steamer Faraday for laying them, and in fact has been closely identified with the progress of all branches of science and industrial art in England, for many years past.

Carving and Engraving upon Crystal and Wrought Glass.

The art of manufacturing crystal, of carving it and engraving it, is of very high antiquity, for Pliny informs us that "sometimes glass is blown, sometimes made in a furnace, sometimes chiseled as silver is."

Leaving for a while antiquity and its rare vestiges, let us, making a rapid leap over the centuries, return to our own age, and notice what the processes are which are employed now.

The carving of crystal and glass has generally for its object the obtaining of ornaments in relief; it is obtained by means of four vertical grindstones which, employed one after another, are brought into play either by the foot of the workman or by steam.

The first of these grinders is made of iron, the second of grit-stone, the third of marl, and the fourth of cork.

On the iron wheel the workman throws from time to time sand which has been moistened by means of a sabot or of a small wooden bucket which is placed above the wheel, and which causes the water to fall drop by drop upon the sand.

The first, rough-hewing sort of process being completed, there is placed, instead of the iron wheel, a grinder of grit-stone, the less hard action of which gives an additional degree of perfection to the cutting. Then comes the wooden wheel, on which are thrown in rotation the sediment of the sand pulverized by the previous processes, emery, becoming gradually finer and finer, and last of all pewter. The process is terminated either by means of the same wooden grinder sprinkled with dry pewter, covered with woolen stuff, or by means of another grinder made of cork.

The chiseling of the glass or crystal is obtained either by applying the process to smooth and lateral surfaces, or to the cylindrical part of the glass, or, it may be, on the *arete* of the wheels when put in motion.

This system of decoration requiring, as we see, a rather long process and an inevitable loss of material, cut glasses could not be purchased under somewhat high prices, till a simple workman introduced a complete transformation into this branch of glass manufacture by the invention of moulding.

A young workman of the name of Robinet, who was employed as a glass-blower in the manufactory of Baccarat, happening to have delicate lungs, and finding his strength diminishing to such an extent as to threaten his means of getting a livelihood, invented a pump which more than supplied the place of human strength. This invention, which dates from 1831, consists of a small cylinder made of tin or brass, from thirty to forty centimeters in length, by from six to eight in diameter, and closed by an end piece. In the interior of the cylinder is to be seen a spring on rollers made of iron, at its lowest portion a wooden piston with an opening in the middle mounted with leather, and closed by a fastening *a baisonnette.* The mouth of the cylinder being thus placed in contact with the piston, the air is compressed with a strong pressure, and being held back within the cylinder and then forcibly thrown out, it causes the material to penetrate into all the anfractuosities of the mould.

It is by this cheap and expeditious means that wine-glasses, decanters, etc., can be produced for a very low price, their ornamentation usually being what are technically called "slices of melon," or *quadrilles.* These glasses, though made in a mould, can be tooled by the crystal cutter.

This invention, known as the Robinet pump, is doubly valuable from a philanthropic and from an industrial point of view. It obtained for its inventor a gold medal from the Society d'Encouragement, and a pension secured to him by the municipality of Baccarat.

Although engraving upon glass produces a result totally opposite to what cutting does, because the former is made on the hollow surface, while the latter, as we have just shown, seldom produces anything besides ornaments in relief, the modes of execution offer at the same time a rather strange resemblance, for both are produced by *turning*, with certain differences which we are about to mention.

In place of the wheels, which in cutting glass wear out and consume the material, the graining is obtained by the help of a pin, which, terminated either by a point of tempered steel or by a piece of flint, is adjusted to a kind of small barrel, set in motion by a lathe. The motion once given, the workman takes the object which he wishes to engrave, and following the outlines of the pattern he leans more or less hard upon the point of the pin, according as he wishes the engraving to be more or less deep.

The difficulties of this process, which, as one may easily believe, require great lightness of touch in combination with great practice, can only be appreciated when one examines carefully those works on which the artist has been able to engrave, with great delicacy and in a small space, the most complicated landscapes and other subjects.

We may quote what M. Labarte says on this subject:

"About the commencement of the seventeenth century there had been sent forth from certain manufactories of Bohemia vases of a correct form, and enriched with ornaments, with subjects, and above all with engraved portraits.

"Distinguished artists in Germany and Italy were employed, notwithstanding the fragility of the material, in decorating these vases, in imitation of those in rock crystal, with arabesques, and with subjects in intaglio, remarkable for their composition, the purity of the design, and the finish of the execution. These pretty engravings would often have merited being fixed upon a subject less fragile."

While perfectly agreeing with what is here stated respecting the beauty of these designs, we must own that there is a certain degree of monotony in them. . . . We have seen that with regard to cut glass, industry has discovered a process of popularizing them by means of a preliminary blowing; well, engraved glass has also its imitation, and the process employed is thus described by M. Peligot:

"For the purpose of engraving on glass, fluorhydric acid, either in the gaseous or the liquid state. It is perhaps preferable to employ it in the last named form.

"The fluorhydric acid is prepared by the ordinary processes, by leaden retort, a portion of powdered flowers of calcium, and three portions and a half of concentrated sulphuric acid. The acid is mixed with half or a third part of its own weight in water, and is kept in a bottle made of lead, or still better, of gutta percha. The glass is coated with a varnish of wax and turpentine, applied hot with the aid of a brush. For designs intended to be especially fine, siccative oil of linseed is employed.

"The design is traced out with a point, as with engravings, in aquafortis. The transparence of the linseed oil varnish renders it easy to reverse the tracing. The portion that has been varnished is then surrounded by a waxed pad, and the acid is caused to bite the glass for a longer or shorter time, according to the depth of the intaglio. It is then washed, first with water, and then with essence or with alcohol, to remove the varnish.

"Of course the glass is only attacked in the portions which have been laid open by the graving tool."

As it is quite impossible, however carefully this chemical process may be performed, for *every* part into which the acid has bitten to have the neatness and perfect finish which can alone be imparted by the point of the tool, it will always be easy to distinguish the results of hand labor from those articles which are thrown off by machinery.—*London Pottery Gazette.*

SOME interesting facts concerning the disturbing effects of earthquakes on the working of the telephone are reported by Mr. Weaver, superintendent of the Oriental Telephone Company at Singapore. During the recent earthquake at Java and the eruption of the volcano at Krakatoa, it was found impossible to work the telephone lines at Singapore, in consequence of a roaring sound in the receivers, which drowned the voice. On the line between Singapore and Ishore, a part of which consisted of a cable about a mile long, occasional reports resembling a pistol shot were heard as well as the roaring sound. The volcano Krakatoa is situated on the island of the same name, about 500 miles south of Sumatra. The noises in question were heard during the eruption of the 27th of August last. They were probably due to disturbances in the terrestrial magnetic field brought about in some way by the volcanic action.

AN exchange prints a long article telling us how the men in tropical countries raise the banana. This may be true in the tropical countries aforesaid, but here, where we occasionally have a "cold day" (which may, perhaps, account for it), we incline to the belief that the banana oftener "razes" the man. Any how our own experience on divers occasions would seem to indicate this to be the case.

IF a printer sets up 12,000 letters a day, works 300 days in a year, and the distance from the case to the stick be taken at one foot, his hand will travel about 1,364 miles each year. This calculation makes no allowance for his reaching after missiles to throw at his "devil," which would probably bring the above distance up to 10,000 miles at least.

Locks and Keys.

At a recent meeting of the Society of Antiquaries, Colonel Fox Rivers gave a *viva voce* description of a wondrous collection of locks and keys of all ages and from all countries which occupied the table in the center of the hall, while the walls were covered with drawings illustrative of the principle on which the locks themselves were constructed, and the keys used to open them. Without following Colonel Fox Rivers's vivid description, it is interesting to trace the growth of these door-fastenings and treasure-keepers. The inventive Chinese had almost constructed a Bramah lock when Egypt herself was young, and the keys found in our tumuli and tombs show how much ingenuity was expended in the construction of these supposed safeguards in all ages. The rude savage was contented, in all probability, with a combination of knots, and, indeed, Captain Galton, in his "Art of Travel," laments the want of some form of knot which would, while holding tight the stores, show whether they had been tampered with or not—thus asking for a Chubb's detector lock or sinew or string in the bush or the desert,—but such a series of knots does exist, and possibly a native guide or attendant would fail to untie the famous knot which so puzzles ingenious monkeys. Alexander found it easier to cut than to untie the famous Gordian knot, and many primitive locks in use, even in the British Isles, depend on a combination of string and wood, which suffice to keep out cattle, if not burglars. It is to guard against the latter that modern ingenuity has been so freely expended, and it would appear really as if the latest Yale lock was only a modification of the well known Egyptian model of some thousand years ago, and there are in existence examples of locks on the Egyptian model which have survived, and are found to answer their purpose even at the present time, and it has been suggested that with a slight modification, this could be used with advantage to "lock" pictures on gallery walls, so that they could be removed, in case of fire, easily and rapidly. This lock was obviously invented to secure a bar of some size, and has since been used on a much smaller scale.

Some of the earliest and most perfect specimens of locks which have come down to us are padlocks and fetter locks, some apparently, only adapted to fasten the girdle of a lady, while others are ponderous enough for the heaviest chest. Examples of these are in every museum of importance. They have been found in London, in Colchester, and in Silchester, as well as in many other Roman sites in England. Some of these might be copied with advantage by our metal workers at a time when cheapness of production is not the rule, as at Willenhall, where good locks can be made and sold at a profit at a few half-pence a dozen. When some of the examples shown by Colonel Fox Rivers come to be more generally known, it is possible that there may be some principle which even our acute lock-makers have failed to discover. It is well known that Bramah believed his famous lock to be unpickable, because he could not pick it himself, and this has been the case with other inventors, though perhaps the triumph of Hobbes, in 1851, in proving that the champion lock was pickable, excited the most attention; but we shall not in our desire for small keys, imitate the lock which required a species of sickle to open it, for this key has to be carried over the shoulder, like the Egyptian keys which are mentioned in Isaiah, and figured in the great temple of Karnac, in use at the present day. These sickle-like keys could only be used to move a bolt on a large gate, and when, as in many modern instances, the bar was hung in an iron frame and suspended in the center by a chain, a smaller key was required to open it, and thus gave rise to those ring keys described by Tacitus, and which answered the purposes of a signet ring as well as a key. Many of the wards of these Roman keys are so much like the ordinary flat or French latch-key in common use a generation ago as to suggest a doubt as to their antiquity. The curious implements found in Anglo-Saxon graves, and which are supposed to be keys, from their being fastened together by a ring and slung at the girdle, are, as a rule, but rude pieces of bronze without a pretence to the formation of a ward, and in this particular only do they resemble the keys of the Yale locks of to-day. They could only be used to raise the rudest form of latch.

Among the locks which seem to have been most popular, and which are indeed the most curious, are what are known as "puzzle locks." They are found in the shape of a bird, as in India. They are hidden in the interlaced bolt-and-belt ornamentation of an Elizabethan linen chest, or in the form of a "letter" lock, and then they are independent of a key. The former depend on a secret spring moving the escutcheon; the latter on a certain combination of words, which require to be remembered accurately by the person using the lock, or it becomes useless to him. Some of the more modern letter locks are very ingenious,—in fact, more ingenious than secure. A couple of centuries ago they were far more popular than they are now, and in the time of our grandfathers, and even later, these secret springs and hidden mechanism were freely used by the novelists of the Mrs. Radcliffe school. They are immortalized in Beaumont and Fletcher's play of "Noble Gentleman," where we find—

> "A cap case for your linen and your plate,
> With a strange lock that opens with A M E N."

It is a somewhat singular circumstance that the best of our modern safes have locks which closely follow the secret apparatus described by the Marquis of Worcester in his "Century of Inventions." He describes a little key, not weighing more than a shilling, which shall be capable and strong enough to bolt and unbolt "round about a great chest, an hundred bolts, through fifty staples, two in each, with a direct contrary motion, and as many more from both sides and ends, and at the same time shall fasten it to the place beyond man's natural strength to take it away." He also describes a curious escutcheon, and it was for the invention of "secret apparatus" of this kind that the Society of Arts awarded one of their first premiums to Mr. Marshall, shortly after the commencement of their Transactions, in 1784.

That there were warded keys and locks from Roman times is indisputable, and they were excellently made by the early English metal workers. No one suspected their weakness until a century ago, and then their unreliability was proved by the easiness with which which they were picked by the simplest novice in housebreaking. In vain were back springs invented and French tumbler locks introduced. A simple piece of twisted steel sufficed to open them all. The ponderous wooden and iron contrivances which had been trusted as locks should be trusted if they are reliable, were found to be of little worth. The tumbler locks of Barron and of Bramah, patented as far back as 1778 and 1784, respectively, head a long list of inventors of many tumbler and wheel locks. There have been locks with master keys invented, and changeable key-locks invented for doors of safes and other receptacles for valuables. These hardly came within the cognizance of the Society of Antiquities. They belong rather to the domain of the mechanical engineer. Many of the latter are nearly perfect specimens of simplicity and security, with keys which, if not so light as those mentioned by the Marquis of Worcester, are at least sufficiently portable to be carried in the waistcoat pocket. There are specimens of many of these ancient locks in South Kensington and in the British Museum, with keys remarkable for beauty of design as well as workmanship, showing, if another instance were needed, how well beauty can be combined with utility.—*Iron Age.*

From the tone of the daily and even the scientific press in this country, one would infer that the principle of compounding, as applied to locomotives, was something new. Compound locomotives have been in use on some European railways for years, and have given perfect satisfaction, and demonstrated the fact that a saving of fuel from 12 to 20 per cent. results from their use.

How to Boil Linseed Oil.

First be sure that you have the pure linseed oil. There is much sold as such manufactured out of peanuts. The test is simple. Nut oil has a sharp, acid taste, smells just like sour peanuts, is darker and thicker than the other oil, has a clinging tendency when rubbed on the finger, dries with a gloss even in priming coats, and is very much given to gumming up when sanded. Pure linseed oil has a bright amber color, runs freely, sparkles when flowing from the can, tastes smooth and mild, and has the smell of a flaxseed poultice. When you are satisfied you have the genuine oil, and wish to boil it thoroughly, first take, say about ½ lb. of red lead and the same quantity of sugar of lead, put into 5 gallons of the oil, and place over a slow fire, so as to boil evenly. Do not let your fire get either too hot or too low; keep an even temperature, if possible; coke or charcoal is preferable to either hard or soft stone coal. Avoid a wood fire, as, after the oil gets to boiling heat, a sudden flame shooting up might ignite the entire lot. Let it boil seven hours full; the red lead and sugar of lead will then become dark-brown. Stir all the time while boiling slowly, and only one way; do not change the direction of the stroke, or you will burn the oil, just as you would starch. After you have taken it from the fire cover it up and let it stand to cool off, say over night. The sediment will settle; pour out the oil and strain; your oil is boiled, and a better article you could not have, as all the fatty substances are destroyed. This is the English method, used in all the carriage factories in the United Kingdom.—*U. S. Carriage Monthly*

Improvement in the Blue Printing Process.

An improvement has recently been made in this very convenient process for producing copies of drawings in white lines on a blue ground by Messrs. Schleicher and Schull, of Duren, Rhenish Prussia. These enterprising paper manufacturers have introduced a continuous transparent drawing parchment in rolls forty inches wide, and at a very reasonable cost, which is sufficiently transparent to be used in place of the usual tracing, and is still an excellent drawing paper, with a very fine surface, takes pencil and ink well and will allow lines in pencil to be rubbed out or ink lines to be either scraped out or washed off the surface. It is, moreover, exceeding tough and well suited for small scale drawings. The instructions for producing blue prints supplied by the above mentioned firm are as follows:

Ammonia citrate of iron, ...	2 lb. 5½ oz. avoir.
Red prussiate of potash, ...	1 " 9 " "

Dissolve separately in water, mix, and make the whole up to one gallon, this solution to be kept carefully from light. Ordinary paper upon which the copy is to be produced is then well brushed over with the solution in a dark room and there left to dry. The drawing on transparent parchment, or a tracing, is then placed in a copying frame with its face to the glass, a piece of ferroprussiate paper is placed behind, and the frame closed, taken out of the dark room and exposed to the sunlight. The yellowish green color of the prepared paper changes through bluish green and bluish gray tints into an olive green with metallic reflections; at this stage the process must be interrupted, the frame taken back to the dark room and opened, the drawing washed in cold rain water until the lines are pure white on blue ground, when it can be dried between blotting paper. To be able to watch the progress of the process better it is advisable to leave the ferro-prussiate paper longer than the frame; the exposure varies with the intensity of the light from five to thirty minutes; the correct time is soon learned by experience.—*Van Nostrand's.*

Electric Tram-Cars at Paris.

Engineering says: Some authentic facts have now been published about the recent trials of tram-cars driven by storage batteries in Paris. M. E. Rouby, engineer of arts and manufactures, has furnished the data which we are about to give. The car propelled is of the large size, constructed by the Compagnie Générale des Omnibus de Paris. It carries fifty-two passengers, and was built for horse traction. M. Raffard, the engineer who had charge of the experiments, fixed the dynamo or motor (a Siemens D_2 type) under the floor of the car near the platform. This dynamo received the current from eighty accumulators placed under the seats of the car. From this dynamo a belt and pulley, with differential movement, controlled an intermediate shaft, which carried two pinions gearing with chains and toothed crowns carried by the wheels of the car. On June 24th a car with thirty passengers left the Place de la Nation at 4 A. M., and arrived at La Muette, near the gates of the Bois de Bologne viâ the external Boulevards, at 5.20 A. M. After half an hour's halt, it returned to La Nation by 7 A. M., having accomplished $19\frac{7}{8}$ miles with a mean speed of $6\frac{83}{100}$ to $7\frac{45}{100}$ miles per hour. The total weight of the car, with the eighty accumulators of 66 pounds each, was about 9 tons. The mean current was 35 ampères at 160 volts E. M. F. The electric work furnished to the dynamo was, therefore, $\frac{35 \times 160}{746} =$ (about) 7 horse-power, during $2\frac{1}{2}$ hours, and the accumulators were still unexhausted. In the second experiment at the Champs Elysées, the car went indifferently on the rails or unmacadamized road.

A Snake with Two Feet.

Richard Decker, a resident of Wallkill Valley, while working in his oat field recently, was surprised by a black snake, which came at him with open mouth, its head elevated from the ground twelve or fourteen inches. He succeeded in killing it with his pitchfork, and in measurement found it to be 5 feet 7 inches in length, with a diameter of an inch and a half at the largest part. The extraordinary feature of the creature, however, was the presence of two well-formed legs with feet, attached to the body at a point about 12 inches from its tail. The legs were of a bright pink or flesh color, without bone, and so elastic that when drawn to their full length and suddenly released they would spring back to their normal position at the reptile's side. The feet were about the size of a hazel nut, and were hoof-like in appearance and of a darker color than the limbs to which they were attached. Upon each one of these feet or hoofs were 63 small claws, white and of a horny substance. The body of the snake, with the legs attached, was seen by most of the inhabitants of the village before it was put into alcohol and forwarded to the National Museum at Washington.—*Port Jervis Gazette.*

It is said that cast iron pulleys may be lagged or faced with leather without the use of rivets, in the following manner: First brush over the face of the pulley with acetic acid, which will in a short time rust it, and give it a very rough surface; then attach the leather to the face of the pulley with a cement composed of one pound fish glue and one-half pound common glue, cooked in alcohol and water. This would seem to be worth trying, at least.

Why they Left the Mormons.

Two dust-covered horses, a covered wagon with a man and woman, and a long rope to which was attached an aged yellow dog, appeared on the streets here yesterday. The man was dark and swarth, with a white beard and long hair. The woman was dressed in a faded calico, her skin was as dark as her husband's, and her face covered with wrinkles.

"My name is Sarah Stafford, and this is my husband, Timothy Stafford," said she. "We live, or at least we used to, twenty-eight miles from Portland. For four years we've been galavantin' out west, and are now on our way home, thankful that our lives are preserved.

"We don't look like Mormons, do we? Well, we ain't Mormons any more, but we once were. One day while Timothy was cuttin' grass, a leanish man with an awful oily tongue came along and asked him to join the Mormons. Now, so far as I was concerned, I hated Mormons wus than pizen, but when the man talked so good and kind-like to me, and called me his dear Sister Stafford, I sorter warmed up to him. Well, to make a long story short, Timothy and I were persuaded to sell our farm and go to Utah. After we'd been there a while, along comes a squad of the deacons, who looked pious and resigned-like, and said that Timothy ought to take another wife, a young woman who could be a daughter to me and comfort my declining years. Well, sir, if they'd shot me down there I couldn' have been more surprised. After I had collected my thoughts a little bit I went into the kitchen and got a pot of bilin' water, and then I sailed into them deacons. Scatter? You better believe they did. I thought they'd break their pious necks tryin' to get over the fence. The gate was too small for 'em, and they went down the road like a hurricane. I picked up a rake and went after 'em, and if I didn't baste the hindermost, my name ain't Sarah Stafford. I'll warrant there wasn't two inches of sound hide left on him. When I got back to the house, I found Timothy in a terrible rage. He said I didn't have his pleasure or comfort at heart, and that I didn't love him like I used to in Maine. He even told me I was a-getting too old for him, and he ought to have a young wife if he was going to be a highcockalorum in the church. Well, sir, when he told me that I used the rake on him. Then I took him by the hand and left the country. We walked until mornin', and put up at a farm-house. I bought them horses and that wagon of the farmer, and kivered the wagon myself with cloth. Since then we've been travelin' toward Maine as fast as the critters will carry us, and when we get there we'll never leave again until they carry us out feet first. So there, young man, is our story. It's as true as gospel, and if it'll teach any old folks in this country to stay at home, mind their business and let the Mormons alone, you can print it in your paper, although I'd awfully hate my old neighbors down in Maine to see it."—*A Cleveland Letter.*

The oldest man in the world has been discovered. He lives in Russia. His name is Savtchuk, and he is 130 years old and enjoys perfect health, but it is said that his hair has a greenish tinge. He has a son who is 87 years old, but who is feebler than his father. The village where he resides now contains 120 houses. Savtchuk himself built the first house in the village many years ago. All of the inhabitants of the village are direct descendants of the first two settlers. The tribe is composed of fifty families who, it is asserted, live peaceably and never go to law. This seems incredible.

The Locomotive.

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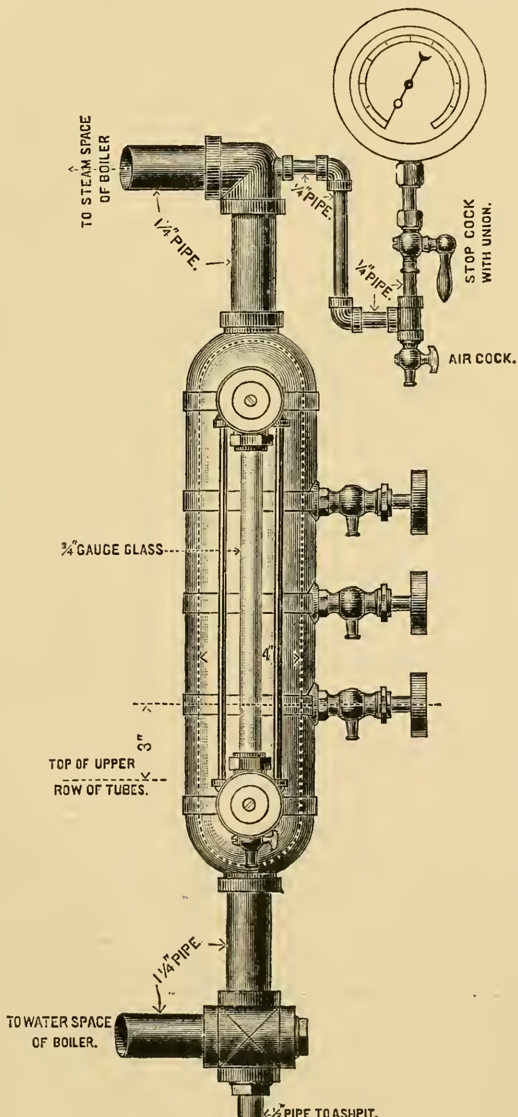
New Series—Vol. IV. HARTFORD, CONN., DECEMBER, 1883. No. 12.

About Water-Gauge Connections.

We give in this ing what we have perience to be the arrangement for "combinations,"as called, for the or- tubular boiler. column is round. is to be preferred easiest to make, est, and altogether form that can be believe in fancy, paneled shapes for cost more, are spite of attempted pend to a great for their good form is better purpose, and in ters,as in the works adapted to the give a better ef- superficial orna-

The diameter of side is four inches insures an ample also leaves a good to deposit in with- connections, or the column itself, pens. The thick- the column should three-eighths of half inch is to be ter thickness will strength, and a than the former. nections to boiler fourth inches.



issue a cut show- found by long ex- most satisfactory water columns, or they are usually dinary horizontal

The body of the The round form because it is the cheapest, streng- the best looking made. We do not square, fluted, or this purpose. They weaker, and in ornamentation,de- extent upon paint looks. The round adapted for this mechanical mat- of nature, forms purpose intended fect than mere mentation. the chamber in- in the clear. This body of water, and space for sediment out choking up the even the body of as sometimes hap- ness of the shell of not be less than an inch, and one- preferred. The lat- insure ample sounder casting

The size of con- is one and one- Experience has shown that this is the smallest size that should be used for this purpose. The usual practice of using one-half or three-quarter-inch pipes for these connections cannot be too strongly condemned. There is always more or less trouble resulting from these small pipes becoming foul with scale or sediment, with anything but the very purest water. It is better to avoid the possibility of trouble by making the pipes of ample size to begin with. Even when one and one-quarter-inch pipes are used, it is always better to connect the nipple at the lower end of the column with the pipe entering the water-room of the boiler, by means of a cross, instead of the usual T, so that by simply removing the plug the pipe may be thoroughly cleaned out. Where the pipe turns in the smoke connection to enter the tube-sheet, a T should be used with the outlet looking out, and plugged. By removing these plugs the entire length of the pipe may be thoroughly scraped out without disconnecting a pipe or breaking a single joint.

A half-inch pipe should be led from the lower outlet of the cross, as shown in the cut, to the ash-pit. This pipe should be provided with a valve a few inches below the cross, by opening which, all sediment may be blown out of the water column. By leading this pipe into the ash-pit we can not only blow out the column without filling the boiler-room with steam, but we have also a convenient means of filling the water cavity in the ash-pit with water. The extent to which this pipe will naturally be used for this purpose, will be sufficient, under ordinary circumstances, to keep the connections to water column thoroughly cleaned out.

A three-quarter-inch gauge-glass should always be used. For a boiler five feet in diameter this should be twelve inches long, and the gauge-cocks may be four inches apart from center to center. For smaller boilers the glass may be somewhat shorter, and the cocks may be say three, or three and one-half inches apart. For all sizes of boilers the lower cock should set three inches above the top of the upper row of tubes. Then, when two gauges of water are carried, there will be a depth of six to eight inches over the tubes. The boiler should be set one inch lower at the back end than at the front, so that all water will be drained out of it when the blow-off valve is opened.

Some engineers object to the lower connection to water column being made so far below the top of tubes as that shown in the cut, for the reason that if a gauge-glass breaks during the night, or when no one is about, the boiler will be more quickly emptied of water than it would be if the lower connection were above the tubes. This objection has little force, for we do not think many engineers are foolish enough to leave a boiler over night, or even for an hour, without shutting off the connection to the glass by means of the small valves always provided for that purpose. A great risk is incurred, whatever the position of the connection, if this precaution is neglected.

Inspectors' Reports.

OCTOBER, 1883.

The number of visits of inspection made during the month of October last foots up 2,452; the total number of boilers examined was 5,445; the number examined both externally and internally was 2,107; the number tested by hydrostatic pressure was 420, and the number condemned was 58.

The total number of defects reported was 4,042, of which 559 were dangerous. The usual analysis of defects is appended:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	346	28
Cases of incrustation and scale,	527	37
Cases of internal grooving,	18	8

Cases of internal corrosion,	130	-	26
Cases of external corrosion,	208	-	49
Broken and loose braces and stays,	61	-	30
Defective settings,	108	-	5
Furnaces out of shape,	83	-	25
Fractured plates,	147	-	67
Burned plates,	101	-	49
Blistered plates,	253	-	27
Cases of defective riveting,	749	-	39
Defective heads,	26	-	7
Leaky tubes,	581	-	50
Leaky seams,	287	-	40
Water-gauges defective,	90	-	7
Blow-out defective,	36	-	8
Cases of deficiency of water,	16	-	6
Safety-valves overloaded,	19	-	3
Safety-valves defective in construction,	32	-	15
Pressure-gauges defective,	223	-	32
Boilers without pressure-gauges,	1	-	1
Total,	4,042	-	559

Defective safety-valves are much more frequently met with than is at all desirable. And by this we mean those that are constructed or connected in such a manner as to either partially or wholly defeat the purpose for which they are intended, that is, prevent the accumulation of an undue pressure of steam in the boiler. This is quite distinct from *overloading* of safety-valves, which is usually done intentionally to obtain a greater steam pressure.

Safety-valves may be defective in various ways. They may be too small to serve the purpose intended. This often occurs where one safety-valve is made to do duty for several boilers, being attached to a drum which is connected to all the boilers, though quite frequently boilers are furnished separately with safety-valves much too small for them. In such cases the only remedy is, of course, to provide larger valves. Then valves may be designed and constructed in such a manner that they are in a chronic state of leakage. While a leak is not a dangerous thing in itself, yet it is a very wasteful one, and is very apt to tempt the engineer or fireman to overload the valve to stop the leak, and this is a dangerous practice. When a safety-valve shows signs of leakage, the only thing to be done or the only thing which ever *should* be done is to grind it until it is tight.

But safety-valves are oftener spoiled in putting up than in any other way. Just let the average steam-fitter alone, and he will be tolerably certain to botch a job when he comes to the safety-valves. One of the favorite methods of doing this is to put a stop-valve between the safety-valve and the boiler. There should be a statute law against this practice in every state in the Union, and it should be enforced with a good hard club in the hands of one who knows how to use it. Another way is to attach a small escape pipe to the outlet of the valve. This is bad enough when the pipe is short and straight, but it is generally furnished with several elbows, and pitched *up* from the valve. This allows the pipe to fill with water, and if any considerable portion of the pipe is exposed to the atmosphere, it will freeze in the winter, and the valve will then be perfectly useless. Several explosions have occurred from this cause alone.

Another method, which is practiced by some steam-fitters, is to run the escape pipes from the safety-valves directly into the flue leading to chimney. The reason given for doing this is, that the steam blowing into the flue acts as a steam jet and improves the draft, though why the draft should be improved when the boiler is blowing off steam, passes ordinary comprehension.

Safety-valves should be made of ample dimensions, which practice has proved to be necessary; they should be attached to the boiler by an independent nozzle; no escape pipe is needed in nine cases out of ten; the lever should always be cut off at the point where the ball or weight gives the maximum pressure allowed, so that any overloading will necessarily be in the nature of extra weights, and may be readily detected, and the valve and its seat should be kept tight and in good order. The valve should be of such size that the pressure at which the valve lifts should not be exceeded by much more than five pounds, even if the fires are forced.

BOILER EXPLOSIONS.

OCTOBER, 1883.

SAW-MILL (137.)—A boiler in the saw-mill of J. H. Moody, Salida, Colo., exploded October 1st, killing the proprietor. Several persons had narrow escapes.

STEAMER (138.)—October 3d, as the harbor tow-boat, William Wagoner, was coming up the Ohio river, light, at the head of Brunot's island, the boiler exploded, fortunately without injuring any one. The captain, who was seen at the inspector's office, where he was making a statement, says that "the boat was coming up the river without a tow, when the boiler gave way; not exactly an explosion, but more of a rupture; that it was simply laid open, the force of the steam blowing the fire brick away and doing no other damage." He can give no theory for the cause of the accident.

NAIL MILL (139.)—A boiler in the Belmont nail mill, Wheeling, W. Va., exploded October 6th, with no fatal results to employees, but doing considerable damage to mill property.

SAW-MILL (140.)—The steam mill of Charles Mears, at Little Point, Au Sable, Mich., burned October 8th. The boiler exploded while a tramway was being torn down to aid in extinguishing the fire and to save some lumber piles. One fragment of the boiler killed a horse, another knocked John Odell insensible, and a third, which was about eight feet long, struck a barn thirty rods distant. Joseph Murray was severely injured in the side and leg, and others were more or less hurt.

LOCOMOTIVE (141.)—A shifting engine on the Georgia Central Railroad exploded Oct. 10th. W. C. Starr, the engineer, and Thomas Watkins, the fireman, were probably fatally scalded.

LOCOMOTIVE (142.)—The boiler of a Grand Trunk freight locomotive exploded at Yarmouth, Me., Oct. 15th, carrying the whole top, weighing over a ton, a quarter of a mile. Engineer Pierson was slightly injured. The fireman was hurled out of the tender, but was not much hurt.

LOCOMOTIVE (143.)—As a Central Iowa freight train was on the grade, four miles north of Oskaloosa, Iowa, Oct. 16th, the boiler of the engine exploded, causing a bad wreck, nineteen cars being piled up in a space of one hundred and forty feet. The engineer, Edward Bayley, was instantly killed, and fireman Charles and brakemen Elmer and Blanchard, were probably fatally injured. The boiler was carried forward one hundred and fifty feet, and the wreckage was piled up thirty feet in height.

Saw-Mill (144.)—On October 20th a boiler exploded in the sash, door, and blind factory of Ross Brothers, at Grand Haven, Mich., wrecking a three-story building, demolishing a residence, damaging a machine shop and other buildings, killing one man and wounding several other persons. H. A. Beckwith, who was running a planer, was the unfortunate one who perished. John Alsup, Thomas McClelland, Burr Ross, and A. W. Comstock, were injured in various ways and degrees of severity. The loss was $10,000. A high wind was blowing, and it was with great difficulty that a severe conflagration was suppressed.

Saw-Mill (145.)—A twenty-horse power boiler in the planing mill of John Loomis of Brooklyn, N. Y., exploded Oct. 21st, and killed Nicholas Lick, watchman. The portion of the building in which the boiler stood was wrecked. One section of the boiler was found three hundred yards distant, and another, weighing four hundred pounds, was found in a tool shop a block distant.

Saw-Mill (146.)—A ten-horse threshing-machine boiler, which was running a mulay saw in Asa Jones' mill, at Cadott, Wis., exploded October 23d. No one was hurt, but the building was wrecked, and a great havoc created among the neighboring trees.

Pump Factory (147.)—A boiler exploded in the pump factory at Bellpre, Ohio, Oct. 23d, and nine persons were injured, four of whom will probably die. O. Lagrange died in an hour. Charles Cranston, James Hutchinson, George Gurlosh, Frank Brookhard, and Will Howard were severely burned. George Miller had his leg broken in two places.

Saw-Mill (148.)—The saw-mill of Bliss, Brown & Co., East Saginaw, Mich., together with two salt blocks, one thousand barrels of salt, and two drill houses, burned October 24th. The origin of the fire is unknown. After it started a nest of seven boilers exploded, but no one was injured. The loss was $60,000, and the insurance was $43,000.

Steam Tug (149.)—Sunday afternoon, Oct. 28th, the steam tug Edie exploded her boiler four miles south of Fort Morgan, Mobile Bay. The boat sank immediately with Captain John Carney, Mate Andrews, and a colored fireman. The engineer and cook were picked up, but the latter died while on his way to Fort Morgan. The former was painfully wounded.

Shoe Shop (150.)—The boiler of a gilding machine in John Baker's boot factory, Holliston, Mass., exploded with terrific force Oct. 31st, severely scalding Mrs. Ella Hart, an operative, and damaging the building.

Creosoting Works (151.)—One of the boilers of the Old Dominion creosoting works, near Norfolk, Va., exploded Oct. 31st, and, setting fire to one thousand barrels of oil, caused the total destruction of the works, together with a large stock of lumber on hand for impregnating. The loss is about $75,000. The explosion was fearful, some of the cylinders weighing ten tons being hurled a quarter of a mile away.

The two following, which occurred in March last, have just been brought to our notice:

Saw-Mill (152.)—A portable saw-mill, belonging to R. F. Alexander, exploded near Watertown, Washington county, Ohio, March 14th, and severely wounded several persons.

Lead Works (153.)—The boiler in Fahnestock's white lead works burst March 20th, but as there was only a small amount of steam on, the damage was slight; had it occurred about eight hours earlier, the whole building would have been blown up.

The Locomotive.

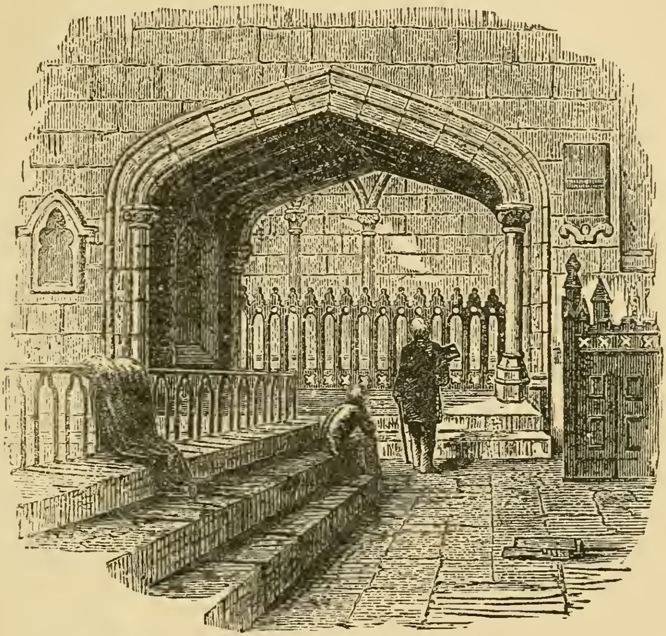
HARTFORD, DECEMBER, 1883.

THE last month of the year is here, and its affairs must soon be wound up and the balance struck. On the whole there has been a fair measure of prosperity during the year. It is true that some interests have suffered from over-production in the great manufacturing centers of the country, and no doubt the discussion of the tariff question has very much disturbed business channels. It may be next to impossible to do it, but if a fair and reasonable tariff could be agreed upon, and have it understood that there was some certainty in regard to its permanence, and that it was not to be disturbed at every presidential election, business would soon accommodate itself to the conditions, and experience less fluctuation and disturbance. It is true that a well regulated tariff will in no way avoid the results of bad management in business. If expansion and production are far in excess of the demand, there must sooner or later be a crash. But when a manufacturer has planned his business for the future on present conditions of supply and demand, and tariff as well, and finds in a short time that the conditions are, prospectively at least, entirely changed by the speeches and newspaper articles *pro* and *con* during a presidential campaign, he finds it necessary to protect his own interests by cutting down here and there so as to be ready to meet the storm if it comes, and in this respect an uncertainty is nearly equivalent to the realization of one's fears. It results in reduction of working hours, or wages, and in many cases brings about strikes with all their evil consequences. It is a singular fact that many of the men who speak and write fluently on the subject of free trade are men who never earned a dollar in their lives in any of the great departments of manufacturing. They know little of the care and anxiety which their theories create for the manufacturer who has thousands at stake and hundreds of men and women in his employ. Let them but step into his shoes for a few days, when business is greatly disturbed by such agitation, and they would soon find themselves in the midst of an experience and worry that had never fallen to their lot before. Another point. We find many professors in our colleges who are mere theorists, but the outcome of whose teachings from a practical standpoint would close up most of our manufacturing establishments. Now, when these professors seek endowments for their colleges, to whom do they go for the money? Is it not to the rich men who have made their money in some one of the departments of manufacturing or in a business that is largely dependent thereon? The manufacturing, railroading, and mercantile interests are all dependent upon each other, and largely upon these depends the value of the agricultural interests of the country. Hence, the discussion of all the questions affecting the vital, material interests of our great country should be intelligently and calmly done. Party politics should have no influence in such important matters, nor should such questions be settled on mere theories. The practical side should receive the fullest consideration, and such a result be attained as will insure some degree of permanency, and re-establish confidence.

A FIRM of boiler-makers in Birmingham, England, have arranged an electric light apparatus for lighting up the interior of steam boilers while they are under steam. It is said to work successfully, and we see no reason why such apparatus would not be very useful. Certainly, valuable information regarding the influence of different methods of construction upon the very important subject of circulation might be obtained in this manner, which cannot be gotten at in any other way.

The Tomb of James Watt.

We are indebted to the editor of "*Steam*," an enterprising paper published in Chicago, for the cut illustrating The Tomb of James Watt. He was buried in Handsworth Church, England.



INSCRIPTION:

NOT TO PERPETUATE A NAME,

WHICH MUST ENDURE WHILE THE PEACEFUL ARTS FLOURISH,

BUT TO SHOW

THAT MANKIND HAVE LEARNED TO HONOR THOSE WHO BEST DESERVE

THEIR GRATITUDE,

THE KING,

HIS MINISTERS AND MANY OF THE NOBLES AND COMMONERS OF THE

REALM, RAISED THIS MONUMENT TO

JAMES WATT,

WHO, DIRECTING THE FORCE OF AN ORIGINAL GENIUS,

EARLY EXERCISED IN PHILOSOPHICAL RESEARCH,

TO THE IMPROVEMENT OF

THE STEAM ENGINE.

ENLARGED THE RESOURCES OF HIS COUNTRY; INCREASED THE POWER

OF MAN, AND ROSE TO AN EMINENT PLACE

AMONG THE MOST ILLUSTRIOUS FOLLOWERS OF SCIENCE AND

THE REAL BENEFACTORS OF THE WORLD.

BORN AT GREENOCK, MDCCXXXVI.

DIED AT HEATHFIELD, IN STAFFORDSHIRE, MDCCCXIX.

Notes on Mill Shafting.

The determination of the proper size for a shaft to transmit any required power at any given speed is a very simple matter if it is to be subjected to torsion or twisting only. But generally, shafts are also subjected to transverse or bending stresses, due to the weight of pulleys and gears, the pull of belts, etc., which complicates the problem greatly. In fixing the size of a shaft we must therefore consider all of these conditions if we would make sure that our shaft is strong enough to resist twisting of, stiff enough to prevent undue deflection, while at the same time it shall be no larger than is really necessary, for this means increased first cost, and increased expense of running and maintenance. In calculating the size of shafts it is best to compute the diameter required to resist torsional stress first, then make the proper allowance for bending stresses. We must take into consideration the character of the load to be driven, as whether it is steady or variable; if variable, whether the variations are great or sudden, etc., from which it may rightly be inferred that considerable practical experience (the more the better) is essential in properly proportioning shafts.

The torsional strength of shafts is proportional to the cubes of their diameters. That is, suppose we have three shafts whose diameters are 1, 2, and 3 inches. Then their relative strength to resist twisting off will be as 1, 8, and 27. The reason for this is apparent when we consider that in two shafts, one of which is double the diameter of the other, the larger shaft has *four* times the sectional area of metal to resist stress, and that the aveiage distance of this metal from the center of the shaft is twice as great as in the smaller shaft. Thus its leverage to resist stress is twice as great, and four times the metal acting at double the leverage gives us eight times the strength. In the case of two shafts, one of which is three times as large as the other, we have nine times the metal we have in the smaller, and its radius of gyration, as it is called, is three times as great as in the smaller shaft; hence we have twenty-seven times the power to resist torsion; and so on for other sizes. The radius of gyration is the distance from the center of the shaft, at which, if all the metal in the shaft were collected, the strength would be the same as it is in the actual shaft. For round solid shafts it is .707 the radius of the shaft.

To find the actual strength of a solid round shaft of wrought iron we may proceed as follows: Take a piece of turned shafting just one inch in diameter, key to one end of it a strong lever, support it in suitable bearings, bring the lever into a horizontal position, secure the other end so that it cannot turn, and attach weights to the lever at a distance of one foot from the center of the shaft. If we add weights carefully we find that with wrought iron of fair quality about 800 pounds will be required to twist off this piece one inch in diameter. If we use a piece two inches in diameter, the weight required to twist it off would be 6,400 pounds, or if our lever were two feet long the weight required to twist the piece off would be 400 and 3,200 lbs. respectively.

We can now express the foregoing facts by means of a formula, as follows:

$$\frac{\text{leverage in feet} \times \text{breaking force in pounds}}{\text{cube of diameter in inches}} = 800 \quad \ldots\ldots\ldots \quad (1)$$

or, more briefly, if we represent the leverage by r,
the breaking force in pounds by w,
and the diameter in inches by d,

then $\frac{r \times w}{d^3} = 800.$

By transposing the terms of the above formula, we have

$$d^3 = \frac{r \times w}{800}, \quad \ldots\ldots\ldots \quad (2)$$

from which we can readily find the diameter of a shaft to resist any given twisting force of w pounds acting at a distance of r feet from the center of the shaft. We can assign any required factor of safety we please by simply dividing the constant 800 in formula (2) by the required factor. Thus if the factor of safety was to be 5, 8, or 10, we would use 160, 100, or 80 for the denominator in the second member of formula (2). A factor of $5\frac{1}{3}$ is used by the writer, which gives 150 for the constant. Formula (2) then becomes

$$d = \sqrt[3]{\frac{r \times w}{150}}, \quad \ldots \quad (3)$$

It is generally more usual and convenient to express the load which a line of shafting is to drive in terms of horse power. As a horse power is a certain definite amount of work, or force exerted in a given time, we can easily find an equivalent expression for $r \times w$ in the above formula (3) in terms of horse power and revolutions per minute.

Now a horse power is 33,000 pounds raised one foot high in one minute. Suppose we retain our lever one foot long on the shaft, and cause it to revolve once in one minute, then the end of the lever will describe a circle whose circumference is 6.2832 feet. Divide 33,000 by 6.2832 and we get 5252, which will be the number of pounds pull to be exerted at the end of a lever one foot long to develop one horse power when the shaft makes one turn in a minute. For we have a force of 5252 pounds exerted through a distance of 6.2832 feet, and 5252 lbs.$\times$6.2832 feet=33,000 ft. pounds; and as the time occupied was one minute, we have accomplished one horse power. If, therefore, we substitute 5252 for w in formula (3), we have

$$d = \sqrt[3]{\frac{1 \times 5252}{150}} = \sqrt[3]{35}, \quad \ldots \quad (4)$$

for the diameter of a shaft to transmit safely one horse power at a speed of one revolution per minute.

But suppose we wish to transmit more than one horse power, then we simply multiply the 35 in formula (4) by the number we wish to transmit before extracting the cube root. The formula then becomes

$$d = \sqrt[3]{35 \times h.\,p.} \quad \ldots \quad (5)$$

Then if the shaft is to make more than one revolution per minute, we can make it smaller in proportion to the increased number of revolutions. This is done by simply dividing by the number of revolutions per minute, when we have

$$d = \sqrt[3]{\frac{35 \times h.\,p.}{revs.}}, \quad \ldots \quad (6)$$

As 35 is a constant quantity, we may extract its cube root and remove it from under the radical sign, when we shall have

$$d = 3.27 \sqrt[3]{\frac{h.\,p.}{revs.}}, \quad \ldots \quad (7)$$

That is: to find the diameter of a wrought iron shaft to transmit any given load:— *Divide the number of horse power to be transmitted, by the revolutions per minute which the shaft is to make; extract the cube root of the quotient; multiply this root by* 3.27. *The product is the required diameter, for a safety factor of* $5\frac{1}{3}$.

Example. A certain line of shafting is to drive 90 horse power, and run 300 turns per minute; what should be its diameter? $90 \div 300 = .3$, the cube root of $.3 = .669$; $.669 \times 3.27 = 2\frac{3}{16}$, the required diameter.

The following table has been constructed by the writer in accordance with the foregoing principles. He has used it for several years and finds it the most convenient one he has ever seen.

$\frac{\text{H. P.}}{\text{Revs.}}$	Diam.	$\frac{\text{H. P.}}{\text{Revs.}}$	Diam.	$\frac{\text{H. P.}}{\text{Revs.}}$	Diam.
.023	$\frac{15}{16}$″	.414	$2\frac{7}{16}$″	1.746	$3\frac{15}{16}$″
.048	$1\frac{3}{16}$″	.555	$2\frac{11}{16}$″	2.499	$4\frac{7}{16}$″
.085	$1\frac{7}{16}$″	.725	$2\ \frac{5}{6}$″	3.443	$4\frac{15}{16}$″
.137	$1\frac{1}{16}$″	.926	$3\frac{3}{16}$″	4.598	$5\frac{7}{16}$″
.208	$1\frac{15}{16}$″	1.162	$3\ \frac{7}{6}$″	5.986	$5\frac{15}{16}$″
.299	$2\frac{3}{16}$″	1.434	$3\frac{11}{16}$″	7.630	$6\frac{7}{16}$″

A single example will illustrate the use of the table. How large a shaft is necessary to transmit 275 horse power at a speed of 300 revolutions per minute? 275÷300=.92. Looking in the table in the column headed $\frac{\text{H. P.}}{\text{Revs.}}$ for the nearest number to this quotient we find it to be .926, and opposite, in the column headed Diam., we find 3 $\frac{3}{6}$″, which is the required size, that is:—Divide the horse power to be driven by the revolutions per minute which the shaft is to make, look in the column headed $\frac{\text{H. P.}}{\text{Revs.}}$ for the nearest number; opposite to this number in the column headed Diam. will be found the required size.

For head length shafts, that is, the lengths which carry the main driving pulleys, and have to bear the transverse strain resulting from the pull of the main driving belts, the diameter, as computed by the above rules for torsion only, should be increased *one half.* This will give sufficient transverse strength where the distance between bearings is not much over eight feet, and also gives sufficient metal for a boss for key seat, etc.

For line shafts in cotton and woolen mills, where circumstances make it necessary to belt from near the center of a bay with a heavy belt, it may sometimes be found necessary to increase the size given by the above rule by one size or say $\frac{1}{4}$″ for the sake of stiffness. This, however, will rarely occur except in the case of the smaller sizes, and is a matter which can only be governed by the circumstances in each particular case, and must be left entirely to the judgment of the designer, when the emergency arises. It is not usual to make line shafts in such mills *less* than $1\frac{3}{4}$″ diameter.

H. F. S.

Inventor of the Bicycle.

A discussion has been going on in the pages of the *Scottish American Journal* respecting the question as to who is entitled to the honor of having invented the bicycle. In some parts of Europe the bicycle is becoming an important auxiliary of travel, and is regarded as the poor man's horse. By its aid many workmen are enabled to reside with their families in healthy rural dwellings, away from the moral and physical pestilence of the crowded cities, as they can travel cheaply and expeditiously to and from workshops and factories in the manufacturing centers. From the evidence given regarding the early history of the bicycle, there appears to be no doubt that Gavin Dalzell, of Lesmahagow, Scotland, invented and made a machine as early as 1845, which must be regarded as the prototype of the bicycle. The inventor was in the habit of riding the machine about the country, propelling it much in the same way as the bicycle is propelled to-day, and ample testimony is borne to the truth of the statement. Mr. S. W. Dalzell, assistant engineer on the Pittsburgh division of the Pennsylvania Railroad, is a son of the inventor of the bicycle, and is ready to substantiate the claims made on behalf of his father.—*American Machinist.*

The St. Gothard Railway.

From papers read by Herr E. Wendelstein, of Lucerne, before the Institution of Mechanical Engineers, and published in *Engineering*, vols. XXXV and XXXVI, we condense the following interesting facts relating to the St. Gothard Railway:

The line from Lucerne to Brunnen need not be specially described. . . . From Brunnen the line is carried parallel to the well-known piece of road called the Axenstrasse, along the eastern shore of the Bay of Uri. The limestone peaks here sink at a very high angle into the lake, and send down several torrents which, in flood-time, carry immense quantities of stone and mud. In some cases the line is taken across these torrent beds on a solidly built embankment, with a wide, open span in the center. In others it is carried under the torrent in a short tunnel. There are in all, eight tunnels between Brunnen and Flüelen, occupying $3\frac{3}{10}$ miles out of the whole distance of $6\frac{9}{10}$ miles. When in the open the line is chiefly carried on a terrace cut along the steep face of the cliffs....

From the Pfaffensprung tunnel to the north portal of the great tunnel at Göschenen there is a vertical rise of 1,080 feet in a horizontal distance of 22,000 feet. A gradient of 1 in 20 would therefore have been necessary if the railway had been taken straight up the valley ...Some artificial lengthening was therefore necessary,....and the choice therefore lay between employing zigzags, or spiral tunnels driven in the side of the valley....The spiral tunnels were, on the whole, preferred, and the first of these is the Pfaffensprung tunnel, 4,842 feet long. Above this the nature of the ground about Wasen enabled three lines to run parallel to each other for about $1\frac{2}{10}$ miles, and advantage was taken of this to construct a gigantic zigzag, of which the arms were united by curves of about 990 feet radius. As there was not room to make these curves in the open, they were constructed for the most part in tunnel. The total length of the line as laid from the Pfaffensprung tunnel to that of the great tunnel is 9.13 miles, as against 4.16 miles, the horizontal distance.

On the southern side of the great tunnel the ground was more favorable for the railway except at three points, the gorges of Stalvedro, Dazio, and Giornico, where the valley falls rapidly in a sort of step. The first of these is the shortest, and it is avoided by means of a tunnel on the right bank of the Ticino, without any special lengthening of the line. At Dazio, however, there is a fall of 525 feet in about 6,550 feet, and it was necessary to lengthen the line about 13,120 feet. The steep cliffs on each side forbade the construction of zigzags as at Wasen, and the lengthening was accomplished by two spiral tunnels, each about one mile long.

At Giornico there was a fall of 384 feet in 2,300 feet, and it was necessary to lengthen the line 13,400 feet. The line was therefore taken partly in terrace, and partly in the open, through the gorge, and just at its exit passes through two spiral tunnels in rapid succession, each about one mile long. From thence it was enabled to follow the fall of the valley to Biasca, where it loses the character of a mountain railway.

Including galleries, there are on the mountain section of the road, which is 109 miles long, fifty-one tunnels (exclusive of the great tunnel), having an aggregate length of $15\frac{1}{10}$ miles. The more important of these tunnels are the following:

Oelberg, at Brunnen, - - - - - -	length = 6,399 feet.
Monte Cenere, - - - - - - -	" = 5,490 "
Naxberg, at Göschenen, - - - - - -	" = 5,151 "
Freggia Spiral Tunnel, above Faido, - - -	" = 5,148 "
Prato Spiral Tunnel, above Faido, - - -	" = 5,385 "
Trari Spiral Tunnel, above Giornico, - - -	" = 5,076 "
Piano Tondo Spiral Tunnel, above Giornico, - -	" = 4,947 "
Pfaffensprung Spiral Tunnel, below Wasen, - -	" = 4,842 "

The length of the great tunnel, the St. Gothard Tunnel proper, is 48,885 feet, a trifle over $9\frac{1}{4}$ miles. In plan it is a straight line. The northern portal is at a height of 3,640 feet above the sea, the southern 3,760 feet. From the northern portal the line rises with a gradient of 1 in 200 to a point 25,593 feet within the tunnel, and then falls toward the southern portal with a gradient beginning with 1 in 200, then changing to 1 in 500, and ending with 1 in 1,000. It was driven without shafts from above. The time occupied was about $9\frac{1}{4}$ years of continuous labor, day and night, the work being commenced in the summer of 1872 and finished towards the end of 1881.

The motive power for driving the air-compressors at both ends of the tunnel was furnished by the streams in the neighborhood. At Airolo the only available source at first was the Tremola torrent, the supply of which sometimes fell to 200 cubic metres per second. To obtain sufficient power it was necessary to lead the water from a vertical height of 594 feet. Such a head applied to powers above 200 horse-power occasions great practical difficulties. Besides the tendency to leakage in the pipes under such great pressure,....the water has an extraordinary effect on both cast and wrought iron, and even on steel, riddling them with a number of small holes, and rendering renewal necessary every few months. This effect is supposed to be due to oxidation, stimulated by impact and by the air contained in the water.

The cost of the tunnel was, in round numbers, about 58,000,000 francs, equal to say $11,600,000, or $1,254,000 per mile.

Some general features of the construction of the line are as follows:

The gauge is normal standard of 4′ $8\frac{1}{2}$″. The maximum gradient is 1 in 37 on the the mountain section, and 1 in 100 on the valley section. The minimum radius for curves is 984 feet. The stations are so placed as to lie always on a straight portion of the track. The ballast has a thickness of $13\frac{8}{10}$ to $15\frac{8}{10}$ inches, and in the cuttings of $19\frac{7}{10}$ inches. The width at the level of the rails is $11\frac{15}{100}$ feet on the valley section, and 11 $\frac{81}{100}$ feet on the mountain section. The permanent way consists of steel rails weighing 72 lbs. per yard. The length of rails is $26\frac{1}{4}$ feet. They are fastened by dogs to sleepers $8\frac{2}{10}$ feet by $9\frac{4}{10}$ inches by $5\frac{9}{10}$ inches, and spaced 3 feet apart on the valley section, and 2′ 8″ on the mountain section. On the latter the sleepers are of oak and larch, on the former of fir and pine. On the north side they are pickled with chloride of zinc, on the south with sublimate of mercury.

The line, exclusive of the great tunnel and the valley section on the southern side, is 100 miles long, and was built within three years, inside of the estimated cost of $13,478,400.

THE habit which the editors of some so-called practical journals have of sneering at and deprecating the use of symbols for indicating mathematical operations is a very pernicious one, and is an insult to their intelligent readers. It is almost superfluous to say that any man who does not know that + means *plus*, and — means *minus*, and that $\sqrt[3]{\ }$ denotes that the cube root is to be extracted, does not know enough to perform the operations indicated, even though they be expressed in the plainest English possible. Those who do know enough to add, or subtract, and extract the cube root, know the value and convenience of the symbols denoting those operations, and the only effect any attempt to decry their use can possibly have upon their minds is to create a feeling of contempt for those who ridicule their use.

An interesting and valuable series of articles on Steam Pipe Covering, by Prof. M. Ordway of the Massachusetts Institute of Technology, has just appeared in *Cotton, Wool, and Iron.*

A Good Hotel.

The following advertisement was picked up by us several years ago while in Fort Scott, Kansas. It is printed on the back of a bill of fare, gotten up in the same burlesque style. Every paragraph is brimful of genuine humor, and contains a hit at some of the foibles of a certain class of travelers who are never satisfied with the treatment they receive. Probably every one who has been a hundred miles from home has met the traveler whose wants are so c everly anticipated here.

GULF HOUSE, FORT SCOTT, BOURBON CO., KANSAS.

BAYLES & ROBINSON, ... PROPRIETORS.

ITS ADVANTAGES.

This hotel has been built and arranged for special comfort and convenience of the traveling public.

On arrival, each guest will be asked how he likes the situation, and if he says the hotel ought to have been placed nearer the railroad depot, the location of the house will be immediately changed.

Corner front rooms, up only one flight, for each guest.

Bath, gas, water closet, hot and cold water, laundry, telegraph, fire-alarm, restaurant, bar-room, billiard tables, daily papers, *coupe*, sewing-machine, grand piano, a clergyman, and all other modern conveniences in every room.

Meals every minute, if desired, and consequently no second table.

English, French, and German dictionaries furnished every guest, to make up such a bill of fare as he may desire, without regard to bill of fare afterwards at the office.

Waiters of any nationality and color if desired. Every waiter furnished with a libretto, button-hole bouquets, full dress suits, ball tablets, and his hair parted in the middle.

Every guest will have the best seat in the dining hall, and the best waiter in the house.

Any guest not getting his breakfast red-hot, or experiencing a delay of sixteen seconds after giving his order for dinner, will please mention the fact at the manager's office, and the cooks and waiters will be blown from the mouth of the cannon in front of the hotel at once.

Children will be welcomed with delight, and are requested to bring hoop-sticks and hawkeys to bang the carved rosewood furniture, especially provided for that purpose, and peg tops to spin on the velvet carpets; they will be allowed to bang on the piano at all hours, fall down stairs, carry away desert enough for a small family in their pockets at dinner, and make themselves as disagreeable as the fondest mother can desire.

Washing allowed in rooms; ladies giving an order to "put me on a flat iron," will be put on at any hour of the day or night.

A discreet waiter, who belongs to the Masons, Odd Fellows, Sons of Malta, Knights of Pythias, K. O. M's and M. D. R's, and who was never known to tell the truth or the time of day, has been employed to carry milk punches and hot toddies to the ladies' rooms in the evening.

The office clerk has been carefully selected to please everybody, and can lead in prayer, play draw-poker, match worsteds in the village store, shake for the drinks at any hour, day or night, play billiards, a good waltzer, can dance the German, make a fourth at euchre, amuse the children, repeat the Beecher trial from memory, is a good judge of horses, as a railroad or steamboat reference is far superior to Appleton's or anybody else's guide, will flirt with any young lady, and not mind being cut to death when "Pa comes down"—don't mind being damned any more than a Connecticut river. Can room 40 people in the best room in the house when the hotel is full, attend to the annunciator and answer questions in Greek, Hebrew, Choctaw, Irish, or any other polite language, at the same moment without turning a hair.

Dogs allowed in any room in the house including the w(h)ine room. Gentlemen can drink, smoke, swear, chew, gamble, tell shady stories, stare at the new arrivals, or indulge in any other innocent amusements, common to watering places, in any other part of the hotel.

The landlord will always be happy to hear that some other hotel is "the best house in the country."

Special attention given to parties who can give information as to "how these things are done in YEWRUP."

WHAT TO DO AFTER A FIRE.—The Boston Manufacturers' Mutual Fire Insurance Company have issued the following instructions as to what to do after a fire, as well as to their liability.

First.—Take prompt measures, without waiting for the presence of the underwriters or their agents, to clean machinery and prevent rust, to sort stock and save it from damage by mildew or by heating, to protect buildings partly burned from exposure to further damage from the weather. In other words, take the same measures to save further damage as would be taken if there were no insurance upon the property.

Second.—Notify the underwriters to send their agents to the premises to assist in ascertaining the exact amount of loss.

It will be observed that damage to property by fire and water does not cause a surrender of property to the underwriters, or impose any duties upon them for its further protection, except so far as they may choose to advise. If damage is caused to property by negligence on the part of the assured, or by their not using due care and diligence in saving and protecting it after a fire occurs, such additional loss falls upon the assured, and not upon the underwriters. The contract which the underwriters enter into with the assured to indemnify them for loss by fire is in the following words, taken from the Massachusetts standard form of policy now issued by this and other companies: "Said property is insured . . . . against all loss or damage by fire, ... the amount of said loss to be estimated according to the actual value of the insured property at the time when such loss or damage happens. . . . . It is, moreover, understood that there can be no abandonment of the property insured to the company."—*Mechanics.*

MR. F. M. SHIELDS, of Cooperwood, Miss., has invented a new gun to be called the "Mississippi Sweepstakes," which is thus described: "The gun shoots four thousand balls at the explosion of one cap; it will kill eight hundred men out of a regiment of a thousand at a distance of three hundred feet; it has forty-nine barrels all combined in one, each barrel shooting one degree and twelve minutes on a horizontal plane from the others. Shooting a distance of one hundred yards, it will cover a space of one hundred yards." It is not stated whether the ammunition used is whiskey or not; we presume it is.

THE ARLBERG TUNNEL through the Alps was completed a few days ago. Its length is $6\frac{382}{1000}$ miles, and the entire work was completed in less than four years, and the actual boring in three years; which is in striking contrast to the time spent on our Hoosac Tunnel. The contract time was six years, and the contractors receive 2,000 florins or about 760 dollars for each day of time they have saved. The estimated cost was about 6,162,000 dollars. The number of men engaged on the work varied from 500 at the beginning, to 4,800 towards the close of the work.

Explaining the Sunsets.

Among the many explanations that have been offered to account for the recent remarkable sunsets, that advanced by C. E. Pickering, superintendent of Harvard observatory, and by Prof. N. S. Shaler is apparently the most plausible. Both consider that the cause lies in an unusual degree of moisture in the air. As to this Prof. Shaler says, " that during the present autumn the atmosphere was very rich in water vapor, and there had been no severe cold weather, which would cause this vapor to settle near the earth's surface. Added to this, we have just had a period of extremely warm weather, unusual at this time of the year, which would tend to vaporize the moisture in the air. The phenomenon does not come from cosmic vapor, as the clouds change their form too often for such to be the case." The displays of the past week he regards as mere accentuated forms of the ordinary sunset, which is supposed to be caused by the selective refraction of the particles of moisture contained in the atmosphere. As an evidence that there was a large amount of moisture in the atmosphere, and that this fact may have caused the sunsets, last Tuesday morning the ground and sidewalks were wet, almost as if there had been a rain. This was caused by the precipitation of the moisture in the air, and it will be remembered that the sunset on Tuesday evening was the most brilliant one of the series. In regard to the theory of zodiacal light, he stated that, had it been due to this cause, the sunset, instead of overspreading the whole horizon, would have appeared in the form of the segment of a cone. In explanation of the occurrence of the afterglow, it could be supposed that the watery vapor rose high from the earth and there caught and refracted the rays of the sun. The following law was given in regard to such phenomena. "As long as a phenomenon is only a variation in degree from similar phenomena, it can be attributed to an accentuation of causes."—*Cotton, Wool, and Iron.*

The San Francisco *Chronicle* says of hand-writing: The claim is made that, however much the letters may resemble each other to the naked eye, when examined with the microscope, they show distinct and well marked characteristics, which give to each specimen of writing an individuality as great as that possessed by the writer. Every written stroke is seen, when sufficiently magnified, to consist of a very irregular line, and this irregularity is always in a more or less marked degree characteristic of the writer. This microscopic character is supposed to be due to what are known as nerve tremors or rhythms, which all individuals possess in different forms and to different extents. All handwriting is affected by three kinds of rhythm of forms, the rhythm of progress and the rhythm of pressure. The first of these causes every line, no matter how clear and perfect it may seem to the naked eye to show a scalloped edge when sufficiently magnified. No two writers make the same kind of scallops and those made by the same writer always and under all circumstances have a sufficient resemblance to render identification possible. The rhythm of pressure causes a variation in the intensity of shading in a stroke, and shows when sufficiently enlarged, that each stroke consists of an alteration of light and dark shades. These variations in the minute character of the shading are held to be as distinctive as the other rhythms.

A correspondent of one of our exchanges proposes to change the course of cyclones by touching off a large quantity of gunpowder in its path. Naturally any cyclone bent on destroying anything would change its path after meeting with such strong competition in its own line.

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