HARTFORD STEAM BOILER ★ INSPECTION AND INSURANCE CO. ★

HARTFORD

CONN.

The Locomotive.

PUBLISHED BY THE

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

NEW SERIES.

Vol. V.

HARTFORD, CONN.

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The Locomotive.

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Experiments upon Iron and Steel.

By J. M. Allen.

When we wish to break a bar of iron, we usually cut a channel with a cold chisel around the entire bar at the point where the break is desired. This having been done we place the bar on an anvil with the channel slightly over its edge. A smart blow on the out-lying portion will cause a fracture which at first sight has all the appearance of crystallization. Now if we take this same bar and cut a channel on one side and subject it to the same treatment with the channeled face up, the crystalline appearance will show slightly, in close proximity to the bottom of the channel, but the main body of the bar will be bent and partly broken displaying a fiber with a long silky appearance.

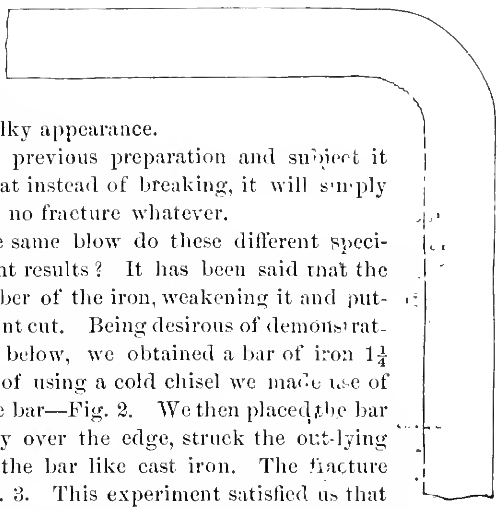

Fig. 1.

Now if we take this bar with no previous preparation and subject it to the same treatment we shall find that instead of breaking, it will simply bend to a right angle or more, showing no fracture whatever.

The question arises why, with the same blow do these different specimens of iron show such widely different results? It has been said that the blow on the cold chisel disturbed the fiber of the iron, weakening it and putting it in condition to fracture at the point cut. Being desirous of demonstrating this matter, and for reasons given below, we obtained a bar of iron $1\frac{1}{4}$ inches wide and $\frac{3}{8}$ inch thick. Instead of using a cold chisel we made use of a file and cut a channel around the entire bar—Fig. 2. We then placed the bar on an anvil with the channel slightly over the edge, struck the out-lying portion a smart blow and it flew from the bar like cast iron. The fracture presented a crystalline appearance—Fig. 3. This experiment satisfied us that something other than the disturbance of the fiber by the cold chisel was the cause of this sudden disruption and consequent crystalline appearance.

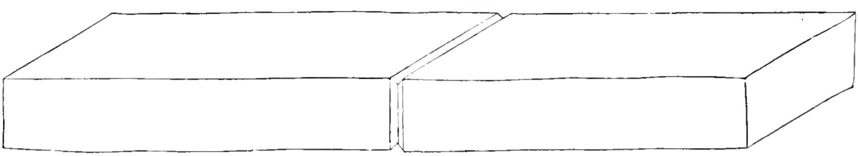

Fig. 2.

Some have argued that when the original skin of the iron was broken or cut the strength was greatly reduced and that fracture in bending was well nigh certain.

To settle this theory, we cut again a channel around the bar and put it upon a planer and planed away the surface for some distance each side of the channel until the channel was entirely "planed out"—Fig. 4.

The bar was reduced in thickness nearly one-third, but the "original skin" of the iron was gone. We next subjected this to the same treatment as described above, and it bent beautifully with no indication of fracture. This demonstrated to our satisfaction that the "original skin" of the iron was not, in this kind of strain, what saved iron from fracture. (It should be stated here that iron of good quality has been broken with an apparently crystalline fracture, where no channeling or previous preparation had been made. See Kirkaldy's Experiments on wrought iron and steel. But the circumstances were different from those under discussion here). When we bend a bar of iron slowly the fibers on the convex or outer surface of the bend are disturbed very greatly comparatively, and this distention or elongation of fiber decreases as approach is made to the other side of the bar, where a crumpling of the surface fiber will take place. From a careful examination of the bent portion, the different layers of fibers, so to speak, appear to have slipped or slid one over the other to an extent depending upon the degree of strain brought to bear upon each. Sections cut from the bent portion when examined with a microscope show, more or less distinctly, that the laminae and iron threads have become disturbed and loosened in their cinder envelopes, particularly on the outer side of the bend. If the bending is repeated back and forth several times the loosening up of fiber is distinctly seen without the aid of a glass. Having briefly considered the action of iron fiber in the process of bending we return to the question of fracture. Why does the bar break suddenly and with a crystalline appearance under a smart blow, at the point marked or channeled with a file? When a bar of iron is bent the outer fibers receive the strain first, breaking its severity as it is transmitted to those underlying. The disturbing force is distributed over the

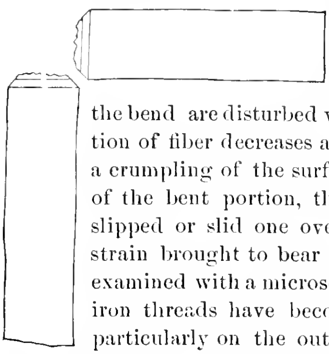

Fig. 3.

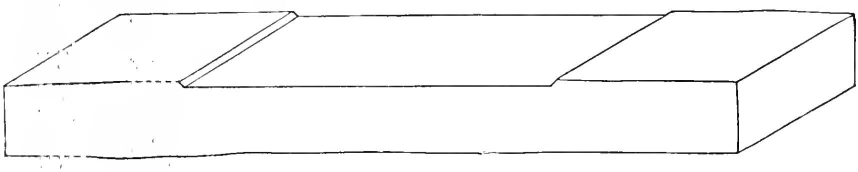

Fig. 4.

entire portion of the elongated fiber, diminishing each way from the point of greatest strain. Now it will be seen that by cutting a channel through the outer layer of fiber the strain is confined to the point where the channel is cut. The fiber on either side to the depth of the channel is not acted upon at all and exerts no influence as a protection to the underlying layers of fiber, hence when the blow is received the effect is confined to the channel, the fiber having little or no opportunity to protect itself, and it breaks short off. When a channel was cut in the bar on both sides and then planed out, the bar was virtually restored to its normal condition and its behavior was the same as when in its original condition. Had we space allusion might be made to inferior qualities of iron, where in piling the center portions are very poor indeed, while the outside bars are of unexceptionably good quality. This kind of iron presents a good surface, but in bending and breaking its inferior quality is readily discovered. But the experiments which we made, were with good bar iron. Now the object of these experiments was this. We not unfrequently find boilers fractured along the edge of the outer lap of the sheet both transverse and longitudinal, and we further find a great many boilers where the calking tools have been most carelessly used. It often occurs that the corner of the tool is allowed to cut a channel entirely through the skin of the iron, which renders the plates weak at the point, often of greatest strain. The immense force in a boiler under pressure, is little understood by those not familiar with the laws of steam, and when we take into consideration the fact that this immense pressure is striving to force the surrounding iron into a truly cylindrical form, we shall gain some idea of the grea strain brought to bear along the lap of the joints,—the points deviating farthest from a true cylinder,—and the importance of having the iron of the best quality and free from all defects by the careless use of calking tools, or otherwise. The fractures found at joints, both longitudinal and transverse, are brought about by expansion and contraction or by fretting of the iron from uneasy seating of the boiler in its setting, and it will be readily seen that any defect in the iron at or near the point of greatest strain is very liable to result in fracture. Boilers are sometimes met with that are at least of one-third less capacity than they should be for the work required. The engine requires more steam than they can easily and steadily carry, hence at every revolution the draft is so great that the hand of the pressure gauge will vibrate through an arc, measuring a variation of from 10 to 15 pounds. The boiler feels the accumulating pressure resulting from fires fiercely urged, and expands to its utmost to accommodate it, until the opening ports conduct the steam to the cylinder and afford it momentary relief. Thus the boiler like a great animal "breathes," and its "respirations" can sometimes be detected by the eye. With this slow but continuous process of bending back and forth, is it any mystery that boilers finally "give out?" And if instead of good sound iron, there are defects at the points of greatest strain, need we look for mysterious agencies when boilers rupture—burst—or explode?—(*To be continued.*)

Inspectors' Reports.

NOVEMBER, 1883.

The usual monthly summary of the work done by the inspectors of the company during the month of November last is given below. From it we learn that the number of inspection trips made, foots up 2,409, the total number of boilers examined was 5,024, the number inspected internally reached 1,765, the number tested by hydrostatic pressure, 364. The number of defects reported was 3,024, of which 650 or 21½ per cent. were considered dangerous; 46 boilers were condemned.

The following table exhibits the defects in detail.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	385	68
Cases of incrustation and scale,	500	68
Cases of internal grooving,	18	7
Cases of internal corrosion,	92	18
Cases of external corrosion,	132	33
Broken and loose braces and stays,	19	8
Settings defective,	130	19
Furnaces out of shape,	100	19
Fractured plates,	115	45
Burned plates,	94	43
Blistered plates,	207	28
Cases of defective riveting,	362	76
Defective heads,	20	6
Serious leakage around tube ends,	361	101
Serious leakage at seams,	173	25
Defective water-gauges,	52	27
Defective blow-offs,	28	4

Cases of deficiency of water,	8	6
Safety-valves overloaded,	22	3
Safety-valves defective in construction,	46	15
Pressure-gauges defective,	158	31
Boilers without pressure-gauges,	2	0
Total,	3,024	650

The penny-wise and pound-foolish policy pursued by some boiler owners is well illustrated by the following which we clip from a daily paper published in a neighboring city. The names are omitted for obvious reasons.

"A disastrous explosion, and possibly an appalling calamity, as the result of the criminal carelessness or neglect of some one, was recently narrowly averted at ——— opera house in this city. A brief summary of the story is this:—

"A steam boiler under the opera house, which was condemned six years ago, suddenly collapsed on a recent night, while the engineer (?) was crowding it with 10 pounds pressure more than should have been used, in order to heat the theater for an entertainment.

"It seems that when ——— bought the opera house property of ———, five or six years ago, there was included in the purchase an old boiler which had been condemned by experts, and which had been plugged and repaired time and time again. This is the identical boiler that recently collapsed, it having been used all this time, to the danger of people and property.

"This boiler, and also two others, under ———'s hotel were run for some time by a man named —— ——, he receiving $5 a week, ... for his services . . . . . He gave up work two or three weeks ago. . . . .

"A Mr. ——— succeeded ———. . . . . On the night of the disaster, he was urging the fires, ... so as to expedite the heating of the theater, and succeeding in raising the pressure to 15 pounds per square inch. Some boiler men had ordered that five pounds pressure should be the limit.

"Whether ——— knew of the frail condition of the boiler, and of this limit of steam allowed, does not appear. The fact remains, however, that the excess of steam was raised, and that the head of the boiler was blown off, which of course created much excitement about the premises. . . . . The theatre's patrons had to sit in the frigid auditorum that night by reason of the accident, they being in ignorance of the cause. . . . . A messenger was sent to some boiler-maker, who, upon arriving, said he knew pretty well what had happened to the boiler, although he was not told anything about the nature of the call. . . . ."

The above calls for very little comment. Many of our large public buildings are in very much the same condition as regards boilers.

BOILER EXPLOSIONS.

NOVEMBER, 1883.

PLANTATION (154).—The boiler on James Goldberry's plantation, near Terra Haute, Miss., exploded Nov. 1st. Engineer and two negroes killed. Several wounded.

LOCOMOTIVE (155).—Frank Stevens, a mechanic of Cleveland, while repairing an engine at the Valley Railway round-house, Akron, Ohio, Nov. 4th, was terribly burned by the explosion of crude oil in the steam dome.

Locomotive (156).—A switch engine burst in the T. & P. railroad yard Dallas, Tex., Nov. 7th, Wm. Ellis, the fireman, was scalded to death; S. Fahrlander, a fireman was fatally scalded.

Steam Tug (157).—About 11 o'clock a. m., Nov. 7th, a terrible explosion took place on board the tugboat James W. Thompson, which was steaming up the Harlem river, while opposite the Ward's Island ferry at One Hundred and Tenth street. The boat was blown to atoms, and the splinters and planking were thrown high into the air. The tug sank almost instantly, carrying with it the larger part of her crew. Seven persons were on the tug, of whom four were killed. Capt. Earle and his wife, John Kelly, the cook, and Charles Conners, a deck hand. Charles Kelly, the engineer, was picked up and taken to Ward's Island alive, but with broken limbs.

— Mill (158).—An explosion at the mills of Simmons & Egerton on the Bell Mill property in Norfolk County, Va., Nov. 8th, caused by the boiler bursting. One of the workmen was slightly scalded on the hands, but with that exception no one was hurt. The damage to the mill is estimated to be about $300.

Threshing Machine (159).—A threshing machine boiler exploded Nov. 8th, on the farm of widow Geottge, Dover township, Tuscarawas County, Ohio, Mrs. Geottge was blown 15 feet and her shoulder broken by a flying piece of the machine. Her recovery is doubtful. John Smith, engineer, was blown 60 feet and badly wounded. Peter Lintner was blown a considerable distance and injured about the back. Others had miraculous escapes. The barn was fired by the explosion and destroyed, with large quantities of grain and hay.

Steam Shovel (160).—At Ogle Station, on the Cairo Short Line Railroad, the boiler of the engine running a steam shovel, exploded Nov. 9th, seriously, perhaps fatally, injuring the engineer and fireman.

Hoisting Engine (161).—A stationary engine, used for hoisting freight at the Cairo and St. Louis Narrow Gauge depot, blew up, Nov. 10th. The engineer and another were slightly hurt. The boiler was blown 300 yards by the force of the explosion. No other serious damage.

Sugar House (162).—The boilers in George Pondely's sugar house, at Bayou Bœuf, Assumption Paris, La., exploded, Nov. 12th, killing the chief engineer, the assistant overseer, and the colored fireman. The victims were blown to atoms. Pondely's loss will be heavy from the delay the explosion will occasion in taking off the crop.

Saw-Mill (163).—The boiler of John Shylock's saw-mill, near Dundas, Richland County, Ill., exploded Nov. 13th, and almost instantly killed a man named McVine who was standing near.

Wood-Working Shop (164).—The furniture factory of Gary Gladdis, at Olney, Ill., fell Nov. 14th. Mr. Gladdis was within four feet of the boiler when it exploded, but strange to say, no one was hurt. Damage $500.

Saw-Mill (165).—The boiler of Smalley & Harris' saw-mill, Moscow, Texas, exploded Nov. 15th. D. Cooper was killed, and J. A. Jones fatally, and two others dangerously wounded.

Saw-Mill (166).—The steam boiler of Kimball & DeLaites mills at Easton, Me., blew up on Nov. 14th. Four men were scalded, three of them so severely that their recovery is doubtful.

Coal Mine (167)—A dispatch from Fontanet, a mining town twelve miles from Terre Haute, Ind., reports the explosion of a boiler at the Coal Bluff Mining Company's works, Nov. 16th, killing James Hurst, and scalding John and William Kyle fatally, and ten others seriously.

SAW-MILL (168).—The saw-mill of M. Maxwell, in Jackson township, Lycoming County, Pa., was destroyed by the explosion of a boiler Nov. 16th. James Huff, Charles Riggs, and Nathan Ridout, employés, were killed, and James Campbell, U. Reed, Grant Huff, and L. Moyer were wounded.

LOCOMOTIVE (169).—The boiler of a locomotive on the Chicago, Burlington & Quincy railroad exploded Nov. 16th, near Streator, Ill., in consequence of a collision. About 20 persons were injured, seven of whom were killed outright.

SAW-MILL (170).—The boiler in Martin's mill, Fairfax C. H., Va., exploded Nov. 18, killing a white man named Burnside, and two colored men, and injuring T. B. Martin and David Skeele, the former probably fatally.

STEAM TUG (171).—The boiler of the tug Erie Belle, owned by Odette & Wherry, of Windsor, Ont., exploded Nov. 21st, blowing the boat to atoms and killing the engineer, William Osgoode of Loraine, Ohio, and Frank Eikenhurst of St. Louis, Mo., the fireman, William Sayles of Detroit, Mich., and the cook, name unknown. The eight remaining members of the crew, who were struggling in the water, were picked up by the life-saving crew of Kincardine station.

SAW-MILL (172).—A boiler in Frank Page's mill, near Caseyville, Ky., blew up about Nov. 24th, killing the engineer, Dangerfield, a boy named Schadd, and breaking the owner's arm. The mill was blown over 40 rods, and the engineer was torn into fragments.

SAW-MILL (173).—The boiler in Watt's saw-mill at Newbern, Tennessee, exploded Nov. 30th, slightly scalding Mr. Watts, and seriously scalding his son and a bystander, Mr. Doddridge, who also had one of his arms crushed in two places. Portions of the boiler were blown over the chair factory near by, and the fire-box was blown a distance of two hundred yards.

Action of Hydraulic Cements upon Embedded Metals.

Mr. J. C. Trautwine published the following a short time before his death:

"The fact that this important subject has of late been brought somewhat prominently before the notice of civil engineers and builders, induces me to give the results of ten years' trial by myself. The hydraulic cements used were English, Portland, and Louisville, (Ky.), besides which I tried plaster of Paris, both pure and mixed, with equal measures of the cements. All were of about the consistency of common mortar, and all were kept in an upper room during the ten years, unexposed to moisture other than that of the indoor atmosphere.

The metals were partly embedded in the pastes and partly projecting from them. They consisted of cut iron nails (some of which were galvanized), smooth iron wire nails, brass in both sheet and wire, zinc in sheet, copper wire, and solid cylinders of lead, three-eighths of an inch in diameter.

The result at the end of ten years was that all the metals in both the *neat* cements were *absolutely unchanged;* and this was the case with the plaster of Paris with the exception of the *ungalvanized* nails, which had become covered with a thin coating of rust, as were also those in the mixtures of plaster and cement, but to a less degree.

This experience leads to the inference (already suggested by others), that moisture or dampness is the injurious agent in those cases of corrosion of iron and lead laid in cement that have lately appeared in the journals; and that if dampness can be absolutely excluded both cement and lime mortar will probably protect from injury all the metals employed in ordinary constructions for an indefinite time.

Such entire exclusion of dampness may at times be somewhat difficult of attainment, for capillary attraction alone (unaided by hydrostatic pressure) will cause water to rise several inches in well hardened cement, and it would be difficult to assign limits to its penetration when aided by a high head of water. Rain water is well known to percolate through many feet in depth of brickwork or masonry laid in lime mortar, even when it consists partly of cement."

The Locomotive.

HARTFORD, JANUARY, 1884.

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

The article on page first of this issue of the Locomotive was originally published in the annual report of the Hartford Steam Boiler Inspection and Insurance Company for 1875, but the experiment was made several years previous. Since that time we have made numerous experiments upon iron and steel under different conditions of stress, with a view to obtaining more correct data in regard to the result of such conditions upon the fiber of the material. The experiments have been made with much care under the direction of the President of the Company, who has been ably assisted in the details by efficient men in the experimental and chemical departments. Some very interesting and rather unexpected results have been obtained. The experiments have been repeated in many instances so that in laying the results before our readers there should be no doubt as to their truthfulness. It is now our purpose to publish these results in a series of articles in the Locomotive, with such illustrations and comments, as shall seem necessary, to make them of practical value. The suggestions which led to this inquiry came from the practical work of our mechanical department. The behavior of iron and steel in the processes of construction, and under usual and unusual conditions in use led to the inquiry, why is this so? There are many theories given to account for unusual phenomena. But what we need to-day is careful demonstration founded upon intelligently conducted experiment. The writer has had but little time, comparatively, to devote to these investigations, because of other and pressing duties. The experiments, therefore, have had little range beyond matters intimately connected with our special work. We shall continue these investigations, and the result will be laid before our readers from time to time, with the hope that they will add something to the accumulating knowledge upon the subject of iron and steel fiber.

The article on "London Smoke" in the *American Machinist* of Dec. 16th, is one of the most sensible lectures on the subject of smoke that we have read for some time. We would advise every one who has anything to do with coal burning to preserve a copy of it and read it carefully and often.

Such paragraphs as the writer takes for his text are quite too common, and when one gets started about every paper in the country is sure to copy it, and it thus gets a very extensive circulation, and many people who have the foolish habit of believing everything they see "in print," take them for gospel truth, and they become powerful promoters of the sale and use of all kinds of patented smoke consuming, fuel economizing, money and labor saving — humbugs. This is especially true of boilers and boiler appliances.

After all the inventions that have been made and tried, and all the printer's ink and mendacity that has been used to push their sale and use, the hard fact remains to stare us in the face, that the best economy is attained, and the least smoke made when we have a boiler of simple construction, set plainly and substantially, with a *good amount of heating surface to each square foot of grate surface*, a plain straight grate bar with about 50 per cent. air space, and a *good chimney* with as few bends as possible between it and the grate. When a man has these, and he can very easily obtain them without paying royalty to anyone, he has the best and most economical steam plant that has yet been devised.

Comparison of the Metric System of Weights and Measures with U. S. and British Standards.

The use of the Metric System of Weights and Measures has become so common, and metric terms are so often met with in reading, especially in scientific books and papers, that we have prepared the following tables which will afford those who are not familiar with the metric system a ready and convenient means of comparison of metric quantities with our ordinary standards. The tables are taken principally from Clark's *Manual*, and Trautwine's *Pocket Book*, with some amplifications to render them more convenient for popular use.

MEASURE OF LENGTH.

The unit or basis of this system is the *metre*, which is equal to 39.370428 inches.*

METRIC MEASURES WITH U. S. AND BRITISH EQUIVALENTS.

Metric Measures.	Inches.	Feet.	YARDS.	Rods.	Miles.	Approximate Equivalents.
1 Millimetre,	.039	.0033				$\frac{1}{25}$ inch.
1 Centimetre,	.394	.0328				$\frac{4}{10}$ "
1 Decimetre,	3.937	.3281	.1094			$3\frac{15}{16}$ "
1 METRE,	39.370	3.2809	1.0936	.1988	.0006	$39\frac{3}{8}$ "
1 Dekametre,	Road Measures.	32.8087	10.9362	1.9884	.006	2 rods.
1 Hectometre,		328.0869	109.362	19.884	.062	20 "
1 Kilometre,		3280.8690	1093.623	198.841	.621	$\frac{5}{8}$ mile.
1 Myriametre,				1988.405	6.214	$6\frac{1}{5}$ "

U. S. AND BRITISH MEASURES WITH METRIC EQUIVALENTS.

U. S. and Brit. Measures.	Millimetres.	Centimetres.	Decimetres.	METRES.	Dekametres.	Hectometres.	Kilometres.
$\frac{1}{64}$ inch.	.397						
$\frac{1}{32}$ "	.794						
$\frac{1}{16}$ "	1.587	.159					
$\frac{1}{8}$ "	3.175	.318					
$\frac{1}{4}$ "	6.35	.635					
$\frac{1}{2}$ "	12.7	1.27	.127				
1 "	25.4	2.54	.254	.025			
1 foot.	304.797	30.48	3.048	.305			
1 YARD.			9.144	.914	.091	.009	.0009
1 rod.				5.029	.503	.05	.005
1 mile.				1609.33	160.93	16.093	1.609

* This is the length adopted by the U. S. Government. But according to the investigation of Prof. W. A. Rogers of Harvard College, who is undoubtedly the best authority on such matters in the world, the true equivalent of the metre in inches "cannot differ much from 39.37015 Inches." This makes the Government equivalent about $\frac{1}{3600}$ part of an inch *too long*, a very considerable error.

MEASURES OF SURFACE.

METRIC MEASURES WITH U. S. AND BRITISH EQUIVALENTS.

Metric Measures.	Square Inches.	Square Feet.	Sq. Yards.	Square Rods.	Acres.
1 Square millimetre,	.00155				
1 " centimetre,	.155				
1 " decimetre,	15.50	.108			
1 " metre or centiare,	1550.03	10.764	1.196	.0395	.00025
1 " dekametre or are,		1076.41	119.6	3.95	.0247
1 Hectare,				395.37	2.47
1 Square kilometre,	= .386 sq. miles.			39537.	247.11

U. S. AND BRITISH MEASURES WITH METRIC EQUIVALENTS.

U. S. and British Measures.	Square Millimetres.	Square Centimetres.	Square Decimetres.	Sq. Metres or Centiares.	Sq. Dekametre or Ares.	Hectares.	Square Kilometres
1 Square inch,	645.15	6.457	.065	.00065			
1 " foot,	92901.	9 9.014	9.29	.093	.0009		
1 " yard,		8361.125	83.61	.836	.008		
1 " rod,				25.29	.253		
1 acre,				4046.78	40.468	.405	.004+
1 Square mile,						258.99	2.5899

MEASURES OF VOLUME.

METRIC MEASURES WITH U. S. AND BRITISH EQUIVALENTS.

Metric Measures.	Cubic Inches.	Cubic Feet.	Cubic Yards.
1 Cubic millimetre, ...	.00006		
1 " centimetre, ...	.061		
1 " decimetre, ...	61.025	.035	.0013
1 " metre, ...		35.316	1.308

U. S. AND BRITISH MEASURES WITH METRIC EQUIVALENTS.

U. S. and British Measures.	Cubic Millimetres.	Cubic Centimetres.	Cubic Decimetres.	Cubic Metres.
1 Cubic inch, ...	16387.	16.387	.016	
1 " foot, ...		28315.31	28.315	.028
1 " yard, ...				.7645

LIQUID MEASURE—U. S. ONLY.

METRIC MEASURES WITH U. S. EQUIVALENTS.

Metric Measures.	Cubic Inches.	Gills.	Pints.	Quarts.	GALLONS.
Cubic centimetre or millilitre, .	.061	.008			
Centilitre, ...	.61	.085	.021		
Decilitre, ...	6.103	.845	.211	.106	
LITRE or cubic decimetre, . .	61.025	8.454	2.113	1.057	.264
Dekalitre or centistere, . .	610.25 cubic feet .353			10.567	2.642
Hectolitre or decistere, . .	3.532				26.418
Kilolitre, cubic metre or stere, .	35.316				264.179

U. S. MEASURES WITH METRIC EQUIVALENTS.

U. S. Measures.	Cubic inches.	Millilitre or cub. centimetre.	Centilitre.	Decilitre.	LITRE or cub. decimetre.	Dekalitre or centistere.
1 Gill. . . .	7.219	118.291	11.829	1.183	.118	.012
1 Pint. . . .	28.875	473.164	47.316	4.732	.473	.047
1 Quart, . . .	57.750	946.327	94.633	9.463	.946	.095
1 GALLON, . .	231.000	3785.309	378.531	37.853	3.785	.378

DRY MEASURE—U. S. ONLY.

METRIC MEASURES WITH U. S. EQUIVALENTS.

Metric Measures.	Cubic inches.	Pints.	Quarts.	Pecks.	BUSHELS.
Millilitre or cubic centimetre,	.061	.0018			
Centilitre, ...	.61	.018	.009		
Decilitre, ...	6.103	.182	.091	.011	
LITRE or cubic decimetre, .	61.025	1.816	.908	.114	.028
Dekalitre or centistere, . .	610.25 cubic feet .353	18.162	9.081	1.135	.284
Hectolitre or decistere, . .	3.532	181.62	90.81	11.351	2.838
Kilolitre, cubic metre, or stere,	35.316	1816.2	908.1	113.51	28.378

U. S. MEASURES WITH METRIC EQUIVALENTS.

U. S. Measures.	Cubic inches.	Millilitres or cub. centimetre.	Centilitres.	Decilitres.	LITRES or cub. decimetres.	Dekalitres.
1 Pint. - -	33.6003	551.	55.1	5.51	.551	.055
1 Quart, - -	67.2006	1101.2	110.12	11.012	1.101	.11
1 Peck, - -	537.605	8809.	880.9	88.09	8.809	.881
1 BUSHEL, - -	2150.42	35238.	3523.8	352.38	35.238	3.524

MEASURES OF WEIGHT.

METRIC WEIGHTS WITH U. S. AND BRITISH AVOIRDUPOIS EQUIVALENTS.

Metric Weights.	Parts of a gramme.	Grains.	Ounces.	Pounds.	Tons of 2,000 lbs.	Tons of 2,240 lbs.
Milligramme,	$\frac{1}{1000}$	.0154				
Centigramme,	$\frac{1}{100}$	.154				
Decigramme,	$\frac{1}{10}$	1.543				
GRAMME,	1	15.432	.035	.0022		
Dekagramme,	10	154.32	.353	.022		
Hectogramme,	100	1543.2	3.527	.22		
KILOGRAMME,	1,000	15432.	35.274	2.205	.0011	.00098
Myriagramme,	10,000			22.046	.011	.0098
Quintal=100kilogs,	100,000			220.46	.110	.098
Millier, or metric ton	1,000,000			2204.6	1.102	.984

U. S. AND BRITISH AVOIRDUPOIS WEIGHTS WITH METRIC EQUIVALENTS.

U. S. and Brit. Weights.	Milli-gramme.	Centi gramme.	Deci-gramme.	GRAMME	Deka-gramme	Hecto-gramme	KILO-GRAMME.	Myria-gramme	Quintal	Millier or metric ton.
1 Grain,	64.799	6.48	.648	.0648						
1 Ounce,	28349.54	2834.95	283.495	28.35	2.835	.28				
1 Pound,				453.593	45.359	4.536	.454			
Ton of 2000 lbs.,							907.185	90.72	9.072	.907
Ton of 2240 lbs.,							1016.047	101.6	10.16	1.016

FOR the benefit of the curious, as well as those who wish to be very precise in their calculations, we insert a close approximation of the value of the ratio of the circumference of a circle to its diameter. The approximation *has* been carried to 600 places of decimals, but the value given below will be found sufficiently accurate for *most practical purposes.* The value of π, generally taken at 3.1416 when extended to 207 decimal places, becomes, 3. 14159265358979323846264338327950288419716939937510582097494459230781640628 62-08998628034825342717067982148086513282306647093844609550582231725359408128 4847-3781392038633830215747399600825931259129401832806 5174.

If any one is captious and wishes a still greater degree of accuracy, he may get it down as fine as he pleases by means of the following formula, *if he has time:*

$$\pi = 4\left(\frac{2\times4\times4\times6\times6\times8\times8\times10\times10\times12\times12\times14\times14\times16\times16}{3\times3\times5\times5\times7\times7\times9\times\ 9\times11\times11\times13\times13\times15\times15\times17}\right) \text{etc.},$$

using the *even* numbers for the numerator, and the *odd* numbers for the denominator.

THE steamboat Lexington was lost by fire on Long Island Sound on the night of the 13th of January, 1840. Among the passengers were Rev. Mr. Follen, Mr. H. J. Finn, the actor, Mr. Howard, a merchant of Boston, etc. It is not generally known that Hon. William M. Everts was intending to take passage on board this boat, but failed to reach the boat in time.—*Hartford Evening Post.*

The Coming Metal.

The following article is so interesting, that we give it to our readers entire. It is from the columns of the *Springfield Republican:*

Aluminum, with one exception, is the most abundant metal known. The material, alumina or clay, from which it is produced, is not confined to any locality or country. It is found everywhere. It is more than half a century since the eminent German chemist, the late Friederich Wöhler, who for fifty years was professor of medicine and director of the chemical institute at Gottingen, discovered aluminum and that it could be produced from common clay and from alum and still it is among the least familiar of metals. Its usual price is $20 per pound, and until the past year it has only been known as "aluminum gold." After many experiments extending over a series of years, its manufacture was abandoned, except in one instance, to the French, who only produced it in inconsiderable quantities.

After more than thirty years' labor and at a cost of more than £250,000, the eminent English chemist and metallurgist, James Webster, has discovered a method of making aluminum by burning or roasting alum, instead of making it in the old and tedious way by precipitation. By the new process it takes only $\frac{1}{24}$ of the time required by the old method and costs less than $\frac{1}{10}$ as much. Instead of producing the alumina powder, by the old and slow method of precipitation, Mr. Webster burns the alum with pitch in a calcining or roasting furnace, prepared expressly for this purpose, the product being a gray ash or powder, in appearance much like the ashes and cinders from an engine furnace. This gray powder, according to all scientific authorities, is no more or less than burnt alum. By another process this ash is converted into another product, which contains from 84 to 95 per cent. of alumina, having left behind it several bi-products, which nearly pay the cost of working. The alumina thus produced is much better than that by the old method of precipitation, in that it is much finer in texture and almost entirely free from silica. An analysis of the first alumina produced in quantities gave alumina 84.10, sulphate of zinc 2.68, silica 7.40, water 4.20, alkaline salts 1.62. Recent experiments on new alumina have given as high a per cent. of alumina as 89.92 and in one case 95, the gray powder having lost more of foreign matter. At first it took 12 tons of alumina to make one ton of aluminum, but now 10 tons of the former are sufficient for one ton of the latter. By the old process it took six months to do what is done in a week. The discoverer has been producing 200 pounds of aluminum per week for more than a year, the value of which is £4,000 or £208,000 per annum, the result of which has been that at the present time a manufactory which covers more than one-half an acre is kept busy night and day, with orders ahead for more than fifteen months' work. The present output is 20 tons of aluminum metal per week. From the results already obtained by the aluminum bronze factory (near Birmingham, Eng.) it is plainly evident that in a very short time this almost new and peculiar metal, which never oxidizes or corrodes, and which never tarnishes under any circumstances, to which can be given the color of gold, silver, bronze, or purple, and which differs from all other metals in that it is never produced direct from ore, but only by a long and elaborate process, must become an important factor in the manufacture of jewelry; and not only so, but that almost every article made from metal, from the screw-propeller or anchor of the largest steamship down to the tiniest tea-spoon, must be manufactured from it, or its alloy or bronze.

The chief value of aluminum, at present, is in tempering or giving strength and a surface or body to alloys, bronzes or metals, so that they will not corrode. Thus far in its use only enough of it is present, even in the bronze ($\frac{1}{1700}$ part), to soften or mollify the brittle or hard nature of the base metals of which it is composed. To copper, tin or zinc it gives such properties as can be obtained by no other means, softening their nature while increasing their real hardness and strength, and enabling them to resist all the tests applied to gold or silver, preserving them from corrosion and rendering them more ductile and refined, and giving them a surface and body that withstands the chemical action of the elements. As a result of this new process of making aluminum, all plated goods, nickel or silver, watch cases, cups, saucers, spoons, knives, forks, gun and pistol barrels, pistol handles, gun, harness, carriage and saddle ornaments made of brass, nickel, German silver, bronze or silver, must give way to those made of aluminum or bismuth bronze. Piano-forte wires made from it will vibrate ten seconds longer than the best now in use. The tensile strength ot aluminum or bismuth bronze being the same, only in the latter $\frac{1}{1800}$th part of bismuth is added, had been proved, by repeated tests, to bear a strain of forty-two tons to the square inch, or fourteen tons more than gun-metal, and 12 tons more than best Bessemer steel. Whenever and wherever there is need of a metal, and one is demanded that cannot crystalize or corrode under any circumstances, a metal that combines great strength and flexibility, it is plain that aluminum must be used.

In the tests already made with propeller-screws, blades, journal bearings, and heavy artillery made from aluminum or bismuth bronze, as against those made from the best gun-metal, the ship builders decided in favor of the former as the strength was so much greater and the weight so much less, being only one-fourth as great. The aluminum or bismuth bronze which is used in the manufacture of propeller-screws, shafts, and every appliance employed partly or wholly in salt sea-water, is a hard, tough, strong sonorous alloy, upon which the chlorine and hydrochloric acid of the salt water has no effect whatever. For pianos and telegraph wires it has no equal, on account of its tensile strength and toughness. For table-ware it is superior to all other metals, as it is always bright, hard, and durable, polishes well and easily, always retaining its bright color. In addition to the articles already named, aluminum bronze has been made and tried in dish and pot-covers, pots, kettles, tea-pots, jugs, crucibles, dressing-cases, soap-dishes, brush-trays, and other toilet articles, in which the colors, gold, silver, purple, and bronze, are very bright and never change. Octants, sextants, compasses and other instruments used for marine observations and service are made from the aluminum bronze and stand the tests of sea air as no other metal does. These instruments, which if made of any other metal would weigh four pounds, when made of the above only weigh one pound. These bronzes are easily turned, filed away and worked.

Aluminum, as now produced from alumina, or alum, is nearly the same color as silver, and might be taken for it, were it not so much lighter, bulk for bulk. Until three or four years ago it ranked as one of the precious metals, and justly too, for since first discovered, more than half a century ago, no doubt but that as much money has been spent in experimenting with and in trying to produce it, as would probably equal the value of all the aluminum made, had it been gold itself. At present aluminum does not cheapen the price of the alloys, into which it enters, but the reverse, and until produced in much larger quantities than at present, it cannot be used where the cheaper brass and copper will serve the purpose as well. If the single $\frac{1}{1800}$ or $\frac{1}{1700}$ part of it, so readily affects the alloy with which it is mingled, it is readily seen that one ton of it will go a long way in the manufacture of the articles named. All these facts point to a very extended use of aluminum for even the purposes named, being only a few of those of constant demand. Dr. Gehring of Landstreet, has invented a process by which ordinary iron is coated with aluminum. Iron rods, tubes and pipes, iron plates and sheet iron are made very beautiful. The process is said to be inexpensive. He uses a Bunsen burner with a blast or muffle. He is able to give the coating or finish any color desired. Another inventor, according to Mr. Howe of the American society of civil engineers, is able to produce aluminum from its oxidized compounds by placing them in a carbon crucible, which is connected as the cathode of an electric current of great intensity. A voltaic arc is then thrown across from another electrode against this carbon crucible, the current first melting and then decomposing the aluminous compounds, and metallic aluminum is produced, being deposited on the sides of the crucible. Monier, the French metallurgist and chemist, once said that he would produce aluminum for seven cents per pound. Another well-known metallurgist says that he will produce it for fourteen cents per pound.

What may be the future of aluminum or bismuth bronze, is left in the wide field of conjecture, experiment, and practical application. That it will supersede the use of the common metals, cannot be supposed for the present, but what another decade of years may bring about, no one can imagine and especially in the production and use of metals, where only one part in 1700 is needed to entirely change the nature of the alloy or bronze made, as in this case of aluminum and bismuth bronze. For instance, for a very hard, tough bronze or metal, such as is required for propeller screws, journal bearings and shafts, for artillery, gun and pistol barrels, only one part of bismuth is used in 1700 parts of tin, copper and spelter, zinc and nickel. In the manufacture of domestic and other articles exposed to atmospheric and other corroding influences, only one part each of aluminum and bismuth is used in 1800 parts of the above alloy. There can be no doubt but that one result of these important discoveries will be, the rejection of all plated goods in favor of solid articles made of the aluminum and bismuth metals. Table-ware, such as plates, cups, saucers, pitchers, knives, forks, spoons, and stove or range hardware, made of these bronzes, have all the appearance of solid gold and silver goods, not changing their beautiful color under any circumstances and wearing through without any change in the looks of the metal. These bronze goods are sold as low as twenty cents per pound, as high as seven dollars, according to style of finish.

It is believed by those competent to judge and who have given the subject much careful attention, that these new discoveries in the production and use of aluminum are as important, if not more so, as those made in the past few months in the manufacture of iron and steel, and that in a very short time, enough aluminum will be produced from the great clay beds of the East, the vast mountains of alum in Baja, California, Mexico, to supply all that may be required in order to use its bronzes in the manufacture of wagons, carriages, railroad and passenger cars, steam and electric engines of every description, railroad and suspension bridges, and in fact, in every department of mechanical industry. The discoveries of large deposits and veins of nickel in Oregon, California, Nevada, and Baja, California, and the new process by Prof. Rockwell, by which pure nickel can be produced direct from the ore by one step, must soon place that metal at such a price that it will be within the reach of all, and materially reduce the cost of aluminum—bismuth bronze. Copper, zinc, lead, and spelter, are very cheap. Copper must still be lower in price, as it can be produced in Arizona and Baja, California, for five cents per pound, at a good profit. When we stop and think that the Swedish puddled iron, that contains $\frac{20}{100000}$ of phosphorus is very tough, and of the best quality, while that containing $\frac{21}{100000}$ is very brittle, and almost unfit for use, that gold which contains $\frac{1}{2000}$ part of lead, is extremely brittle, both metals being very soft before being mixed, that lead containing more than $\frac{1}{14000}$ of copper cannot be manufactured into white lead, that brittle cast steel is rendered malleable by adding $\frac{1}{12}$ of one per cent. of magnesium, that pure nickel which is too hard and brittle to be rolled, hammered, or welded, is rendered soft and malleable by the addition of $\frac{1}{1000}$ of magnesium, or $\frac{3}{1000}$ of phosphorus, we can readily believe that Mr. Webster by the use of $\frac{1}{1700}$ of aluminum radically changes the nature or character of the alloy or bronze into which it enters, and that all he claims for it, most of which he has proved, may be true. Already steps have been taken to introduce his process for making aluminum, and the manufacture of his aluminum-bismuth bronze goods into the United States and Mexico.

Useful Numbers for Rapid Approximation.

From Hamilton's *Useful Information for Railroad Men.*

Feet	×	.00019	=	miles.
Yards	×	.0006	=	miles.
Links	×	.22	=	yards.
Links	×	.66	=	feet.
Feet	×	1.5	=	links.
Square inches	×	.007	=	square feet.
Circular inches	×	.00546	=	" "
Square feet	×	.111	=	" yards.
Acres	×	4,840.	=	" "
Square yards	×	.0002066	=	acres.
Width in chains	×	8.	=	" per mile.
Cubic feet	×	.04	=	cubic yards.
Cubic inches	×	.00058	=	" feet.
U. S. bushels	×	.046	=	" yards.
" "	×	1.244	=	" feet.
" "	×	2,150.42	=	" inches.
Cubic feet	×	.8036	=	U. S. bushels.
" inches	×	.000466	=	" "
U. S. gallons	×	.13368	=	cubic feet.
" "	×	231.	=	" inches.
Cubic feet,	×	7.48	=	U. S. gallons.
Cylindrical feet	×	5.875	=	" "
Cubic inches	×	.004329	=	" "
Cylindrical inches	×	.0034	=	" "
Pounds	×	.009	=	cwt. (of 112 lbs.)
Pounds	×	.00045	=	tons. (of 2240 lbs.
Cubic foot of water	×	62.5	=	pounds avoirdupois.
" inches "	×	.03617	=	" "
Cylindrical foot of water	×	49.1	=	" "
" inches "	×	.02842	=	" "
U. S. gallons of water	÷	13.44	=	cwt. (of 112 lbs. ea.)
" " "	÷	268.8	=	tons.
Cubic feet of water	÷	1.8	=	cwt. (of 112 lbs. ea.)
" " "	÷	35.88	=	tons.
Cylindrical foot of water	×	5.875	=	U. S. gallons.
Column of water, 12″ high, 1″ diameter,			=	.34 pounds.
183.346 circular inches			=	1 square foot.
2,200 cylindrical inches			=	1 cubic "
French metres	×	3.281	=	feet.
Kilogrammes	×	2.205	=	avoirdupois pounds.
Grammes	×	.0022	=	" "

Our landlord came into the dining-room early the other morning, and was immediately seized with a violent chill. Calling up the head-waiter, he said: "Sam, it's too cold here, you must keep the room warmer; when it is cold the boarders eat too much; keep the room uncomfortably warm, so it will take away their appetites." Fact. We do not know whether the chill was caused by the low temperature of the room, or the thought that the boarders would eat too much.

The Locomotive.

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Experiments upon Iron and Steel.

By J. M. Allen.

In the January Locomotive we explained the behavior of the fiber of iron when a bar was subjected to bending or sharp blows. It is our purpose in this article to show the fiber under different treatment. Some years ago new boilers were purchased by a large manufacturing firm in New England. They were made by boiler makers of high reputation. Each plate was plainly stamped with the maker's name. After being used a year or so, the fire surface of one of the plates was found by our inspector to be covered over,

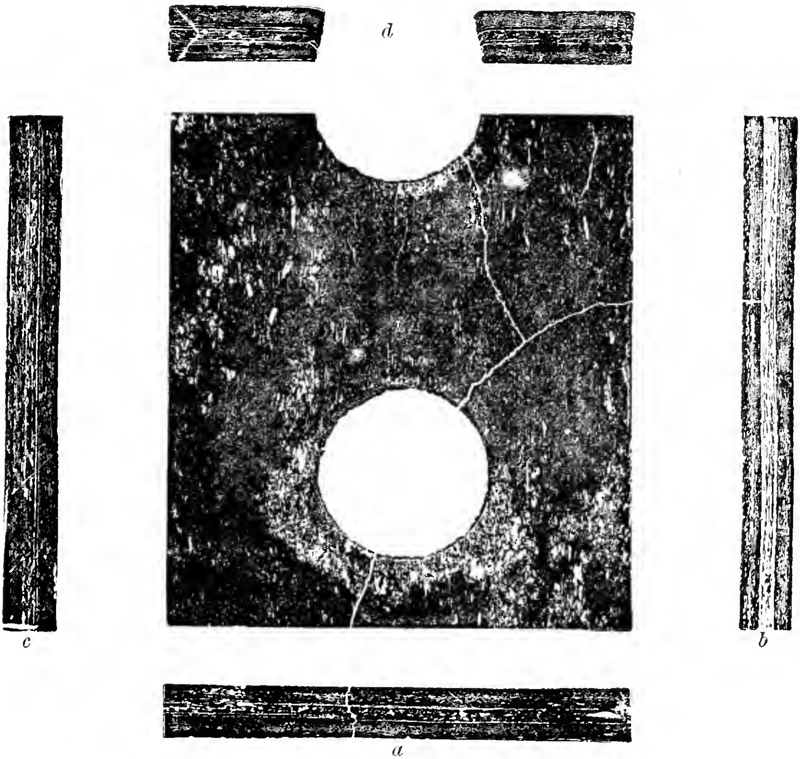

Fig. 1.

in places, with small cracks, running irregularly, like fractures in glass. These cracks appeared to extend only through the skin of the iron, but at a subsequent inspection they had increased, and it was thought best to have the plate removed, and replaced by a new one. The plate was brought to this office, and a series of experiments were made upon pieces cut from it. It should be stated here that the fire plates were fire box iron, marked F. B.; but on this particular plate, while the maker's brand was all right, the F. B. mark was of different type, and bottom side up, appearing to have been stamped by some one not connected with the mill where the iron was made, and the presumption was that it was not fire box iron. When subjected to bending, it sometimes broke with a crystalline fracture, while other portions showed a fair fiber. Under sharp blows it would sometimes behave like cast-iron. It appeared to have been made from a pile of very dissimilar iron, the expansion of the layers under heat being unequal.

We prepared a piece for experiment by filing the surface smooth, and then submitting it to a process of etching or maceration. The irregular cracks were distinctly developed, and Fig. 1 shows the impression:*

The Figs. *a*, *b*, *c*, *d*, show the edges of the Fig. 1. The center layers of *a*, *c*, and *d*, it will be noticed, are harder than the outer layers, while in *b*, it was much softer. Figs. 2, 3, 4, and 5, were from different parts of the same plate:


FIG. 2.

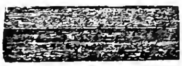
FIG. 3.


FIG. 4.


FIG. 5.

The conclusion must be, that in making the pile for this plate, the iron was of widely different grades. The other plates in the boilers, used under the same conditions, showed no such peculiar behavior.

Fig. 6 shows the layers of fiber in a piece of good boiler iron; specimen cut or planed through the punched hole, parallel to fiber.


FIG. 6.


FIG. 7.

Fig. 7 is from the same specimen, cut or planed through the punched rivet hole, across the fiber.

The fiber on one side of the hole does not differ much from the specimen cut parallel with the fiber, while, on the other side, there is a marked difference. When examined with a microscope, the difference is distinctly seen. Each layer of fiber on one side is nearly of uniform thickness, while on the other, each layer is of varying thickness. In so coarse a material as boiler-plate, the fiber, while well defined, does not show those fine threads that are found in the higher grades of iron.

In order to ascertain the effect of driving a "drift pin" violently into the rivet hole, we riveted together two pieces of good boiler plate, leaving a hole between the rivets to be experimented upon. Having violently driven the pin, we planed the joint in two, through the center line of rivet holes, and subjected the piece to treatment. The plates were parted asunder somewhat, but no fractures were developed on the surface of the plate, nor was there any great disturbance of fiber. Compression was distinctly shown around the edges of the hole by the use of a glass of medium power. Figs. 8 and 9.

* These illustrations are not from engravings, but from the specimens experimented upon.

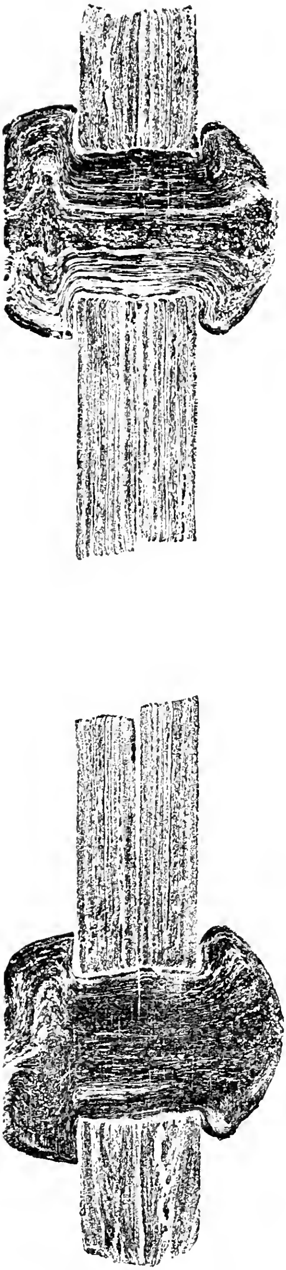

Fig. 8.

Fig. 9.

Further experiments are in process, and will be duly reported.

Attention is called to the fiber of the rivets. The compressed head, or end, shows the flow of the metal distinctly. The rivets were "button-set," and very little crystallization, if any, is shown on the driven head or end. But, to carry this matter further, we secured a machine-driven rivet and a hand-driven rivet. The latter was an old one which had been long in use, and had done good service. The fiber was sound and the material ductile.

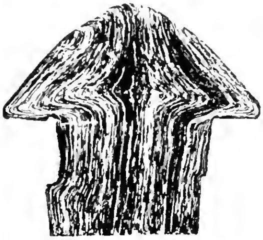

FIG. 10.

Fig. 10 illustrates the machine-driven rivet, and Fig. 11 the one hand driven. The driven head of the latter shows unmistakable indications of a breaking up of the fiber, and a kind of welding together of the fractured pieces. Its appearance under the microscope is very interesting.

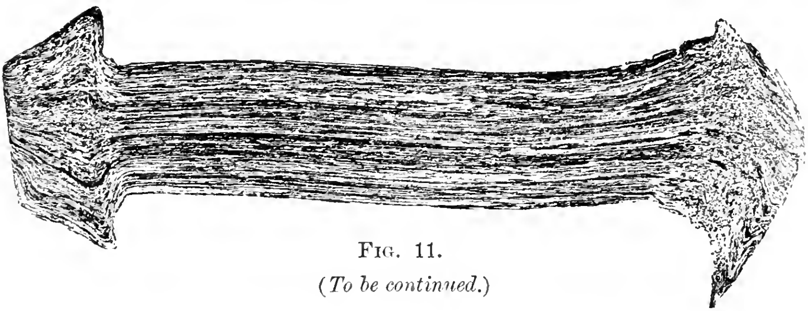

FIG. 11.

(To be continued.)

Inspectors' Reports.

DECEMBER, 1883.

The summary of the work of the inspectors for the closing month of the past year is given below. The whole number of inspection trips made was 2,527, by which 5,001 boilers were examined. Of this number 2,269 were inspected internally, and 297 tested by hydrostatic pressure. 4,007 defects were reported, of which 857 were considered dangerous. 44 boilers were condemned. Appended is the usual tabular statement of defects reported.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	392	51
Cases of incrustation and scale,	597	39
Cases of internal grooving,	17	4
Cases of internal corrosion,	111	19
Cases of external corrosion,	193	39
Broken and loose braces and stays,	44	12
Settings defective,	169	27
Furnaces out of shape,	110	14
Fractured plates,	184	77
Burned plates,	133	54
Blistered plates,	333	48
Cases of defective riveting,	347	153

Defective heads,	36	13
Serious leakage around tube ends,	661	140
Serious leakage at seams,	289	45
Defective water-gauges,	51	13
Defective blow-offs,	44	12
Cases of deficiency of water,	27	10
Safety-valves overloaded,	52	29
Safety-valves defective in construction,	31	13
Pressure-gauges defective,	181	42
Boilers without pressure-gauges,	5	3
Total,	4,007	857

Summary of Inspector's Reports for the Year 1883.

We also give a summary of the result of the work of the inspectors for the entire year, together with that of the year previous, for the purpose of ready comparison. For a year of such general depression of manufacturing interests, as the past one has been, the result is extremely satisfactory.

	1883.	1882.
Visits of inspection made,	29,324	25,742
Total number of boilers inspected,	60,142	55,679
" " " " " internally,	24,403	21,428
" " " " tested by hydrostatic pressure,	4 275	4,564
" " " defects reported,	40,953	33,690
" " " dangerous defects reported,	7,472	6,867
" " " boilers condemned,	545	478

The following is the detailed analysis of defects reported during the year 1883.

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	4,424	506
Cases of incrustation and scale,	6,121	541
Cases of internal grooving,	204	78
Cases of internal corrosion,	1,168	214
Cases of external corrosion,	2,267	476
Broken and loose braces and stays,	518	227
Settings defective,	1,595	197
Furnaces out of shape,	1,232	184
Fractured plates,	1,610	768
Burned plates,	1,318	445
Blistered plates,	3,240	394
Cases of defective riveting,	4,638	824
Defective heads,	424	148
Serious leakage around tube ends,	4,889	818
Serious leakage at seams,	2,642	410
Defective water-gauges,	1,031	220
Defective blow-offs,	371	87
Cases of deficiency of water,	175	89
Safety-valves overloaded,	407	176
Safety-valves defective in construction,	367	163
Pressure-gauges defective,	2,281	486
Boilers without pressure-gauges,	31	21
Total,	40,953	7,472

GRAND TOTAL OF THE INSPECTOR'S WORK SINCE THE COMPANY BEGAN BUSINESS.

Visits of inspection made,	241,175
Whole number of boilers inspected,	494,284
Complete internal inspections,	171,581
Boilers tested by hydrostatic pressure,	37,978
Total number of defects discovered,	258,818
" " " dangerous defects,	56,767
" " " boilers condemned,	3,223

BOILER EXPLOSIONS.

DECEMBER, 1883.

LOCOMOTIVE (174).—The boiler of a locomotive on the Louisville & Nashville Railroad exploded at Montgomery, Ala., Dec. 2d. The engineer was badly scalded and will probably die. The fireman was badly hurt. A man named Allen, who was standing by, was struck on the head by a piece of flying iron and instantly killed.

FERTILIZER WORKS (175).—Two fertilizing tanks in Glyck Bros.' establishment at the stock yards, Chicago, Ill., exploded Dec. 5th, wrecking the entire building, a one-story structure thirty by forty feet. Fourteen men and two boys were in the place at the time, and it is thought that some of them were buried in the ruins. Nine persons are known to be seriously injured, and one or two will probably die. The damage to the property will be between $4,000 and $5,000.

SAW-MILL (176).—The boiler of a saw-mill at Branchville, Southampton County, Va., owned by Joyner, Whitehead & Cooke, exploded Dec. 6th, wrecking the building and scalding six colored men, four of them fatally. Messrs. Whitehead and Cooke, two of the owners of the mill, were very badly hurt, having bones broken and their bodies cut and bruised. The mill was a new one and commenced work only two days previously.

SAW-MILL (177).—The boiler in Shipley Brothers' saw-mill at Clay Pool, Ind., exploded Dec. 10th, completely wrecking the building. John Haddix, the engineer, was instantly killed. Harris Ramsey and William Bloom, other workmen, were fatally injured.

SAW-MILL (178).—The boiler in a saw-mill at McAdams, Chambers County, Ala., exploded Dec. 12th, killing three negroes named Ross, Brooks, and Halloway. No one but the unfortunates were about the premises, and all knowledge of the cause of the accident is swallowed up in death.

SUGAR HOUSE (179).—The boiler in Wm. Kepler's sugar house, Bayou Cypremort, La., exploded Dec. 17th. Several men were dangerously wounded.

OIL REFINERY (180).—Two boilers in D. P. Richard's oil refinery on Fifty-first street, on the line of the Allegheny Valley Railroad, Pittsburgh, Pa., exploded Dec. 18th, with terrific force, scattering the debris in all directions and injuring six of the workmen. The boiler-house was demolished and a portion of one boiler was carried over 100 yards. Samuel Henderson and West Roup were seriously injured.

SAW-MILL (181).—The boiler of the steam mill of Messrs. Oxley & Hill at Lacota, Mich., exploded Dec. 21st, instantly killing Jesse Oxley, one of the proprietors, breaking one arm and internally injuring the engineer, John Clark, so that he died in about two hours, and crushing the thigh, the arm, and internally injuring Orrin Roath, a Casco farmer, who happened to be in the mill, so that he died during the night.

Oil Well (182).—George D. Westervelt and William McNorton, the former a prominent oil operator, were killed by a boiler explosion at a well near Allentown, Allegheny County, N. Y., Dec. 23d. Westervelt's head was torn off and his body was terribly mangled. McNorton was pierced through the chest by an iron pipe.

Saw-Mill (183).—The Jackson saw-mill at New Orleans, La., owned by Lambau & Noel, was burned Dec. 27th, together with a large stock of lumber and several neighboring cottages. The fire was accompanied by a boiler explosion, and caused a loss to the mill property of over $45,000, with an insurance of but $10,000.

By some unaccountable oversight the explosion of the Steamer *Riverdale* was not recorded in the October Locomotive.

Steamer (184).—The steamer *Riverdale* exploded her boiler Aug. 28th, as she was about making a landing at the foot of Twenty-second street, New York. Several persons were killed and many injured.

Summary of Boiler Explosions during the Year 1883.

We give below a summary of the number of boiler explosions which occurred during the past year, so far as we have been able to obtain a record. Our source of information is the principal newspapers throughout the country, and we believe the record to be tolerably complete, though there were doubtless a number of minor accidents in remote sections of the country, involving no serious loss of life, which were not reported. As it is, however, the list is frightfully large, and exceeds that of any previous year.

As will be seen by the table given the number of recorded explosions reached a total of 184, by which 263 people were killed outright, and 412 injured. As many of the latter were reported fatally injured at the time of the explosion, it is probable that the number of deaths considerably exceeded 263. This reckless waste of human life is entirely unnecessary, and might be to a great extent prevented by the exercise of even ordinary care and prudence.

On examining the summary given below one will probably be struck with the very great number of explosions of boilers located in saw-mills. Of 184 explosions, 74, or over 40 per cent., were of this class. This is generally attributed wholly to the kind of fuel used, but from this view we most strongly dissent. Our experience gives us ample proof that carelessness and ignorance in management is the principal cause of what may be aptly termed the very great "mortality" among saw-mill boilers. To illustrate this point, we give the following, which is characteristic of the management of many of this class of boilers, which occurred in this State, where one would naturally expect better things.

A boiler in a certain wood-working shop was insured in this Company. When the first quarterly visit was made by the inspector, the safety-valve was found stuck so tightly that no amount of force that could be applied to the end of the lever would move it, even with 100 pounds pressure on the boiler at the time. When inquiries were made as to the length of time it had been in this condition, the only information that could be given was, "about three months." When the proprietor was asked how that fact was discovered, he replied that one of the neighbors happened into the mill at noon-time, when no one was there, and found over 200 pounds pressure by the gauge on the boiler, and "it wasn't blowing off." Further inquiry elicited the fact that the fireman and engineer was "anyone who wanted more steam." As no amount of argument could change the programme, the insurance was canceled, and soon afterward the daily papers chronicled the fact that so-and-so's shop was shut down in consequence of "an accide n to the boiler which necessitated a new crown sheet." Had it not been a new boiler and excellently made, there would probably have been another disastrous boiler explosion. Many boilers of this class are run in a similar manner, hence the frequency of explosions among them. Below is given the summary for the past year.

CLASSIFIED LIST OF BOILER EXPLOSIONS IN THE YEAR 1883.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total per class.
Saw-mills and wood-working establishments,	9	4	6	6	10	7	5	4	4	6	8	5	74
Locomotives, ...	3	1	1		1		1	2	1	3	3	1	17
Steamboats, tugs, etc., ...	1		1		1	1	2	2	3	2	2		15
Portable, and agricultural engines generally,	1	1				2		1	4		5	1	15
Mines, oil-wells, collieries, etc., . . .	1	3	1	1	1	1		1			1	1	11
Paper-mills, bleachers, digesters, etc., .	1		2		1	3	1	1					9
Rolling-mills, and iron works generally,	1					1	1		2	1			6
Distilleries, breweries, sugar houses, etc.,		1			1			1				2	5
Flour-mills, elevators, etc., ...	1				1			1	1				4
Textile manufactories, ...	1		1	1		1							4
Miscellaneous, ...	3	2	4	2	1	1		5	2	3	1		24
Total per month, ...	22	12	16	10	17	17	10	18	17	15	20	10	184
Persons killed, total 263, total per month,	29	18	17	11	30	25	18	18	30	12	37	18	
Persons injured, total 412, total per month,	63	23	22	24	38	29	35	17	50	24	65	22	

In discussing a bill which has been introduced into the British Parliament to prevent any one being employed to fire a boiler on land who has not passed a Board of Trade examination and received a certificate, Mr. Lavington E. Fletcher, Chief Engineer of the Manchester Steam Users' Association, in one of his recent monthly reports says:—"The cause of nearly every explosion is the weakness of the boiler. It is the master's fault that a cheap boiler is laid down in the first instance, and set to work at a higher pressure than it is fit to carry, or that it is worked on and wasted away till it becomes as thin as an old sixpence. Thus it is that the boiler needs examination, rather than the stoker.

"A good boiler, well equipped, is a simple machine to manage, and only calls for ordinary care. It is far more important that a fireman should be careful and attentive than that he should be capable of passing a technical examination. Many firemen appear to know too much already. They know how to tamper with a safety-valve in a most ingenious manner. They can take off a stop ferrule which has been put on to prevent overloading, file it down so that the safety-valve may be locked fast, put on the ferrule again so as to escape detection, then get up steam and drive away until the boiler bursts. Such was the case at Maidstone, where a traction engine boiler burst on Friday, December 3, 1880, from the cause just explained, killing one man and injuring two others. Even railway locomotive drivers, who are superior to the class of men engaged in minding agricultural engines, will gag the safety-valves."

The Locomotive.

HARTFORD, FEBRUARY, 1884.

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

THERE is a strong effort being made in some quarters to break down the insurance laws by securing legislation that will remove the barriers to the organization and operation of companies doing a number of kinds of business on one and the same capital. We were educated in the conservative school of insurance, and believe that the methods which have built up our large insurance institutions, and which have been proved by years of experience to be safe and sound, are safe to follow now. Years ago it was quite common to characterize Western insurance companies as "wild cats," but now the efforts to remove the barriers to sound insurance in some of the Western States seems to emanate from the "virtuous" East. Some of the Western States have especially good insurance laws, and the effort to open the doors to adventurers should be resisted by every legislator who has any pride in seeing safe and sound insurance laws on the statute books of of his State.

WE are indebted to Mr. James E. Howard for a copy of the Report on the Tests of Metals and other materials made at the United States Arsenal at Watertown, Mass., for the year ending June 30, 1882. It is a very valuable report, especially to those interested in the manufacture and use of metals.

WE are indebted to Coleman Sellers, Esq., for a copy of his lecture on *Mechanics*, delivered before the Franklin Institute, Philadelphia. It is a very interesting talk on some of the fundamental principles of mechanics, together with a brief review of the progress made in some departments of mechanical engineering during the last sixty years.

THOS. PRAY, Jr., late editor of *Cotton, Wool, and Iron*, has recently formed a connection with the *Manufacturers' Gazette*, of Boston, by which he becomes manager and managing editor of that paper. Mr. Pray is well known to the manufacturing and mechanical community, and his return to the editorial chair will be very gratifying to his numerous friends.

LOCOMOTIVE engineers in Mexico have a hard time. There seems to be very little difference there between the "authorities" and the lowest class of criminals, except in the methods by which they work. If a Mexican wishes to commit suicide he jumps on the track in front of an approaching train when it is within a few feet of him. Of course, it is impossible for the train to be stopped in an instant, and a dead "greaser" is the result. If this were the only result it might, by a *very* slight stretch of the imagination, be looked upon as a fortunate circumstance; but such is not the case. The engineer is promptly arrested and put into prison, and thus far the railroads have been either unable or unwilling to protect them. Some weeks ago, a Mexican was walking on one of the railroad bridges near Saltillo, and a train came along, and before it could be stopped struck and killed him. The engineer has been in jail ever since, and no one knows when he will be released. We understand that the engineers have organized as a body, and propose to strike *en masse* unless measures are taken by the companies to protect them; and we don't blame them. A country that is not sufficiently civilized to demand a different state of things does not need a railroad, that is certain.

Perforated feed pipes, having their delivery end capped, are very pretty things in theory, but in practice, if the water used be anything but the very best, they are a source of continual trouble and annoyance. The small holes are very easily clogged with scale, and feed-pumps are very frequently broken in the effort to force sufficient water into the boiler. The perforations may be stopped in two different ways: Firstly, by the formation of scale around them, which "cones down," as it is usually expressed, the hole gradually becoming smaller and smaller until it is entirely closed up; secondly, by the lodgment in the end of the pipe of small pieces of scale, which, having been formed in the heater or some remote part of the pipe, has become detached, or "flaked off," and brought forward by the current of incoming water, and lodges in the end of the pipe in consequence of its being capped over, and gradually fills it up. In a case which occurred recently, the feed-pump was twice broken in the effort to keep sufficient water in the boiler, before the cause of the trouble was suspected by the engineer in charge. A steam-gauge placed between the boiler and feed-pump indicated something over 100 pounds as the pressure required in the feed-pipe to keep the boiler supplied with water when the steam pressure was but 60 pounds. Upon examination by the inspector, the perforations were found nearly closed by a formation of hard scale around them. The only remedy in such cases is to remove the perforated portion of the pipe, and discharge the feed-water through the open end. If the pipes are properly arranged, no harm to the plates or seams will result, even if cold water is used; and, unless the water be quite bad, it will be sufficiently well flushed by the incoming water to keep it quite clean for a long time.

The following are the latest instructions issued by the British Admiralty for testing steel rivets. The rivets are to be made from steel bars, having an ultimate tensile strength of not less than 58,000 pounds per square inch of section nor more than 67,000 pounds, with a minimum elongation of not less than 20 per cent. in a length of 8 inches. A portion of one bar in every fifty to be taken for testing before being made into rivets. Pieces cut from every bar, heated uniformly to a low cherry red, and cooled in water at 82° F., must stand bending in a press to a curve of which the inner radius is equal to the radius of the bar tested. Rivets are to be properly heated in making, and the finished rivets allowed to cool gradually. The rivets are to stand the following forge tests: (1.) The shank to be bent double cold, without fracture, to a radius equal to the radius of the shank. (2.) Bent double hot, without breaking, to as small a radius as possible. (3.) Flattening of the rivet-head while hot, without cracking at the edges—the head to be flattened until its diameter is 2½ times the diameter of the rivet-shank. (4.) The shank of the rivet to be nicked on one side, and bent over to show the quality of the material. One rivet in every hundred to be forge-tested as a sample.

Worcester, Mass., is to have a Bessemer-steel plant with two converters. It will be erected by the Washburn & Moen Company.

Professor Thompson, in a recent lecture, stated that the magnetic pole is now near Boothia Felix, more than 1,000 miles west of the geographical pole. In 1657 the magnetic pole was due north, it having been eastward before that. Then it began to move westward until 1816, when the maximum was reached. This is now being steadily diminished, and in 1976 it will again point true north. Professor Thompson says that the changes which have been observed, not only in the direction, but in the strength of the earth's magnetism, show that the same causes which originally magnetized the earth are still at work.—*The Electrician.*

One of our contemporaries prints a letter from a correspondent which it characterizes as "no nonsense." While this is true, there are certain points which the writer touches upon regarding which we think he entertains erroneous views. These are:

First—"I think a tubular boiler should have at least three feet from the grate to bottom of boiler."

Now, three feet from the grate to the bottom of the boiler, is, in our opinion, a greater height than is necessary for burning any ordinary kind of coal. There will always be found a direct loss by placing the grates further from the boiler bottom than is necessary for ordinary complete combustion, for this reason: We lose the effect of the radiant heat from the bed of incandescent fuel, and this loss is in proportion, not to the distance of the grates from the boiler shell, but to the *square* of that distance, that is, imagine two sources of heat of the same temperature radiating heat to a square foot of any surface; then if our square foot of heating surface is *twice* as far from one of the sources of heat as it is from the other, it will receive but *one-fourth* of the amount of heat from it that it does from the nearer one. There will also be found a further loss, due to the fact that the rate of transmission of heat through a boiler shell at high temperatures is more nearly proportional to the *square* of the difference of temperature in the furnace, and that of the water in the boiler, than to the difference simply of the temperature. These are well established facts, and indicate to us that we should always strive to keep the surface of the fire as near the boiler shell as possible and attain complete combustion, and also get as intense or rapid combustion as possible, for, ordinarily, the more rapid the combustion, the higher the temperature in the furnace, and consequently the greater the proportion of the heat generated which may be transmitted to the water in the boiler. In general it will be found that a greater proportion of heating to grate surface, and a more rapid combustion than is usual would result in greater economy. As a rule, boiler chimneys are far too small to give good results, for unless the chimney power is ample it will be found that it will not force air enough through the fuel to produce sufficiently rapid combustion.

Another point that the correspondent refers to is this: "The side walls to be arched over top of boiler, leaving at least three, and four inches would be better, all around top of boiler, thus allowing the hot gases to pass up over, etc."

To any one who contemplates doing this, our advice is simply, "Don't." The chances are that the boiler will shortly be ruined if it is done. We have seen many boilers ruined, burned out on top by adopting this style of setting, which is fortunately nearly obsolete, in this section of the country at least. In setting a boiler, always follow this rule: *Never expose to the fire or gases of combustion any part of the shell not completely covered with water.* The amount of superheating obtained in this manner is insignificant and will not be sufficient to dry the steam to any appreciable extent, if there be any considerable amount of moisture in it. If steam is to be superheated it must be done in a separate vessel. It *cannot* be done in the steam space of an ordinary boiler where the steam is in intimate contact with the water, whatever the amount of heat applied to it.

The superheated water theory of boiler explosions makes its appearance with the regularity and persistence of the tax collector. The latest on the subject begins thus: "It has been noticed that boiler explosions are especially frequent in the morning."

It would be a matter of considerable interest to know how this fact has been noticed. We would like to see some statistics on the subject. We keep a tolerably complete list of the explosions in this country, and actual examination of it shows that nearly all explosions occur while the boilers are running in their usual manner. About 10 per cent. are reported as having occurred "in the morning" or during the night while only about

2 per cent. occurred at the time of starting up. This does not look as if explosions were "especially frequent in the morning." We think the man who noticed it must have abnormally keen perceptive faculties.

Then after discussing the very great dangers resulting from overheating of the water, the writer recommends injecting air into the boiler near the bottom to prevent the possibility of its occurring. It strikes us that the money which apparatus for such a purpose would cost would be laid out in a much more judicious manner if expended for competent inspections and necessary repairs from time to time. There is something peculiar and suggestive in the fact that good boilers, run by competent men, are hardly ever troubled with "superheated water."

"BACKWARD, turn backward, O time in thy flight!" must have been the idea which was cavorting wildly through the brain of the compositor when he dated the first page of our last number January, 1883, instead of January, 1884, as it should have been.

That Virginia Hoop-Snake Revived.

[From the Page (Va.) News Letter.]

"As a couple of gentlemen were riding down the Roanoke valley, Virginia, recently, they saw a huge green-colored snake writhing and twisting at the root of a beech-tree. Going closer, they discovered it to be one of the horned species of the hoop-snake. It had formed itself into a hoop by taking its tail in its mouth and rolled down the hill in pursuit of a rabbit or some other small game. So great had become its velocity that it couldn't guide itself, and it had struck the tree with such force as to drive its horn into the solid wood to the depth of an inch or more, holding it tight and fast. There are a great many trees in the vicinity that have been struck in the same way, and they invariably die. So deadly is the poison that the leaves on young oaks have been known to wither within an hour after being struck."

The above story we consider a step in the right direction. Heretofore it has always been the snake who was thus leading his unsuspecting victim to commit involuntary suicide by dashing his brains out against a tree. For this is the story, as we have generally heard it: A hog in quest of his dinner espies a hoop-snake, and instantly gives chase, with the dark and bloody design of making a meal of him, if he catches him. The alarmed snake, seeing death approaching in the terrible guise of the "razor back," takes to his heels (or more properly, perhaps, to his hoops) and goes for home by the overland route. The race is one for life. The hog is steadily gaining, and those who have their money up on the snake begin to "hedge," and wish there were some friendly hedge near by. The snake is in despair, for he feels that his fate is sealed, when suddenly he espies a tree ahead. A happy thought strikes him. He rolls straight toward the tree, meanwhile slackening his speed so that his fat (?) pursuer may be just near enough, but not too near, when the tree is reached. On goes the snake. On comes the hog. The tree is reached, with the snake about ten feet ahead. He turns suddenly aside. The hog, unable to do so quickly enough, brings up suddenly against the tree with such force that his brains (?) are scattered far and wide. The wily snake laughs in his sleeve (or rather in his tail, for his tail is in his mouth), and pensively seeks the nearest hen's nest to "put up a job" on some innocent colored person. By the way, who ever really saw a hoop-snake?

The Coming Metal.

The following criticism of an article published in our last issue is quite racy, and will be found worthy of careful perusal. The statement that 20 tons of aluminum metal *per week* is produced by one firm *is* rather startling, to say the least. The writer probably meant 2 tons per week. Be that as it may, however, we reproduced the article *verbatim*.

In regard to the price of aluminum, we beg leave to say that we were shown some very fine castings in this metal a few days ago, at the shop of a prominent astronomical instrument maker, and he informed us that the price of the metal, in the ingot, was $1.25 per ounce, or exactly $20 per pound. [Ed. Locomotive.]

To the Editor of The Locomotive:

As an appreciative reader of your interesting paper, I may be allowed to express my feeling of surprise at the appearance in its columns in January, with a complimentary introduction, of an article under the above caption, purporting to be gleaned from the *Springfield Republican.*

The article in question contains so many errors that I feel really at a loss to know where to begin to expose them. Nevertheless, I will direct my brief criticisms to the statements on the first page of the article, which contains the most glaring of these errors, and which, in justice to your readers, I am sure you would not wish to leave uncorrected.

In the first place, Mr. Webster's patented process relates to methods of producing *alumina*, the oxide of the metal aluminum, not to the production of the metal itself; the statement, therefore, that Mr. W. has "discovered a method of making *aluminum* by burning or roasting alum," simply shows that the writer is blissfully unconscious of the trifling distinction between a metallic oxide and a metal. To the chemist, or metallurgist, I may add, the happy idea of producing metallic *aluminum* by so simple a procedure as "roasting alum" will be a revelation indeed. It is only a pity that St. Claire Deville, the French *savan*, who devoted the best years and energies of his life in the unsuccessful effort to produce this metal cheaply, had not lived long enough to congratulate Mr. Webster upon his discovery.

Further down, on the same page, the *Republican* writer, after commenting on the enormous cheapening of the cost of producing *alumina*, informs his readers that "the discoverer has been producing 200 pounds of *aluminum* (the metal) per week, for more than a year, the value of which is £4,000, or £208,000 per annum; the result of which has been that at the present time a manufactory which covers more than one-half an acre is kept busy day and night, with orders ahead for more than fifteen months' work. The present output is 20 tons of *aluminum metal* per week."

There must be something wrong, either with this writer's arithmetic, or with Mr. Webster's process. He starts out by informing us that "the usual price (of aluminum metal) is $20 per pound," which statement divided by *two* would be very near the truth. But, by the new process, the production has been "200 pounds per week," valued at "£4,000," which would place the cost of the metal at exactly £20 (or about $100) per pound. The economy of Mr. Webster's process is not very apparent from these figures—unless the writer's want of familiarity with British terms has caused him, inadvertently, to mix up pounds sterling with pounds avoirdupois.

The statement in above quotation that "the present output is 20 tons of *aluminum* metal per week," is too ridiculously extravagant for serious consideration, and only serves, by its monumental absurdity, to demonstrate how true it is, that "fools rush in where angels fear to tread." Twenty tons of metal per week at the writer's figure of £20 per pound, would represent a market value of £800,000 (nearly $4,000,000) per week, or

£41,600,000 (about $200,000,000) per year, which, it must be admitted, represents a pretty fair business. As the factory "is kept busy day and night, with orders ahead for more than fifteen months' work," the proprietors are to be congratulated on having "struck it rich." Imagine what must be the feelings of a certain Philadelphia company of manufacturing chemists, that I could name, who had the inconceivable stupidity to decline, less than a year ago, to invest in the right to Mr. Webster's process in the United States, at the ridiculously low figure of $100,000, and informed me shortly afterwards that they didn't want it at any price! Yours truly,

W. H. W.

PHILADELPHIA, Feb. 22, 1884.

A Novel Locomotive.

Considerable interest is exhibited in the performance of a locomotive invented by Mr. Moritz Honigmann. It has generally been described as a fireless locomotive, but like all other so-called fireless locomotives, its original source of energy is coal. We reprint the following account of the principles of its construction, which will be found interesting, from *Engineering:*

Mr. Moritz Honigmann, of Grevenberg, has invented a traction engine especially intended for use in streets, mines, and tunnels, or wherever the absence of noise, smoke, and disagreeable gases is desirable. The salient feature of his invention is the use of caustic soda to absorb the exhaust steam and to liberate a part of its latent heat, to be employed in the production of additional steam to drive the engine. If exhaust steam at a temperature of 212 degrees be injected into a solution of caustic soda, of a specific gravity of 1.7, the temperature of the mixture will rise to about 374 degrees, while the vapor tension will not exceed 1 atmosphere. Supposing the hot solution to replace the fire in a boiler, it is evident that a part of its heat will travel through the plates to the water, if the temperature of the latter be lower than that of the solution, and will evaporate a portion of it, and that this action will continue as long as the soda maintains its power of absorbing the exhaust steam without giving rise to any great back pressure. Mr. Honigmann's engine is at work as a tramway locomotive, and will run continuously for five hours with a charge of 500 kilos. of caustic soda of 1.7 specific gravity. The following description of its mode of action is taken from *L'Ingenieur-Conseil:*

Mr. Honigmann's motor has a small boiler, but no chimney. The boiler is a cylindrical reservoir of water, heated to a temperature corresponding to the pressure desired, and surrounded with another reservoir filled with caustic soda, either in a state of solidity, or of highly concentrated solution. Now, it is well known that caustic soda is a substance having a great affinity for water, with which it forms a hydrate. In the formation of this chemical combination, a considerable quantity of heat is liberated, and Mr. Honigmann has drawn up tables of the boiling points and corresponding effective pressures of different strengths of the solution of caustic soda, from which it appears that a solution of 60 parts of water to 100 parts of soda can absorb vapor at a tension of 7.1 atmospheres, given off by water at a temperature of 332.6 degrees F., without in its turn giving off vapor having a greater tension than 1 atmosphere. It is, therefore, possible to absorb, by means of caustic soda, considerable quantities of exhaust steam without creating behind the piston a counter pressure greater than one atmosphere. Suppose, therefore, that the supply pipe of the steam cylinders communicates with the reservoir of water, heated, for instance, to 331 degrees F., and therefore at a tension of 7 atmospheres, and that the exhaust pipe passes into the reservoir of caustic soda, itself heated by the vicinity of the water to a temperature of about 284 degrees F., it will follow, as soon as the valve is opened the pressure will diminish in the reservoir which contains water and steam; the water will give off a certain quantity of steam, which after it has done work in the cylinders, will pass into the reservoir of caustic soda, the steam will heat the solution and be absorbed by it, a certain amount of heat being liberated in the process, which will raise the temperature of the solution, and the general result will be that the temperature of the solution will rise, and that of the water fall. The difference becomes constant as soon as the amount of heat returned by the solution to the water, through the partition that separates them, becomes exactly equal to that converted into work in the cylinders. Mr. Honigmann had two thermometers placed upon his trial engines, by which these variations of temperature could be exactly followed.

Suppose, again, that the work done in the cylinders is 300 kilogrammetres (2,170 foot pounds) per second, which corresponds to about 4 horse-power, there will be, according to the mechanical theory of heat, an absorption of $\frac{300}{424} = .7$ calories per second. (1 calorie = 3.968 thermal units.) The steam, therefore, which issues from the boiler, parts with .7 calorie of its heat in the cylinders, and carries the remainder into the solution, and, in chemically uniting with the latter, it develops additional heat. Now, if the latter quantity be equal to .7 calorie lost, and if the difference of temperature between the water and the solution be such as to permit it to pass through the partition, the temperture of the water will be kept up, and the pressure maintained. This is exactly what takes place if the dimensions of the two reservoirs and the quantities of water and of solution have been suitably proportioned. The full work is obtained from the engine, and all the heat which is not transformed into energy is stored up in the caustic soda, while the water is vaporized without any notable variation in the pressure. An observer stationed upon the engine will notice that when the locomotive first starts, the pressure falls rapidly for about 1 atmosphere, and then remains fixed ; but if the engine is stopped, it falls a little, and rises again as soon as work is resumed.

In order to put the engine in working order again after the caustic soda has ceased to be sufficiently concentrated, all that is necessary is to fill its reservoirs with water and soda solution under the original conditions. The moisture absorbed by the caustic soda can be driven off again by evaporation, and the solution thus restored to the necessary degree of concentration. This is done in the central station, where the engines receive their supplies, at an expenditure of 1 pound of coal for each 10 pounds of water evaporated. Compared with other fireless locomotives, Mr. Honigmann's is exceedingly economical. The author of the article from which we quote estimates, that in order to do the same work, an engine on the best system now in use would weigh 10 tons 16 cwt., where one of Mr. Honigmann's would weigh only 4 tons 18 cwt.

There are many little things that will work great mischief if they are neglected, and we believe the mystery will recede and vanish in connection with boiler explosions in proportion as sound and careful investigation is made. But patience and painstaking examination, extending over years if need be, are necessary to a satisfactory solution of this question, and the greater the number of boilers under examination, with their particular defects understood, the greater the fund of information from which to make up conclusions.

The Locomotive.

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Explosion of an Upright Cylinder Boiler.

The explosion illustrated in this number of the Locomotive occurred at a well-known iron works in one of the middle States. It was more than usually destructive in its effects, both to life and property.

The boiler was one of a vertical type used to some extent in the locality where the explosion occurred, and is shown in fig. 1. The shell was 36 feet long; 26 feet of the lower portion being 48 inches in diameter, while the upper ten feet was 40 inches in diameter. Thickness of shell $\frac{5}{16}$ inch. Water was usually carried at *h–h*, fig. 1, about one foot above the junction of the upper and lower shells, leaving about 9 feet of steam room in the upper shell. The steam pipe was placed inside the boiler, the upper end being about six inches from the top of the boiler, thence running down through steam and water space and coming out through the small horizontal dome shown on fourth course of plates from lower end of shell in fig. 1. The gaugecock pipes were similarly taken out of the boiler through the same dome or fitting, but of course their upper ends were located at the height at which it was considered desirable to carry the water, or about one foot above the annular head or ring connecting the larger and smaller sections of the shell. The safety valve was situated on the main steam pipe just outside the dome where the pipe was taken out of the boiler. The feed-pipes entered the boiler through the two diametrically opposite fittings shown on the eight course of plates from the bottom of the shell in fig. 1. The blow-off pipe was through shell near lower head. The lower head was $\frac{3}{4}$ inch thick and *unbraced*, the upper head $\frac{1}{2}$ inch thick and reinforced by four $\frac{3}{4}$ inch braces reaching well down the shell. There was a man-hole in lower course of shell, as shown in figs. 1 and 2. This was of the usual size, 10 by 15 inches, and was reinforced by a $2\frac{1}{2}$ by $\frac{1}{2}$ inch wrought iron ring riveted to shell around man-hole.

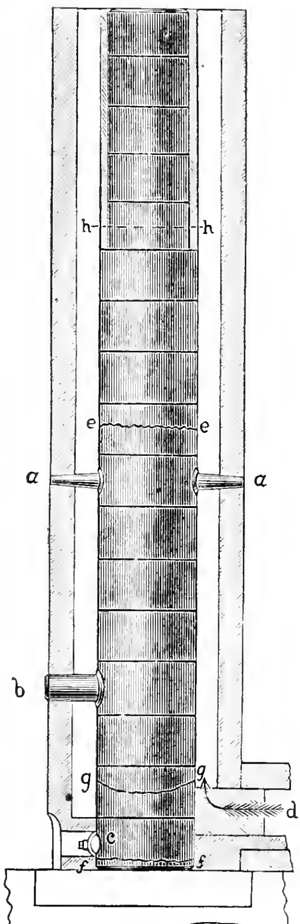


Fig. 1.

The boiler was enclosed in brick as shown in fig. 1, and fired by waste heat from a heating furnace. The distance of brick-work from boiler shell was about one foot. The upper or 40 inch portion of the shell forming the steam space was surrounded with a course of brick to prevent injury from overheating. This course of brick rested upon the offset or ledge formed by the annular head connecting the two sections of the shell.

The gases from the heating furnace entered the annular space around the boiler by an opening at *d*, fig. 1, directly opposite the man-hole, whence they circulated around the shell, passing upward, and finally off through the stack on the top of the brick-work.

THE EXPLOSION.

The initial rupture occurred just above the lower head seam, as shown at *f*, *f*, figs. 1 and 2, below and to the right of the man-hole. A rush of hot water under pressure followed, the reaction of which was sufficient to tilt that portion of the boiler above the fracture over sideways, the lower head remaining on its seat. This of course still further increased the fracture, and in the twinkling of an eye the shell was broken all round, the upper portion shot upward exactly as a gigantic rocket would from the reaction of the issuing steam and water, tore through the setting and roof of the shop and mounted skyward. In the earlier part of its flight, the domes *a*, *a*, fig. 1, to which feed-pipes, as well as

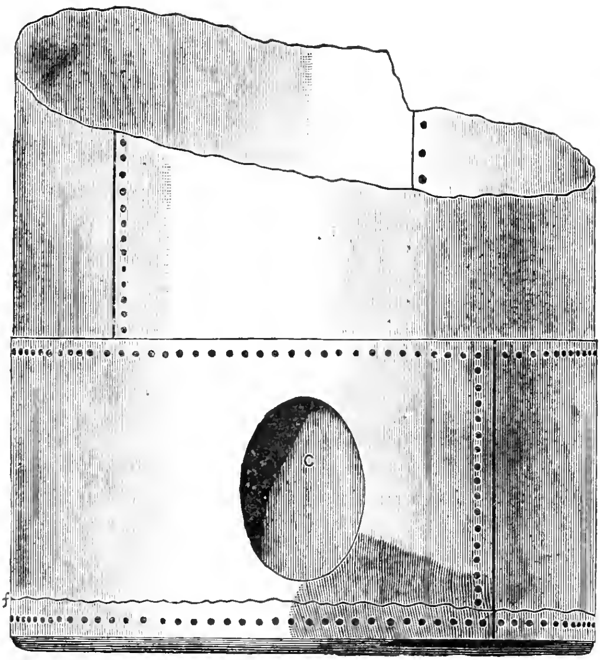


FIG. 2.

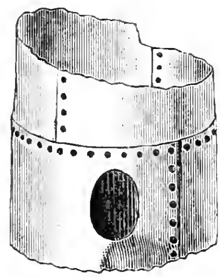


FIG. 3.

that at *b*, fig. 1, to which the steam-pipe was attached, came in contact with either some part of the setting or the building in such a way as to cause the fractures at *e*, *e*, and *g*, *g*, fig. 1; the portion containing the manhole shown in fig. 3 was thrown in a westerly direction about 400 feet, the central portion was torn into various irregular fragments as shown in figs. 4, 5, 6, and 7, and scattered about in all directions, to distances varying from 50 to 250 feet, while the upper portion of the shell, fig. 8, weighing nearly *two tons*, continued onward in its rocket-like course, and finally landed in the Monongahela River *nine hundred feet* distant. The lower head, fig. 9, remained intact on its foundation. The expanding force of this large body of water at such a high temperature and pressure, suddenly liberated, resembled exactly the explosion of a large quantity of gunpowder, and was sufficient to demolish the adjacent buildings, and send a perfect hail of red hot bricks, coals, and fragments of all sorts, for hundreds of feet in every direction, while the shock, or sudden displacement of air produced, effectually shattered all the windows in the neighborhood. The immediate effect of the explosion was to kill five persons outright, and injure thirteen others, besides destroying property to the value of about $10,000.

CAUSE OF THE EXPLOSION.

At the inquest which was subsequently held upon the bodies of the victims of the disaster, the usual class of experts were present in full force, and had a fine opportunity to ventilate their theories and advertise their various explosion preventers to an unlimited extent. The facts in the case, for which we are indebted to Chief Inspector A. C. Getchell, of our Cleveland office, are simply these:

The bottom ring of the plates, below and to the right of the man-hole, as shown by irregular shading in figs. 2, 3, and for a length and breadth of several inches, was corroded and eaten away until the iron was barely $\frac{1}{16}$ of an inch thick, thus weakening the shell at this point until it was simply unable to withstand the strain due to the ordinary working pressure, which does not appear to have been excessive for such a boiler as the one in question if it had been in good condition. It appeared that the safety valve was weighed at 85 pounds, while the pressure usually carried was from 50 to 75 pounds per square inch, this being sufficient to do the work required.

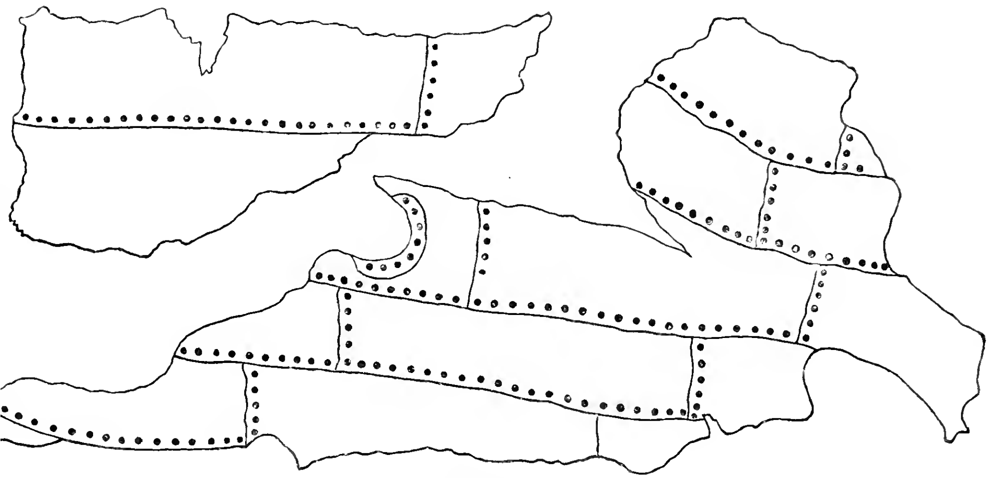


Fig. 4.

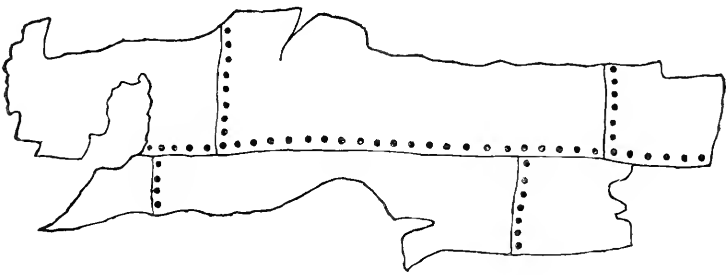


Fig. 5.

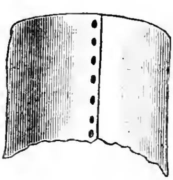


Fig. 6.

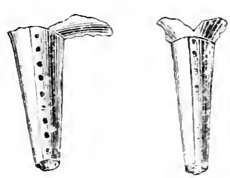


Fig. 7.

That the boiler actually did give out at the point in question is abundantly proved by the testimony of two of the surviving workmen who were in the vicinity of the boiler at the time. One of them says: "I was standing in the yard near by, talking to a blacksmith. All at once a lot of steam commenced blowing out, it seemed to me from under the boiler. I said there must be something wrong, and just as I finished speaking there was a crash."

And the other: "I was sitting down about twenty feet from the boiler at the time. The next thing I knew *I saw steam hissing out of the lower part of the boiler*, and then the whole thing seemed to keel over toward me."

The italics are ours. From this positive testimony we may regard it as absolutely proved that the boiler gave out at the point in question; and we may also be equally certain that it did not give out from the effect of low water. Even the experts who testified that they believed the explosion to be due to low water, failed signally in their efforts to find *any signs whatever of overheating* on any of the parts of the exploded boiler. The very violence of the explosion is positive proof that there was a very large quantity of water in the boiler at the time. The violence of an explosion is always directly proportional to the amount of the explosive, which, in the case of boilers is invariably—water.

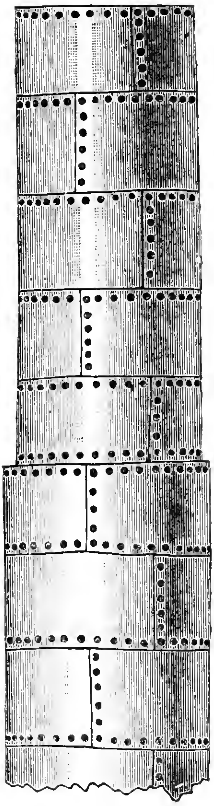


FIG. 8.

It would seem to be proved, then, that the explosion was due to the weak point in the bottom ring of plates, and this, we may add, was the conclusion reached by the coroner's jury. We do not think, however, that they were justified in considering the engineer, who was instantly killed, to be responsible for the disaster. In all probability, the engineer, who appeared to be a careful and conscientious man, always obeyed strictly the orders of his superiors. His continuous employment by the firm would seem to indicate this to be the case.

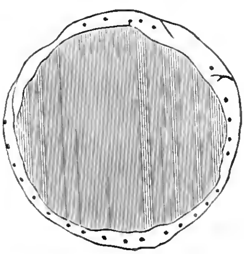


FIG. 9.

The cause of the defect which led to the explosion was very simple, and was one which is so common as to call for no comment. The incoming gases from the heating furnace deposited their ashes around the lower part of the boiler shell. A leak around the man hole kept these ashes in a state of continuous dampness, and thus the iron in contact with them was rapidly eaten away. This was overlooked and allowed to go on unchecked simply because there was no one connected with the management of the boiler whose business it was to look out for and prevent the consequence of such a state of affairs.

Boilers, like other machines, are subject to deterioration through continued use. The amount and character of this deterioration depends to a great extent upon the management and care which the boiler receives, and, as in all other branches of mechanical science, can only be estimated properly by a competent specialist. If the boiler in question had been examined periodically by a competent inspector, who had a direct pecuniary interest in its condition, the defect which led to the explosion would certainly have been detected, pointed out, and the disaster would have been prevented.

Inspectors' Reports.

JANUARY, 1884.

The following is a summary of the work of the inspectors during the initial month of the year:

Visits of inspection made,	2,818
Whole number of boilers visited,	5,998
" " " " examined internally,	1,919
Boilers tested by hydrostatic pressure,	263
" condemned,	39
Total number of defects reported,	3,002
" " " dangerous defects,	672

The following table gives the defects in detail:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	300	29
Cases of incrustation and scale,	504	25
Cases of internal grooving,	6	3
Cases of internal corrosion,	74	11
Cases of external corrosion,	129	22
Broken and loose braces and stays,	54	25
Settings defective,	127	25
Furnaces out of shape,	93	5
Fractured plates,	92	37
Burned plates,	85	36
Blistered plates,	194	33
Cases of defective riveting,	268	111
Defective heads,	47	11
Serious leakage around tube ends,	524	151
Serious leakage at seams,	152	31
Defective water-gauges,	73	18
Defective blow-offs,	35	8
Cases of deficiency of water,	23	15
Safety-valves overloaded,	40	29
Safety-valves defective in construction,	39	20
Pressure-gauges defective,	141	25
Boilers without pressure-gauges,	2	2
Total,	3,002	672

Defective riveting of seams is a more common defect than is generally supposed. When a seam is well riveted, every rivet fills its hole perfectly, there are no cavities around the rivet-shank to cause leakage. But the leakage in itself is not half so serious a matter as the weakening of the joint which necessarily results from the deficient bearing surfaces between the shank of the rivet and the sides of the hole. To attain the maximum strength of a riveted joint it is necessary that the tensile strength of the net section of plate between the rivet holes, and the resistance to shearing of the rivet shank, shall be equal. But this condition necessitates also at least a *fair*-fitting rivet, in order that the bearing surface may be sufficient to give a firm, unyielding joint.

The presence of defective rivets in a seam is very easily shown on new work by the hydrostatic test. Where a rivet does not fill its hole, at least fairly well, it will leak badly, where pressure is applied, and no amount of caulking around the thin edge of the head produced in hand-riveting will make it tight. The only remedy is to cut out the rivet and drive a new one in its place.

Machine-driven and button-set rivets, as a rule, fill the holes much better than hand-driven ones, but care must be exercised or the work may be unsatisfactory. The staunchest riveting seems to done with that class of riveting machines which have facilities for squeezing the plates tightly together before driving the rivet. The difference in the "fit" of the different classes of riveting will be fully shown in the series of articles entitled "Experiments on Iron and Steel," now appearing in the LOCOMOTIVE.

Boiler Explosions.

JANUARY, 1884.

SAW-MILL (1).—The boiler in the planing-mill of the C. N. Nelson Lumber Company at Lakeland, six miles below Stillwater, Mich., exploded January 5th, on account of low water. The fireman, John McCrimmons, was instantly killed, and an employé injured. The loss is about $2,000; fully insured.

SAW-MILL (2).—The saw-mill of William McGee, Bourneville, Ohio, was completely wrecked by a boiler explosion January 6th: McGee was killed, and two workmen, named Brown and Henderson, were fatally injured. Only a few small fragments of McGee's body were recovered.

HEATING BOILER (3).—The heating boiler in the house of Ben. Vasper, Ionia, Mich., exploded January 7th, blowing out the registers and chimneys, and doing some injury to the basement walls.

RANGE BOILER (4).—A range in the residence of Robert Matthews, on Bedford street, Pittsburg, Penn., exploded January 7th, completely demolishing the furniture in the room where the explosion occurred, and quite seriously injuring Mr. Matthews's two daughters. The youngest, a mere child, was badly scalded and burned, and it is feared she also inhaled some steam. Frozen water-pipes caused the accident.

SAW-MILL (5).—The boiler at Hood, Parsons & Co.'s mill at Merrill, Mich., exploded January 7th, killing the engineer, Anthony Moran, and injuring Baptiste Lalonde, Alphonse Legault, William Powers, and Michael Moran. There had been no fire for two weeks, and it is thought that the explosion was caused by ice in the pipes. The loss will be about $5,000.

MACHINE SHOP (6).—At Watkins, N. Y., January 16th, a steam-boiler in an iron-foundry exploded with a report which was heard all over the town. The floors, walls, and roof of the building were brought down, causing a loss of $5,000. All the workmen had gone to dinner, so that no lives were lost.

SAW-MILL (7).—Dickerson & Anderson's portable steam saw-mill, seven miles southeast of Edmore, Mich., was nearly demolished by the explosion of one of its boilers January 17th. Mr. Henry Baldwich, night watchman, was instantly killed, his head being blown off. Two other men had left the mill not over two minutes before. The accident occurred about half an hour before the regular time of going to work, or the loss of life might have been much greater.

RANGE BOILER (8).—A boiler attached to a range in the kitchen of Frank T. Sherwood, Hunter's Point, L. I., exploded with terrific force January 18th, instantly killing Charles M. Sherwood, aged five, fatally injuring Kellogg Sherwood, and burning his mother terribly. Everything in the room was destroyed.

Saw-Mill (9).—The boiler of Brink & Elkins's saw and grist mill at Hawsville, Monroe County, some twelve miles from Columbia, Ill., exploded January 18th, severely injuring several persons and wrecking the engine and engine-room. Simon Roberts and William Walker were fatally scalded. Engineer Nevins was badly scalded and his arm broken. John Elkins's chin was torn off, and he was otherwise hurt. Ludlow French and Mr. Head were slightly scalded.

Shoe Factory (10).—John Grimes, William Cleveland, Angelo Hoitt, and Joseph De Poie were instantly killed, and Joseph Garnier was fatally hurt by the explosion of a boiler at Wallace Brothers' shoe factory, at Rochester, N. H., January 18th. About seven hundred hands are employed in the shop and many were hurt by falling walls and flying debris. The entire side of the factory was blown out and an eighty-foot chimney was thrown to the ground by the force of the explosion. The boiler was blown completely through the main shop and landed on the roof of the store-house one hundred and fifty feet away, demolishing that building. All of the men killed leave wives and families. The safety-valve of the boiler that exploded was out of order, and was weighted down with bricks.

Oil-Works (11).—An explosion in the Eagle Oil-Works at Williamsburgh, N. Y., January 18th, caused damages of about $1,000. Gottlieb Gohl was severely burned.

Machine Shop (12).—A boiler exploded, January 19th, in the Cincinnati Corrugating company's manufactory, on Culvert street and Eggleston avenue, Cincinnati, Ohio, and the building was set on fire. The building was also occupied by the Cincinnati Wire-work company and George H. Bonte & Co., twine manufacturers. The loss is estimated at $50,000; insurance $25,000.

Hoisting Engine (13).—The boiler that runs the elevator of the St. Louis Ice Company, at De Pue, Ill., exploded January 23d, instantly killing Charles Lyons, fireman, mortally wounding Patrick Carney, and dangerously injuring the engineer.

Gas Works (14).—The steam boiler of the Newberne gas works blew up January 27th, damaging the company's property considerably. There was no loss of life. Chief Engineer Green, who was in the building, had a narrow escape from injury.

The days of the ground-mouse, which Burns sings so pathetically about, and of the versatile gopher, and the weather-predicting ground-hog, are numbered. These pests of the farmer have undermined the young corn and burrowed in the flowery meadow since agriculture began, and all the attempts of the gardener to displace them proved futile. Mechanical invention and physical science now threaten to root out these burrowers from their underground resorts. An inventor has obtained the influence of the United States Patent Office to protect his influence in a torpedo, with which he means to exterminate the whole race of ground-burrowing animals. The process is perfectly simple. An exploring party finds all the holes leading to the nest of the offending quadruped, pounds them all air-tight except one, into which a charge of dynamite is inserted. A fuse is connected with this, a match applied, and the party is ready to search for the next burrower, unless the explosion makes a mistake and demolishes some of the hunters instead of the animal.—*American Machinist.*

The other day, while a Vermont woman was frying doughnuts, one of them exploded. Her husband merely observed that he was glad, on the whole, it happened before he had eaten the thing.

The Locomotive.

HARTFORD, MARCH, 1884.

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

Oil in Boilers.

Considerable discussion has been carried on, from time to time, in the mechanical papers on the subject of "lubricating" boilers, or in other words, putting oil into boilers to remove and prevent scale. We have been sorry to see in some cases a wholesale recommendation of the use of oil in boilers for this purpose. It is very evident that the persons making such recommendations have a very limited knowledge of the different qualities of oil which are sold for lubricants, and while they may all be good as lubricants, most of them are very damaging when put inside of boilers. It should be borne in mind that many of the oils which are used on engines are compound oils,—by this we mean that there is a mixture of earth or rock oil, tallow, rosin, whale oil, plumbago, fish oil, beeswax, etc. These substances are mixed with the rock oil to give it body. Now if they are allowed to go into the boiler, the more volatile portions pass off with the steam and do little harm, but the more solid portions and the grease are left behind, and are found in greater or less quantities on the tubes, flues, and lower parts of the shell of the boiler; and keeping the water from contact with the iron, the tubes become distorted and leak around the ends, and the fire-plates bag down and greatly weaken the riveted joints.

Another fact which is usually lost sight of by those who have not given the subject careful study is the quality of the water. Much of the water used in boilers has more or less organic matter, also carbonates, sulphates, and nitrates of lime and magnesia. The carbonates are thrown down in a fine powder, and this mixing with the organic substances and the residuum of the oil, makes a very bad slush or sludge that often gives serious trouble.

The question will be asked, What is the remedy for such difficulties?

The only safe remedy is (under the circumstances mentioned above) to use a closed heater, where the feed water can be heated by the exhaust steam without coming in contact with the water in an way. By this process the heat of the exhaust is utilized and a saving made. But some engineers will say: "I have allowed the exhaust steam from the engine to flow directly into the feed supply, for years, and never had any trouble whatever: in fact, I think my boilers are cleaner for this practice, and I recommend it." This statement may be perfectly true, and such practice has no doubt been followed with good results in many cases. But the whole benefit or danger of such practice depends upon two very important points, viz.: the quality of the oil, and the quality of the water used. With a water free from organic impurities and excessive deposits of carbonates of lime and magnesia, and with an oil consisting largely of petroleum or rock oil, we should expect little trouble, for the conditions necessary to give trouble are absent. The only safe course to follow, then, is to ascertain the quality of the water and the quality of the oil, before adopting such practice. By neglecting this precaution, and following the advice of some person who has had very little knowledge of the matter, beyond his own limited practice, we have seen boilers seriously injured, and in some cases nearly ruined. A case occurred several years ago where the water carried a large amount of organic matter, and an open heater was used. The oil combined with the organic matter, forming a heavy, pasty deposit, which lodged on the flues and fire surfaces, and necessitated expensive repairs. We have specimens of the deposit in this office. The presence of the oil was so marked at the time that fragments of the deposit could be easily ignited, and burned with a bright flame. The effort to save all the waste heat of the exhaust steam is commendable, and it is working in the right direction: but if it is not done intelligently, with reference to all the conditions, it may be carried to a ruinous point. There are dependent and inter-dependent conditions connected with all these questions that should not be overlooked. We have discussed this question of *oil in boilers* in earlier numbers of the Locomotive, and we will close this article by quoting from the December issue of 1882, showing when and how oils may be used with advantage in boilers. The question was asked, "Does the objection to the use of ordinary oils in boilers obtain where the modern preparations of petroleum are used for cylinder oils?" We replied as follows:

"The objection is not as great as when animal oils are used. Still, we find more or less difficulty. The deposit which accumulates is of a tenacious, waxy character, and is more frequently found adhering to the sides of the boiler near the water line and around the upper tubes. We are a little troubled to account for this, but are of the opinion that it is the paraffine in the oil. It should be borne in mind that a large proportion of the oil used in the cylinder is thrown out in the exhaust. We will suppose that one pint of oil is used in a cylinder each day. If the exhaust is returned to the boiler there will have been carried into it in one month not much less than three gallons. If the water is liable to be muddy or carries any considerable quantity of vegetable matter, the oil will combine with it more or less, and certainly give trouble. Therefore, from a wide experience we advise that the exhaust be utilized to heat the feed water, without bringing it in contact with it, which cannot be done unless a pipe or coil heater is used. Crude petroleum is very effective in removing hard scale. But it should be put into the boiler when it is comparatively cool, after blowing down and cleaning out the boiler. The crude petroleum may be put in when the boiler is being filled; it will rise to the surface of the water, and as the water rises in the process of filling, the sides of the boiler will be washed by the rising oil on the surface. We have been able to remove hard scale in this way which could not be removed by any other process. Crude petroleum is volatile, and the amount of residuum which would result from the quantity used in a boiler for such purposes would be so small as to be harmless. We would not, however, advise the indiscriminate use of crude petroleum. If the water carries vegetable matter, or is liable to be muddy, other purgers will be better. But for a hard lime scale we have found crude petroleum very effective. It will be observed that the conditions under which the oil is used in this case are different from those where it is introduced in the exhaust from the engine. In the latter case it is introduced into the water, which is at a high temperature, and may have more or less impurity or scum on the surface; the oil readily combines with this, causing the difficulties mentioned above. While in the former case the oil is introduced cold into cold water, it washes, or "varnishes" the sides of the scale-covered boiler, penetrates it, works its way between the scale and the iron of the boiler, and detaches it. Those who have used petroleum to aid in removing a nut from a rusted bolt will understand its operation. It eats out or dissolves the rust or oxide without injuring the iron. So with hard scale, it works down between the iron and the scale, eats out or lubricates the film of oxide, and detaches it.

Keely's latest rival is not satisfied with ordinary "vibratory" or "odylic" force, but goes in for a triple extract of some kind, in addition to which, not content with ordinary business methods for selling stock in his company, makes it a church affair, starts a big revival, and booms it for all its worth. This strikes us as a pretty bald scheme.

We would call attention to the letter from a correspondent, on another page, on the effect of incrustation on the evaporative efficiency of steam boilers. The European experiments referred to must, it seems to us, have been made under peculiar conditions to justify the publication of such unexpected results. If the ratio of grate to heating surface was very small, or if the rate of combustion was very low, or if only a portion of the heating surfaces were coated with scale, an inexperienced observer might very easily be misled by the results attained, and draw erroneous deductions therefrom. To obtain accurate results of scientific and practical value, experiments of such a nature must be repeated under varying conditions in order to detect and eliminate all possible sources of error.

The effect, on the evaporative power of a boiler, of any given collection or deposition of scale depends both on the character of the scale, and the particular portion of the boiler to which it adheres. If the parts of the heating surface which are exposed to the radiant heat of the incandescent fuel are thickly coated, the evaporative efficiency will always be very greatly reduced; while on the contrary, if the portions covered with scale are the remote ones where the products of combustion are at a much lower temperature, the effect in particular cases might be very slight indeed. We are at the present time making some experiments on the conductivity of different kinds of boiler scale, the results of which will be published in the LOCOMOTIVE in due time.

THE course pursued by some railroads of giving rewards to their engineers and firemen in the shape of percentages of value of fuel saved in hauling certain trains, might, we think, be adopted to great advantage and profit by many of our larger manufacturing concerns. Every steam-user should know how much coal he *ought* to burn each month, and when the quantity exceeds this amount he should investigate, and ascertain the reason therefor. But there are a thousand and one ways in which fuel may be wasted to a slight extent, which are entirely under the control of the engineer in charge, the aggregate of which may amount to a considerable sum. By making it a matter of direct pecuniary interest to him, he will put forth every possible effort to stop all these smaller sources of waste, and at the end of the year both employer and employee may be very materially benefited.

Extent of the Oceans.

SQUARE MILES OF WATERY WASTE IN THOUSANDS AND MILLIONS.

From an interesting work by Dr. Otto Krummel, of Gottingen, we learn the extent of the different seas on our globe. According to his calculations the Atlantic ocean has a superficies of 49,439,468 square miles; Indian ocean, 45,462,040 square miles; Pacific ocean, 99,897,917 square miles. Thus the total superficies of the three largest oceans is 194,787,425 square miles. The Arctic ocean has a superficies of 9,471,294 square miles. In the Arctic ocean, Hudson's bay has a superficies of 663,249 square miles, and the White sea, 7,715 square miles; the Australian sea, 5,112,491 square miles; the Mediterranean, 1,789,029 square miles; Baltic, 257,589 square miles; Red sea, 273,944 square miles; Persian gulf, 146,837 square miles. Then come the seas that Dr. Krummel calls coast seas, namely: North sea, 339,526 square miles; Sea of Great Britain, 126,290 square miles; Sea of St. Laurent, 170,109 square miles; China sea, 761,632 square miles; Japan sea, 647,170 square miles; Sea of Okhotsk, 934,717 square miles; Behring sea, 1,440,338 square miles; Sea of California, 103,678 square miles. The total superficies of these coasted seas is 4,523,460 square miles. Adding the Antarctic ocean, the superficies of which are calculated at 12,690,236 square miles, the total superficies of all the seas is 231,915,905 square miles; while the total superficies of the continents and islands of the globe is only 34,351,750 square miles.—*Pall Mall Gazette.*

Strength of Corrugated Flues.

Corrugated flues, which are becoming quite extensively used in English Marine boilers, have a decided advantage in the quality of strength over the plain cylindrical form. The following result of a test of a furnace-flue of this description, at the works of The Leeds Forge Co., is of interest. It is extracted from the pages of *Engineering*, of Apr. 6, 1883.

The experimental furnace was 6 ft. 9 ins. long, 3 ft. $1\frac{7}{8}$ ins. outside diameter, and had 13 corrugations $1\frac{1}{2}$ ins. deep, pitched 6 inches apart from center to center of each corrugation. The material of which the flue was composed was mild steel, which was, by the testing of a piece cut from the plate found to have a tensile strength of 22.7 tons per square inch (about 51,000 lbs.), with an elongation of 35 per cent. in a length of ten inches. The furnace was enclosed in a strong wrought iron cylinder made specially for the purpose; the annular space between the furnace and cylinder was filled with water, and by means of a hydraulic pump the requisite pressure was applied. Two pressure gauges were attached to the cylinder to indicate the pressure being exerted upon the furnace.

Before any pressure was applied the furnace was carefully gauged for roundness, and was found to be perfectly true along its whole length.

The pressure was then applied, and at each increment of 100 pounds per square inch the furnace was carefully gauged, both vertically and horizontally, at the central corrugation, and the third one from each end, and also longitudinally, so that the elongation under various pressures, the limit of elasticity of the material, and the ultimate strength to resist collapse, should be ascertained. Up to a pressure of 500 pounds per square inch, no alteration in the cylindrical form of the furnace was perceptible, but it had slightly elongated even from the first application of 100 pounds pressure; at 800 pounds it sprung, or altered its circular form to the extent of $\frac{1}{32}$ inch, but on pressure being released, it entirely recovered its original shape; at 850 pounds pressure its alteration was slightly increased, and on relieving the pressure permanent set could be distinctly measured, both cylindrically and longitudinally, and at a pressure of 900 pounds per square inch, it slowly collapsed, altering its form more rapidly than could be followed up by the pump.

After this twelve holes were drilled at various parts of the furnace to ascertain the actual thickness of the plate, and the various places showed thicknesses varying from .51 to .53 of an inch.

The following table exhibits the alteration of form, both longitudinally and transversely at the different pressures.

Pressure in pounds per square inch.	Alteration of form Transversely.						Permanent Set.			Elongation in a length of 5 feet 9 inches.
	Horizontally.			Vertically.						
	A	B	C	A	B	C	A	B	C	
100	nil.	nil.	nil.	nil.	nil.	nil.	nil.	nil.	nil.	.01
200	"	"	"	"	"	"	"	"	"	.035
300	"	"	"	"	"	"	"	"	"	.035
400	"	"	"	"	"	"	"	"	"	.05
500	"	"	"	"	"	"	"	"	"	.07
600	.03	.015	.03	.03	.025	.03	"	"	"	.07
700	.03	.015	.03	.03	.025	.03	"	"	"	.07
800	.04	.03	.05	nil.	.025	.03	"	"	"	.09
850	.10	.05	.08	.04	.025	.03	.035	.04	.035	.11
900	Total collapse ensued.									

A represents third corrugation from one end.
B " " " " other end.
C " central corrugation.

Comparison of the new British Legal Standard Wire Gauge with the old British Gauge (B. W. G.) and the American Gauge.

The appended Table shows the comparative sizes of the wire gauges in ordinary use with the new British Standard, which, we believe, goes into effect March 1, 1884. The sizes, weights, lengths, and breaking strains of the first twenty numbers of the new gauge are given from a circular issued by the British Iron and Steel Manufacturers' Association. From No 20 upward the sizes and numbers only are given. The new gauge was, we believe, originated by the British Board of Trade, and will be known as the Imperial Standard Wire Gauge.

Old British Wire Gauge. (B. W. G.)		Imperial Standard Wire Gauge.										American Wire Gauge.	
					Weight of—			Breaking Strains.					
No.	Diam.	No.	Diam.	Sectional Area.	100 yds.	1 Mile.	Length of 1 cwt.	Anneal'd	Bright.	Diam.	No.	No.	Diam.
	Inches.		Inches.	Sq. Ins.	Lbs.	Lbs.	Yards.	Lbs.	Lbs.	Ins.			Inches.
		7/0	.5	.1963	193.4	3,404	58	10,470	15,700	.5	7/0		
		6/0	.464	.1691	166.5	2,930	67	9,017	13,525	.464	6/0		
4/0	.454											4/0	.46
		5/0	.432	.1466	144.4	2,541	78	7,814	11,725	.432	5/0		
3/0	.425											3/0	.40964
		4/0	.4	.1257	123.8	2,179	91	6,702	10,052	.4	4/0		
2/0	.38												
		3/0	.372	.1087	107.1	1,885	105	5,796	8,694	.372	3/0		
												2/0	.3648
		2/0	.348	.0951	93.7	1,649	120	5,072	7,608	.348	2/0		
0	.34											1/0	.32486
		1/0	.324	.0824	81.2	1,429	138	4,397	6,595	.324	1/0		
1	.3	1	.3	.0707	69.6	1,225	161	3,770	5,655	.3	1		
2	.284											1	.2893
		2	.276	.0598	58.9	1,037	190	3,190	4,785	.276	2		
3	.259											2	.25763
		3	.252	.0499	49.1	864	228	2,660	3,990	.252	3		
4	.238												
		4	.232	.0423	41.6	732	269	2,254	3,381	.232	4		
5	.22											3	.22942
		5	.212	.0353	34.8	612	322	1,883	2,824	.212	5		
6	.203											4	.20431
		6	.192	.0290	28.5	502	393	1,544	2,316	.192	6		
7	.18											5	.18194
		7	.176	.0243	24.	422	467	1,298	1,946	.176	7		
8	.165											6	.16202
		8	.160	.0201	19.8	348	566	1,072	1,608	.160	8		
9	.148											7	.14428
		9	.144	.0163	16.	282	700	869	1,303	.144	9		
10	.134											8	.12849
		10	.128	.0129	12.7	223	882	687	1,030	.128	10		
11	.12												
		11	.116	.0106	10.4	183	1,077	564	845	.116	11		
12	.109											9	.11443
		12	.104	.0085	8.4	148	1,333	454	680	.104	12		
13	.095											10	.10189
		13	.092	.0066	6.5	114	1,723	355	532	.092	13		
												11	.090742
14	.083											12	.080808
		14	.08	.005	5.	88	2,240	268	402	.08	14		
15	.072	15	.072	.0041	4.	70	2,800	218	326	.072	15		
												13	.071961
16	.065											14	.064084
		16	.064	.0032	3.2	56	3,500	172	257	.064	16		
17	.058											15	.057068
		17	.056	.0025	2.4	42	4,667	131	197	.056	17		
18	.049											16	.05082
		18	.048	.0018	1.8	32	6,222	97	145	.048	18		
19	.042											17	.045257
												18	.040303
		19	.040	.0013	1.2	21	9,333	67	100	.04	19		
		20	.036	.001	1.	18	11,200	55	82	.036	20		
20	.035											19	.03589

Comparison of Wire Gauges. (Continued.)

FROM No. 20 UPWARD—SIZES AND NUMBERS ONLY.

Old Gauge.		New Gauge.		American Gauge.		Old Gauge.		New Gauge.		American Gauge.		Old Gauge.		New Gauge.		American Gauge.	
No.	Diam.	No.	Diam.	No.	Diam.	No.	Diam.	No.	Diam.	No.	Diam.	No.	Diam.	No.	Diam.	No.	Diam.
21	.032	21	.032			29	.013							38	006		
				20	.031961					28	.012641					35	.005614
				21	.028462			30	.0124					39	.0052		
22	.028	22	.028			30	.012					35	.005			36	.005
				22	.025347			31	.0116					40	.0048		
23	.025									29	.011257					37	.004453
		23	.024					32	.0108					41	.0044		
				23	.022571					30	.010025	36	.004	42	.004		
24	.022	24	.022			31	.01	33	.01							38	.003965
				24	.0201			34	.0092					43	.0036		
25	.02	25	.02			32	.009									39	.003531
26	.018	26	.018							31	.008928			44	.0032		
				25	.0179			35	.0084							40	.003144
		27	.0164			33	.008							45	.0028		
27	.016									32	.00795			46	.0024		
				26	.01594			36	.0076					47	.002		
		28	.0148							33	.00708			48	.0016		
				27	.014195	34	.007							49	.0012		
28	.014							37	.0068					50	.001		
		29	.0136							34	.006304						

T. Wroblewski compresses oxygen in a vertical glass tube, bent in its upper portion so as to be plunged into liquid ethylene, and produces a vacuum above the ethylene by the aid of a powerful pump. The portion which is plunged into the ethylene has the temperature of the liquid, but in the other portion the temperature increases, after a regular law, with distance from the surface of the liquid ethylene. The temperature of the ethylene depending upon the degree of the vacuum, the pressure, which is observed when the first traces of liquid oxygen appear at the bottom of the curved and cooler portion of the tube, represents the pressure of liquefaction for the corresponding temperature. If a large quantity of gaseous oxygen is used, and the quantity of liquid oxygen increased by diminishing the volume of the unliquefied gas, it is found that in proportion as the column of liquid oxygen surpasses the level of the ethylene the pressure increases; the liquid oxygen comes into the part of the tube where the temperature is greater than that of the liquid ethylene and the observed pressure corresponds to the temperature of the tube at the place of the oxygen meniscus. If the experiment is continued, so as to increase the height of the oxygen column, a pressure is finally reached at which the meniscus completely disappears. Its place can be merely suspected from the difference of the refrangibility of the light above and below. A diminution of the pressure makes the meniscus again visible. This phenomenon always reappears at the same pressure of about 50 atmospheres (750 pounds per square inch). A similar phenomenon can be produced with carbonic acid, and by experiments in liquefying both these gases Wroblewski has arrived at —171.4 F. as a first approximation of the critical temperature of oxygen.—*Comptes Rendus.*

Comparison of the Metric System of Weights and Measures with U. S. and British Standards.

(From D. K. CLARK'S *Manual.*)

EQUIVALENCE OF COMPOUND UNITS OF MEASUREMENT.

The following Table comprises the compound units of measurement most commonly met with in reading the various scientific journals. It will be found useful in ordinary reading for purposes of ready comparison of the two systems.

MEASURES OF WEIGHT AND PRESSURE.

1 kilogramme per metre	=	.672	pound per foot.
1 pound per foot	=	1.488	kilogrammes per metre.
1000 kilogrammes per kilometre	=	1.584	tons per mile.
1 ton per mile	=	631.	kilogrammes per kilometre.
1 kilogramme per square centimetre	=	14.223	pounds per square inch.
1 pound per square inch	=	.07	kilogramme per sq. centimetre.
1 millimetre of mercury	=	.0394	inch of mercury.
1 inch of mercury	=	25.39	millimetres of mercury.
1 millimetre of mercury	=	.0193	pound per square inch.
1 pound per square inch	=	51.7	millimetres of mercury.
1 gramme per litre	=	70.105	grains per British gallon.
1 gramme per litre	=	58.4	grains per U. S. gallon.
1 grain per British gallon	=	.0143	gramme per litre.
1 grain per U. S. gallon	=	.0171	gramme per litre.
1 kilogramme per cubic metre	=	.0624	pound per cubic foot.
1 pound per cubic foot	=	16.02	kilogrammes per cubic metre.

WORK.

1 kilogrammetre	=	7.233	foot-pounds.
1 foot-pound	=	.138	kilogrammetre.
1 cheval-vapeur or cheval	=	.9863	horse-power.
1 horse-power	=	1.0139	chevaux.
1 kilogramme per cheval	=	2.235	pounds per horse-power.
1 pound per horse-power	=	.447	kilogramme per cheval.
1 cubic metre per cheval	=	35.8	cubic feet per horse-power.
1 cubic foot per horse-power	=	.0279	cubic metre per cheval.

HEAT.

1 calorie, or French thermal unit	=	3.968	British thermal units.
1 British thermal unit	=	.252	calorie.
423.55 kilogrammetres = French mechanical equivalent of heat	=	3063.5	foot-pounds.
772 foot-pounds = English mechanical equivalent of heat	=	10.76	kilogrammetres.
1 calorie per kilogramme	=	1.8	thermal units per pound.
1 thermal unit per pound	=	.556	calorie per kilogramme.

MONEY.

1 franc per kilogramme	=	8.798	cents per pound, nearly.
1 cent per pound	=	.114	franc per kilogramme.
1 franc per metre	=	17.73	cents per yard.
1 cent per yard	=	.056	franc per metre.
1 franc per kilometre	=	31.21	cents per mile.
1 cent per mile	=	.032	franc per kilometre.
1 franc per litre	=	73.43	cents per gallon. (U. S.)
1 cent per gallon (U. S.)	=	.0136	franc per litre.

Effect of Scale in Steam Boilers.

EDITOR LOCOMOTIVE:

I notice in a recent issue of a leading mechanical paper an article on the effect of scale in boilers, in which reference is made to experiments made in Bavaria to test the loss of evaporative efficiency of boilers when the heating surface is covered with scale. I quote as follows:

"That there is a false impression about the loss of evaporative effect due to scale we have long felt certain, for we have repeatedly seen locomotive boilers nearly solid with incrustation and sediment, yet the steaming capacity of the engine was not perceptibly affected. Scale is certainly ruinous to heating surface, and is responsible for two thirds of the repairs needed to boilers in some of our Western States."

The last clause is undoubtedly correct; but, if the scale and sediment does not affect the steaming of the boiler, why should the plates be overheated and injured? If the heat is readily taken up by the water so that no loss occurs, the plates cannot well be burned; if, however, the conductivity is but partially destroyed, the evaporative efficiency must be affected thereby, varying, perhaps, with different deposits.

I have known master mechanics of ability who have, with brackish water, considered it economy to remove and clean the tubes in the locomotives under their charge, once a year, and oftener, according to the quality of the water used and the service required.

I would cite two of many cases that I have been directly connected with. Being called upon to examine a boiler, I found a portable boiler and engine of a well-known make; also that a second boiler had been set up and connected to the portable boiler, as that was unable to furnish sufficient steam to drive the engine. Now the portable was well proportioned, and the boiler should have been able to furnish all the steam required. On examination, this boiler was found foul with lime-scale and deposit. It being impossible to enter the boiler for cleaning purposes, solvents and practice for cleaning and washing were directed, and in a very short time the boiler was able to make all the steam required without forcing. The plates showed no overheating nor were the seams or tubes leaking.

Called to examine two horizontal flue boilers, the extremely large grate surface was noted and commented upon, and it was explained that they had been obliged to increase the grate-surface in order to make sufficient steam.

An internal examination showed a heavy coating of scale over the whole heating surface of shell and flues. With proper tools the larger part of the scale was removed, and the boilers started, when it was found necessary to reduce the grate-surface to its original area.

The above are rather extreme cases, but it is noted that no injury had been done the plates by overheating, the nature of the scale being such, that the heat had been communicated to the water so as to prevent this action.

Not from these two, but from the many others, I am most decidedly convinced that deposits of sediment or scale do affect the efficiency or steaming capacity of steam boilers.

F. S. A.

THE multiplication of 987,654,321 by 45 gives 4,444,444,445. Reversing the order of digits, and multiplying 123,456,789 by 45, we get a result equal curious, 5,555,555,505. If we take 123,456,789 as the multiplicand, and, interchanging the figures of 45, take 54 as the multiplier, we obtain another remarkable product, 6,666,666,606. Returning to the multiplicand first used, 987,654,321, and taking 54 as the multiplier, again we get 53,333,333,334—all threes except the first and last figures which read together 54, the multiplier. Trying the same multiplicand and using 27, the half of 54, as the multiplier, we get a product of 26,666,666,667—all sixes except the first and last figures, which read together give 27.—*Exchange.*

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

NEW SERIES—VOL. V. HARTFORD, CONN., APRIL, 1884. No. 4.

Experiments Upon Iron and Steel.

By J. M. Allen.

In riveting boiler plates together one of the important and necessary precautions is, to see that the surfaces of the plates to be riveted together are first brought into complete contact, and firmly held so, while the rivet is being driven. In the best practice of hand riveting this is accomplished by holding the plates together by means of bolts and nuts, in the holes adjacent to the one in which the rivet is to be driven. Some use a lever swung from an internal eye-bolt adjusted in a rivet hole. If the plates are not in actual contact there is danger of a *burr* being formed between the plates as the hot rivet is being driven into place. Such a defect will sooner or later develop a leak. This *burr*

Fig. 14.

Fig. 15.

difficulty is especially liable to occur in machine riveting if it is carelessly done. The rivets are driven so quickly and the blow is given with such force that the hot metal seeks relief at all points.

The riveting machines that are provided with two pistons, one within the other, seem to overcome this difficulty easily. The larger or outer piston brings the plates tightly together, while the inner one drives the rivet in place. We will say, however, that we have seen hand and button set riveting with which no fault could be found. Fig. 12 shows a specimen of button set riveting of iron plates in which the joint is tight. Fig. 13 shows "soft steel" plates riveted with iron rivets. The rivets are button set. It will be noticed in this specimen that the plates are not brought as perfectly together as in Fig. 12. There is some discussion as to the advisability of riveting steel plates with iron rivets, though it is very commonly done at present. Experiments have been and are being made with the view of ascertaining the relative strength of joints of steel plates, with iron and steel rivets. This question will be taken up in the future.

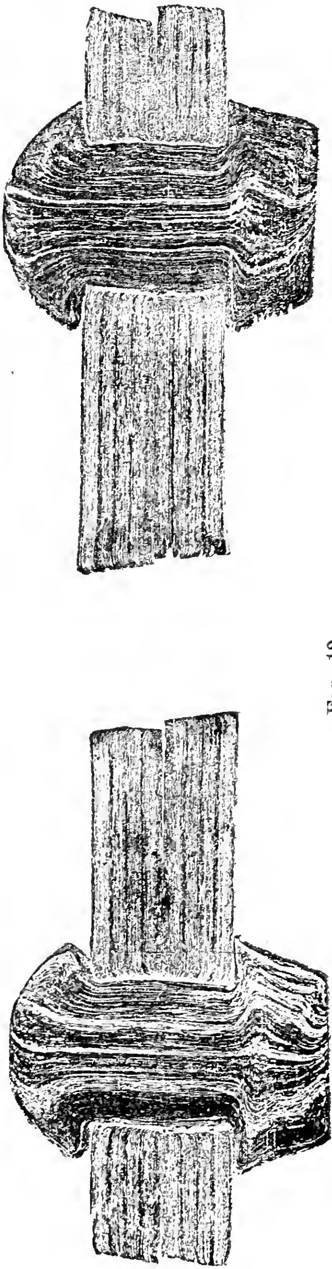


FIG. 12.

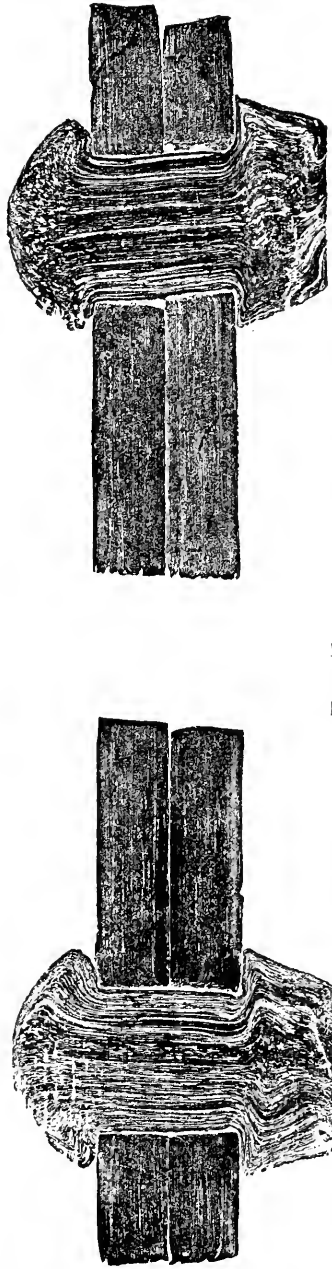


FIG. 13.

WELDING.

The process of welding pieces of iron together is not only one of deep interest but this property of iron is one of great importance in a practical sense. Henry Wurtz says:

"The process of puddling iron is founded on the welding cohesiveness produced at the heat of the puddling-hearth as the iron gradually loses its carbon and other contaminating impurities. Without this property large homogeneous masses could not be readily or cheaply obtained." In welding bars of iron the pieces are scarfed at the ends and heated to the proper temperature, or as it is expressed by *Wurtz*, "A temperature of glutinous cohesion between the surfaces accompanied in the case of iron with a consider-

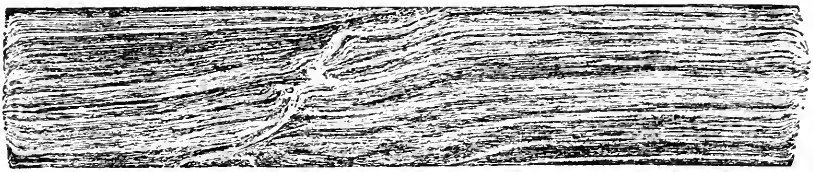


Fig. 16.

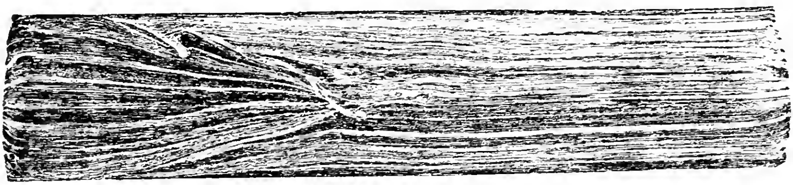


Fig. 17.

Fig. 18.

Fig. 19.

able degree of plasticity and viscosity." The smith heats the scarfed ends on the bars, sprinkles a little sand or borax over each, which fuses and spreads, serving to prevent oxidation as well as to make the surfaces perfectly clean. They are then struck across the anvil to remove any cinder and immediately placed together and hammered with light or heavy hammers according to the size of the bars to be welded. Figs. 14 and 15 show specimens of bars welded with the *long scarf*. Fig 16 is a specimen with the *short scarf*. Fig. 17 is the *tongue* or *split joint*. It will be interesting to notice the fiber of these specimens. The pieces of iron in the *long scarf* were drawn down by hammering as well as the *tongue* in Fig. 17. Iron may be welded to steel also, notwithstanding the fact that the welding temperature of steel is below that of iron on account of its greater fusibility. Figs. 18 and 19 are specimens of iron and steel welded together. The weld of Fig. 18 is quite imperfect. The light spot in the print near the center shows that the two metals did not come together, hence at this point there was no weld, and the joint was consequently weak. The outer surface of the bar when the weld was completed appeared perfect, but on cutting it in two logitudinally, the defect was clearly seen. These specimens under a glass of comparatively low power are very interesting. I will repeat here what I have said in a previous article. The figures or illustrations so far used, are not engravings, but are the exact reproduction of the specimens experimented upon. Engravings may occasionally be used in future articles, but when they are it will be so stated.

TO BE CONTINUED.

Inspectors' Reports.

FEBRUARY, 1884.

The summary of the work of the inspectors of this Company for the month of February, is as follows:

Visits of inspection made,	2,529
Boilers examined,	4,770
" " internally,	1,621
Boilers tested by hydrostatic pressure,	293
" condemned,	29
Defects reported, total,	3,066
" " dangerous,	491

The tabular statement of defects is as follows:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	280	41
Cases of incrustation and scale,	474	38
Cases of internal grooving,	13	4
Cases of internal corrosion,	87	19
Cases of external corrosion,	174	17
Broken and loose braces and stays,	37	7
Settings defective,	107	22
Furnaces out of shape,	81	6
Fractured plates,	96	41
Burned plates,	64	16
Blistered plates,	189	12
Cases of defective riveting,	247	84
Defective heads,	46	13
Serious leakage around tube ends,	649	96
Serious leakage at seams,	191	25
Defective water gauges,	85	13
Defective blow-offs,	36	8
Cases of deficiency of water,	9	3
Safety-valves overloaded,	24	8
Safety-valves defective in construction,	30	4
Pressure-gauges defective,	147	14
Total,	3,066	491

Among the questions most frequently asked of our inspectors when making their ordinary visits are the following, which are of such general interest to engineers as to warrant publication:

1st. How much water per pound of coal should be made into steam at 60 pounds pressure per square inch with 60-inch tubular boilers properly made, well set, and carefully fired?

Under the above conditions, from 8 to 10 pounds, dependent somewhat, of course, upon the quality of the coal, and the temperature of the feed water.

2d.—How much more coal per pound of water does it take to carry 80 pounds per square inch than it does to carry 60 pounds per square inch?

This question could with more propriety be put as follows: How much more heat does it take to make a pound of steam at 80 pounds pressure per square inch than it does to make a pound at 60 pounds per square inch?

Practically, no more coal will be required; *theoretically*, about $\frac{4}{10}$ of one per cent. or about $\frac{1}{250}$ part more.

3d.—Do you get enough better results from steam of 80 pounds per square inch than you do from steam 60 pounds per square inch, to pay for the extra wear and tear of boiler and engine?

Depends entirely upon conditions: If you can *make use* of steam of 80 pounds pressure it pays to use it; there are conditions, however, where 60 pounds, or even less, would be decidedly more economical.

4th.—How much more heat do you get from pipes carrying 60 pounds pressure than from pipes carrying 10 pounds pressure?

Two and one tenths per cent. more heat will be given out per pound condensed from steam of 60 pounds pressure than from steam of 10 pounds pressure, in falling from the temperature due to the respective pressure to 212 degrees Fahrenheit.

5th.—What proportion of direct heating surface to the volume of a fairly protected room is required to maintain the temperature of the room at 60 degrees F., in buildings heated by steam?

From $\frac{1}{75}$ to $\frac{1}{250}$ according to size and exposure of room.

6th.—How much is a given amount of steam reduced in bulk by compressing it from 60 pounds per square inch to 80 pounds per square inch?

About 20 per cent. See any steam table.

Until the South African mines were discovered, the diamond was always found in sands and gravels different from the mineral in which it was believed to be found. At Girqualand West, however, the consolidated eruptive mud of the mines was believed by some to be the true matrix of the diamond; but opinions differed on the question, and arguments were made on both sides. M. Chaper, a French geologist, has, however, during a scientific mission to Hindostan, succeeded in finding the diamond in its mother rock. At Naizam, near Bellary, in the Madras Presidency, M. Chaper has found the diamond in a matrix of rose pegmatite, where it is associated with corundum. The tract of country is almost denuded of trees, bare and rocky, and the rains, wasting the rocks, expose fresh diamonds in the soil. The rock is traversed by veins of feldspar and epidotiferous quartz. Here the diamond is always found, associated with epidotiferous rose pegmatite. The diamond crystals observed are octahedral, but less distinct in line than the stones in South Africa, which seem to have been formed in a freer matrix. It follows from M. Chaper's discovery that diamonds may exist in all rocks arising from the destruction or erosion of pegmatites; for example, in quartzites with or without mica, clay, pudding stones, etc.—*Engineering.*

Boiler Explosions—February, 1884.

SAW-MILL (15).—The boiler in the Twitchell shingle mill, near Blanchard, Isabella county, Mich., exploded February 1st, killing Henry Roop and John Findley, fatally injuring a man named Jerrold, and injuring several others slightly. The mill was owned by R. Ware of Grand Rapids. It was two years old, and the loss will be about $2,000.

SAW-MILL (16).—The Brush saw-mill, four miles back of Rising Sun, exploded its boilers about noon, February 1st, wrecking the mill completely. There were three men at work at the time. Mr. Allen Brush was blown about sixty feet into the creek, and his face, chest, and arms badly hurt. The others were slightly injured.

COTTON-MILL (17).—On Monday, February 4th, a slight boiler explosion occurred at Merrimack Manufacturing Co., Lowell, Mass. A new upright boiler "lost its head," but the damage was only two or three hundred dollars, and only one man, Patrick Conley, was injured.

BREWERY (18).—The boiler of Alexander Brimms & Son's brewery, at Freshwater, N. S., exploded February 8th, doing great damage to the building. No one was hurt.

SAW-MILL (19).—The boiler of Pelgrim's mill at Mason Center, Mich., blew up February 9th, 1884, but no lives were lost.

SAW-MILL (20).—A 30-horse-power boiler in a saw-mill at Irvinetown, Pa., exploded February 16th, completely demolishing the mill and burying five men in the ruins. The boiler was thrown about two hundred yards. Strange to say only one man, the engineer, Charles Smith, was injured, and his injuries are not of a serious nature.

SAW-MILL (21).—A frightful explosion occurred near West Carlisle, Ohio, February 19th, by which two lives were lost. The engineer of a portable steam saw-mill had gone away for a day, leaving the mill in charge of two men named Ridinbaugh and Buckmaster. From some cause, now unknown, the boiler exploded and both men were instantly killed.

STEAMBOAT (22).—The steamboat Clinton burst her steam-pipe February 19th, about one hundred miles above New Orleans, fatally scalding George Pierce. Patrick Murphy, assistant engineer, was also scalded.

SAW-MILL (23).—A flue in the boiler of the St. Croix Lumber Company's planing mill, at Stillwater, Minn., exploded February 20, 1884, blowing the brick-work to pieces, but injuring no one.

PILE DRIVER (24).—The boiler of a stationary engine connected with the pile-driving machinery of the Central railroad, exploded February 27th, near Blakely, Ga., killing the engineer, William Sloan, and seriously wounding his son, also the fireman and two negroes. The engine and car were wrecked.

FOREIGN STEAMER.—The boiler of the steamer Katsai, from Hong Kong to Macao, exploded about February 25th. Seventeen persons were killed, eight of whom were Europeans, the rest natives.

HAS anybody heard any thing recently in regard to the wonderfully economical performance of the steamer *Anthracite?*

The Locomotive.

HARTFORD, APRIL, 1884.

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

Associations of Stationary Engineers.

The Rhode Island Association of Stationary Engineers dedicated their new hall in Providence Saturday evening, March 29th. This was the pioneer association in the country, and was organized through the efforts of Mr. Henry D. Cozens, who was its first president, and who subsequently became president of the National Association.

The new hall, through the liberality of manufacturers and friends, is beautifully fitted up, and gives the engineers very attractive quarters in which to spend their evenings, and discuss questions of interest and profit. They have the nucleus of a fine library, which will no doubt in time become very valuable.

There were present on the occasion large delegations from New Haven, Hartford, and Waterbury, Conn., Boston, Springfield, Worcester, Fall River, and Salem, Mass. The exercises were presided over by President E. A. Beazeley of the Rhode Island Association. Addresses were made by Thos. Pray, Jr., editor of the *Manufacturers' Gazette*, of Boston; J. M. Allen of Hartford; Frank Foster, President of the New Haven Association; Mr. Beswick of the Fall River Association; Harry D. Cozens, and others. Music was furnished by an orchestra, and Mrs. E. J. Carpenter gave some recitations in her inimitable style, which set the audience in a complete uproar. Miss Barnard, of Boston, made a short address, contrasting the illiterate and unskilled engineers with the educated ones, making allusion to scenes she had witnessed in her travels abroad.

The New Haven Association presented an elegant silver water-pitcher, as did the Fall River Association, through their presidents. An immense wooden nutmeg and grater were presented by the New Haven boys, to flavor the lemonade; but the Providence boys were not behind in this part of the exercises. The compliment was returned by Mr. Pray, who, in a facetious little speech, presented the New Haven boys with an immense wooden clam, suitably colored and inscribed. The values of this peculiar engine were gravely discussed.

The occasion wound up with a sumptuous and well-appointed supper, after which were toasts and speeches. Mr. Pray was toast-master, and succeeded in calling out about all the talent, wit, and fun present.

It was our privilege to be present on a similar occasion a few weeks ago in New Haven. The association there has a very fine and commodious hall. The manufacturers have shown a warm interest in the organization, and contributed liberally towards fitting it up and furnishing it.

We regard these associations as valuable in a high degree, both for the manufacturers and the engineers. They will develop a higher standard of ability, and give the engineer a recognition which he justly deserves, but which has not always been accorded him in the past.

It was a gratifying sight to look out upon the intelligent faces of both these assemblies, and to hear from their own lips that their purpose was to labor for social, moral, and intellectual improvement. They disavowed any purpose or plan to array themselves against their employers, but rather to seek to fit themselves more thoroughly for their responsible duties. This has the right ring, and so long as the various associations in the country stand upon such a platform, the manufacturers can well afford to give them encouragement and substantial support.

Obituary.

It becomes our unpleasant duty to make mention of the death of Daniel K. Cosgrove, who for the past fourteen years has been connected with the Inspection Department of our New York office. Mr. Cosgrove was a man of sterling qualities, faithful to every trust, and respected by all who knew him. He had occupied various places of responsibility in New York city, where he lived and died. Mr. Cosgrove's death is the first which has occurred among the inspectors of this company since its organization, and we make this notice with unfeigned sorrow. It reminds us that we are all traveling on to the place from whence there is no return. The important thing is to be ready for such a call. Mr. Cosgrove died March 21st. He was fifty years old.

Many manufacturers who buy engines of larger size than they need when they get them, with a view of increasing the capacity of their works at some future time, carry the highest allowable pressure on their boilers, in consequence of which, the underloaded engine cuts off a very early portion of the stroke. We often find new engines running under a boiler pressure of from 50 to 80 pounds, and cutting off at from one-tenth to one-twelfth of the stroke. This is radically wrong, and is a very wasteful method of running. Such high ratios of expansion are incompatible with any measure of economy in a simple engine. With compound engines a higher ratio of expansion is admissible. In such cases as we have cited, the true course is to carry a *lower steam pressure* and *expand the steam less* in the cylinder. The reason for this is that when expansion is carried beyond a certain moderate limit, the condensation in the cylinder is so excessive, that it causes a far greater loss of economy than is gained by the further expansion.

Some years ago Mr. C. E. Emery made a very complete series of experiments upon the engines of the U. S. Revenue Cutters *Rush*, *Dexter*, *Dallas*, and *Gallatin*, from which he deduced the following simple rule, (subject to certain limitations) for the best ratio of expansion in steam engines.

Rule.—*Add 37 to the steam pressure as shown by the gauge; divide the sum by 22; the quotient will be the proper ratio of expansion.*

A single example will illustrate the easy application of this rule. Suppose we have an engine running under a steam pressure of 90 pounds per square inch;—what should be the ratio of expansion?

Here $90 + 37 = 127$; and $127 \div 22 = 5.77 =$ the best ratio of expansion.

One of our contemporaries seems to feel itself especially aggrieved by a paragraph on page 204 of our last volume, relating to the use of symbols for indicating mathematical operations, and comes out in a column editorial on the subject. We beg leave to say that it seems to have entirely misunderstood the spirit of the paragraph. We said nothing whatever "as to the mathematical faculty," but referred entirely to the use of the ordinary convenient and well known symbols for indicating the *more common arithemetical processes*, such as addition, subtraction, extraction of roots, etc., nor did we refer to or mean any one in particular.

Directions for Collecting Samples of Water for Analysis.

When water is sent to this office for analysis it is of great importance that the sample should represent accurately the supply from which it is obtained, and also that a proper quantity to work upon be submitted to us. We would therefore request those who send us water to observe carefully the following simple directions in its collection.

Procure a *new* two quart *glass bottle* (which can be obtained of nearly any druggist), and a *new* cork to stopper it with. Under no circumstances should water for analysis be put in earthernware jugs, either old or new, preserve cans, old ink-bottles, or any metallic vessel. Use nothing but clean new glass bottles, as above directed.

Before collecting the sample, rinse the bottle thoroughly at least half a dozen times with the water from the source which the sample is to be taken from, filling the bottle about one-third full each time. Then fill it within about half an inch of the stopper, tie the stopper tightly down with a piece of strong twine so there will be no possibility of its coming out in transit.

Precautions to be observed in collecting the samples:—If the sample be taken from a well with a pump in it, pump about four gallons of water before allowing any to run into the bottle; then let the water run directly from the spout of the pump into the bottle.

If the sample be taken from a tap, let a few gallons run to waste; then let it flow directly from the tap into the bottle.

If the sample be intended to represent the water supply of a town, it must be taken from a pipe in direct communication with the street main, and not from a cistern or from any pipe supplied from a cistern.

If the sample be taken from a tank, or well in which no pump is fixed, or stream of any kind, plunge the neck of the bottle completely below the surface, so as to avoid as much as possible collecting the water from the surface. On the other hand be careful not to stir up any mud or sediment at the bottom of the water.

Give as full information as possible on the following points:

From what source the water is collected—wells, rivers, or streams, etc.

If from wells: Describe the diameter and depth of well, nature of soil, sub-soil, the water-bearing stratum into which the well is sunk, and the distance of the well from either drains, cess-pools, or other possible sources of contamination, and describe their nature, if any exist.

If from rivers or streams: Describe the character of the stream; at what point the sample was collected; whether it was taken *directly* from the stream or otherwise; and whether any possible sources of contamination, such as sewerage or other polluting matter, exist on the stream *above* the point where the sample was collected.

The analysis of every sample of water involves considerable time and labor; it is therefore important that the above instructions should be strictly attended to, in order that the result may be reliable.

Cast-Iron in Steam Boilers.

There having been considerable discussion in the Hall of the Franklin Institute, of Philadelphia, concerning the strength of flat cast-iron boiler-heads, an experiment was made immediately after the adjournment of the February meeting, February 20, 1884, to settle some disputed points. The following record of the experiment was read at the Stated Meeting of the Institute, March 19, 1884, by Mr. S. Lloyd Wiegand.

Immediately after the adjournment of the February meeting of this Institute, the drum having flat cast-iron heads was tested by hydrostatic pressure, for the purpose of ascertaining the strength of such heads.

The dimensions of the drum were four feet in length by thirty-six inches in diameter, the heads were of cast iron, of 18,000 lbs. tensile strength per square inch of cross section, and one and fifteen-sixteenths inches ($1\frac{15}{16}$) thick; in one head was a man-hole opening of about 10 x 14 inches, below it a feed inlet of two inches diameter and having a flange fastened thereon by four $\frac{5}{8}$ stud bolts and nuts; there were three openings for gauge cocks, and two for a glass water-gauge connection, such as is usual in cylinder boilers having this form of head. These openings were closed with screw plugs, the man-hole opening by a plate not planed, but simply cast with a flat bearing surface, and a gasket of vulcanized India rubber interposed between it and the slightly raised bearing on the inner surface of the head which had been planed flat.

The other head was simply a casting without any perforations therein excepting of course the rivet holes in the flange.

This drum or cylinder was made by the same parties, Messrs. Sidebotham & Powell of Frankford, who made the boiler which exploded in Gafney & Nolen's dye works, on Martha street, above Huntingdon street, Philadelphia, on May 25, 1881, and the heads were cast from the same pattern, and fitted as nearly as they could be in the same way as the bursted boiler head, the remaining parts of which were produced at the February meeting.

The test was made with a force-pump, having a $\frac{5}{8}$ in. diameter ram and two pressure gauges, each provided with a maximum registering hand, and graduated in 25 lbs. divisions.

The following results were shown: at 425 lbs. to the sq. in. the longitudinal seam leaked just enough to show a wet line, as did also a small part of the seam between the cast-iron head containing the man-hole; at 550 lbs. the head cracked so as to make a noise, but showed very little leakage, the cracks being two radial ones from the man-hole opening, and one some 10 inches around the rim or flange, where it joins the fillet uniting it with the flat part of the head; upon pressure being pumped up to 820 lbs. per square inch, about one-fifth of the head fell out, emptying the vessel of water in less than three seconds.

One of the gauges used for this test was located on the highest part of the drum, and the other on the pipe close to the pump.

Up to the time of breaking out of the piece, not more than a half pint of water escaped, although between 550 lbs. and 820 lbs. pressure, there were about thirty 6-inch strokes of a $\frac{5}{8}$-in. diameter ram made in about $\frac{3}{4}$ of a minute.

The feed-water inlet, which was exactly the same as in the Gafney boiler-head, remains intact, and the fracture is through no other opening than the man-hole.

The back-head of the drum expanded very nearly $\frac{3}{16}$ (within .005 in.) of an inch, in the experiment, and resumed its former shape and appears to be unimpaired in strength.

It had been stated, in the course of the discussion of a paper on this subject, that such heads were unsafe at any pressure, and under a formula submitted on the black-board to the Institute by a member, the ultimate strength of the head without openings in it should have been between 25 and 30 lbs. per square inch.

The result of the test shows that such formula was entirely at fault, and that the strength of such structures is far in excess of any recognized factor of safety for the service to which they are applied, and most strongly suggests that the alarm attempted to be raised upon the subject was without reasonable foundation.

The propriety of experimentally ascertaining the properties of such structures, and the rules which should govern their construction and proportion, as is now being done by the Committee of Science and the Arts, is obvious.

Anti-Incrustation Powders.

The following item of interest is handed in by Chief Inspector Fairbairn of our Boston department. It was clipped from the *Lumber World.*

The Association of German Steam Boiler Inspectors has recently instructed the experimental station at Munich to analyze different forms of so-called Anti Incrustation Powders and Liquids, with the following results:

1. *Incrustation powder.* A. Albert, Berlin. Composed of chalk, salt, quicklime, oxide of iron, etc., etc. Real value about 1½ cents per pound.

2. *Incrustation powder.* I. C. Schwinger, Dessau. Chalk, salt, clay, sand, organic ingredients of various kinds, 44 per cent. of water. Sold at about 4 cents per pound, value one cent. The use of this material will *increase* the incrustation.

3. *German Anti-Incrustation solution.* Patrosio, Bochum. Salt, soda, some organic solutions, all diluted with four volumes of water. Sold at 10 cents per liter, worth 1½ cents.

4. *Anti-Incrustation solution.* I. Warkman, Hamburg. Soda, salt, ammonia, tannin, diluted with eight volumes of water. Its use must be positively condemned as injurious to the boiler.

5. *Incrustation alcohol.* W. Frildo, Hamburg. Salt, carbonate of ammonia, all colored red. Alcohol entirely absent. Undoubtedly injurious to boilers.

6. *Discortante.* Prof. T. Alfieri, Naples. 74 per cent. soda, 6 per cent. vegetable remains, 14 per cent. water, 6 per cent. impurities of all kinds. Sold at 20 cents per pound; value about 3½ cents.

7. *The disincrustant Marsellais.* The Disincrustant Company in Manchester. A very watery solution of some tanning material, possibly catechu. Entirely useless for the purpose.

8. *Disincrustant "Ragosine."* V. L. Ragosine, Paris. A residue of mineral oils, which acts on the inner walls of the boiler much like a coat of tar. Sold at 34 francs per 100 kg. *Real* coal tar can be bought at one-eighth of the price.

9. *Alkalisirte Cellulose.* I. A. Pilgram, Barmen. Soda and starch. Sold at 8 cents a pound, value 1½ cents.

10. *Lepidolyd.* Gebr. Colker, Breslau. Soda, salt, and a little catechu, diluted with 20 volumes of water. Sold at four times its real value.

11. *French-metallic product. Companonyme, Villeneuve.* Simple pulverized chalk, which will only increase the scales.

12. *Extract of Chestnuts.* Esseg in Hungary. A decoction of chestnuts. Not to be recommended, because it pollutes water and does not act as well as common soda.

13. *Anti-incrustant.* Petrick & Co., Bodenbach-on-the Elbe. A concentrated solution of impure soda with a small amount of tanning principles. Sold at $16 per 100 kg., real value about $6.50.

14. *Anti-incrustant.* S. Engel, in Posen. Soda in a solution of tanning materials. Sold at $12.50 per kg.; value about $3.50.

15. *Anti-incrustant with admixture of salt.* S. Engle, in Posen. 3 parts of soda and one part of salt. Sold at $8.50 per 100 kilogrammes, value $5.00.

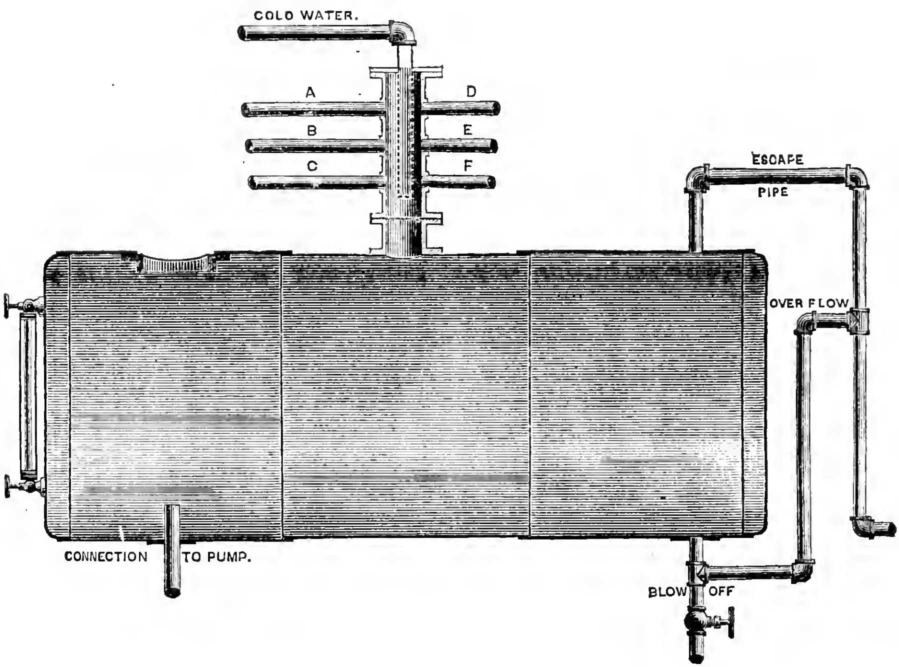
16. *Paralithicon minerale.* A. Bernhard, Altona. Two thirds are impure soda, the other part is composed of clay and organic matter. It will decidedly increase the scale in boilers. Sold at $30 per 100 kg., worth about $2.25.

From these analyses we can form a fair estimate of what may be expected from other much-advertised scale-preventing mediums. The same authorities recommend the purification of the water *before* allowing it to enter the boiler, as the only reliable means for preventing scale. There are various inventions in the market by which this can be effected, and although no method can be given which positively purifies *every* kind of water, it will require but little labor to adapt the *principle* to the various impurities found in most of our springs, streams or lakes.

Receiver for Collection of Water from Drip Pipes.

Where live steam is used for drying, as in paper-mills, cotton-factories, etc., or where circulating coils are used for warming or other purposes, and the water of condensation drains back to a closed tank or receiver, the tank, or heater, as it is usually called, is generally arranged for the hot water and steam to enter at the top, which is proper to avoid concussion from sudden condensation; the pipe for the additional supply of cold water, and the suction of the pump, are usually placed at or near the bottom, sometimes in close proximity to each other. An overflow pipe, located at the highest intended water level, to carry off any excess of water, and an escape pipe for steam, are also usually provided.

We have noticed that in nine cases out of ten a large amount of hot water is lost, or, in other words, the price of a great deal of coal runs off needlessly through the escape pipe. Owing to the difference between the specific gravity of hot and cold water, the cold water sinks to the bottom of the tank and is drawn off by the pump, while the hot water remains at the top and runs to waste through the overflow pipe, nearly or quite at a boiling temperature. We have in several instances changed the arrangement of piping with great success.

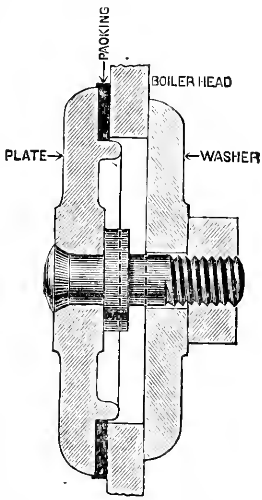


In the annexed sketch we show the receiver with piping connected so that cold water may be taken in with the steam and hot water at the top, so as to become heated by contact therewith; the overflow is connected to the *bottom* of the tank, so that only the coldest water can escape through it; this pipe is carried up to the maximum height at which it is desired to carry the water, and either connected with escape pipe, or the Tee is left open; this is to prevent siphoning of water through the overflow pipe. The blow-off pipe is also taken from this connection, so that any deposit may be removed by blowing out and washing. The suction pipe of pump is extended six or eight inches above bottom of tank, as shown, to prevent its drawing off any sediment that may have collected there and carry it into the boilers. A glass water-gauge is attached to the end of the tank, to indicate the height of water therein, and so enable the attendant to regulate the supply of cold water accordingly.

The pump, in all cases where hot water is to be taken, should be placed below the supply tank, so that it shall be flooded, and thus enabled to work properly.

It is to be borne in mind that the foregoing refers only to receivers where live steam is used, and not where the exhaust steam from an engine is used for heating feed water.

We have often pointed out, in the columns of the Locomotive, the objections to crowding too many tubes into the ordinary type of boiler, in order to gain nominal heating surface. One objection to this practice is this: with hard or muddy water there is great liability of choking up the passages between the tubes, and between the tubes and shell near the back end, to such an extent that there is great danger of burning the plates. This has occurred in many cases that we have been connected with, and we have often had to remove some of the tubes to clean the boiler. To replace the tubes in such cases would simply be paying out money to produce a repetition of the trouble. Instead of doing so we leave them out and stop up the holes with the device shown in the accompanying cut. A small plate similar to an ordinary hand-hole plate, but circular in section, is put on the inside of the head, and packed with rubber. A washer is applied on the outside, and the whole tightened up exactly like a hand-hole plate. No difficulty need be experienced with device, and it may be removed at any time to facilitate cleaning or repairs. In putting the plate on, it will of course be necessary to pass it through the hand-hole in the boiler-head.



The Minister of Public Instruction submitted to the French Academy the proposal of the United States Government for an international congress to select a universal prime meridian and to agree upon a common standard of time. M. Faye, on behalf of the committee to whom the matter was intrusted, cordially recommended the acceptance of the proposal and the appointment of scientific representatives of the various interests of astronomy, navigation, telegraphy, geography, and terrestrial physics. M. De Ahancourtois proposed a decimal division of the day and of the circumference of the globe, somewhat similar to that which was adopted after the first French Revolution, so as not only to adopt a universal hour, but also a universal scale for the absolute measures of time. He thought that the prime meridian should either be that of Ptolemy or that which passes through Behring's Straits, both of which would be free from any competition of national pride, since they traverse no habitable lands.—*Journal of the Franklin Institute.*

Imitation ground glass can be prepared by dissolving two tablespoonfuls of epsom salts in a pint of lager beer and painting the glass with the mixture. After drying, the glass will appear as if frosted.

Production of Rails in the United States, in 1883.

In January last, says James M. Swank, Secretary of the American Iron and Steel Association, we published the statistics of the production of Bessemer steel rails by the Bessemer Steel Works of the United States, in 1883, and now we are enabled to supplement this information with the statistics for the same year of (1) the production of Bessemer steel rails in iron rolling-mills from purchased blooms, (2) the production of open hearth steel rails, and (3) the production of iron rails. These statistics are given in the following table in comparison with corresponding statistics for 1882:

KIND OF RAILS.	TONS OF 2,000 LBS.		
	1882.	1883.	Decrease.
Bessemer steel rails rolled in Bessemer Works, .	1,334,349	1,253,925	80,424
Bessemer steel rails rolled in iron rolling mills, .	103,806	32,629	71,177
Open-hearth steel rails, ...	22,765	9,186	13,579
Iron rails, ...	227,874	64,954	162,920
Total, ...	1,688,794	1,360,694	328,100

The production of street rails in 1883 (included in the total given above), was 19,440 net tons, a decrease of 2,846 tons upon the production of 1882, which was 22,286 tons. The production in 1883, consisted of 1,970 tons of iron rails, 14,499 tons of Bessemer steel rails, and 2,971 tons of open hearth steel rails.

The shrinkage in the production of rails of all kinds in 1883, as compared with 1882, was nearly 20 per cent. This was a larger shrinkage than occurred in 1882, as compared with 1881. We give below the statistics of production of the last three years, premising them with the remark that 1881 was the year of greatest aggregate production of rails of all kinds in our history.

KIND OF RAILS.	TONS OF 2,000 LBS.		
	1881.	1882.	1883.
Bessemer steel rails—all sources, ...	1,330,302	1,438,155	1,286,554
Open-hearth steel rails, ...	25,217	22,765	9,186
Iron rails, ...	488,581	227,874	64,954
Total, ...	1,844,100	1,688,794	1,360,694

The production of all kinds of rails in 1882 was 155,306 net tons less than in 1881, or a decrease of over 8 per cent. Bessemer steel rails increased in 1882 107,853 tons, but iron rails fell off 260,707 tons, and open-hearth steel rails fell off 2,452 tons. The total decrease from 1881 to 1883 was 483,406 net tons, or over 26 per cent.—*The Engineering and Mining Journal.*

The Cost of Producing Pig-Iron.

Mr. J. B. Moorhead of Philadelphia, has addressed to the Committee of Ways and Means of the House of Representatives the following communication:

The undersigned has been engaged in the manufacture of pig-iron since 1857; he has given the business his close personal attention, and claims to be a practical man.

The location of his works (on the Schuylkill) and the character of his plant are fully equal to the average of furnaces in the Lehigh and Schuylkill Valleys. He has now two idle furnaces and none in blast. The reasons for their standing idle at this time will be shown by the following statement of the cost of production and the present ruling prices of the market for pig-iron.

COST OF PRODUCTION.

2 tons of ore,	$9.10
1½ " coal and coke,	5.50
Limestone for flux,	1.00
Labor, oil, and running repairs,	2.70
Actual cost per ton of iron,	$18.30

No allowance is made for interest on capital invested, or for wear and tear of plant. Ruling prices to-day of the different grades of pig-iron *at furnace:*

No. 1 foundry iron,	$20.00
No. 2 " "	19.00
No. 3 gray forge iron,	17.00
Mottled iron,	16.00
White "	15.00

Average of the five grades, $17.40.

Supposing a furnace to make equal quantities of each grade, the *cost* would be $18.30 per ton; and the result of sales, taking the average of the five grades, would be $17.40 per ton, showing a loss, per ton, of 90 cents; no allowance being made for interest on capital or to make good the wear and tear of the plant. Allowing for a blast of two years, which is fully up to the average, an expenditure of from fifteen to twenty thousand dollars is usually necessary to put the work in good repair to start on a new blast.

On a production of 17,500 tons of pig iron in twelve months (the capacity of one furnace), the loss would be, in a blast of two years, say on 35,000 tons of iron, at 90 cents per ton, $31,500.

These facts are sufficient reasons to account for idle furnaces at this time. There should be a margin of profit of at least $1.50 per ton, to pay interest on capital invested, and to make good the wear and tear of the plant after two years' running. To warrant this result, the average ruling price of iron above the present ruling price should be not less than $2.40 per ton. How can this be accomplished with a reduction of the present tariff?

The necessities of the case require an increase of at least two dollars per ton on the present tariff on pig-iron to keep foreign iron out of our market, and that the price here may be advanced to cover the cost of production. At the present prices, it is only a question of financial ability and time to determine the closing of many of the furnaces now in blast.—*The Engineering and Mining Journal.*

The Locomotive.

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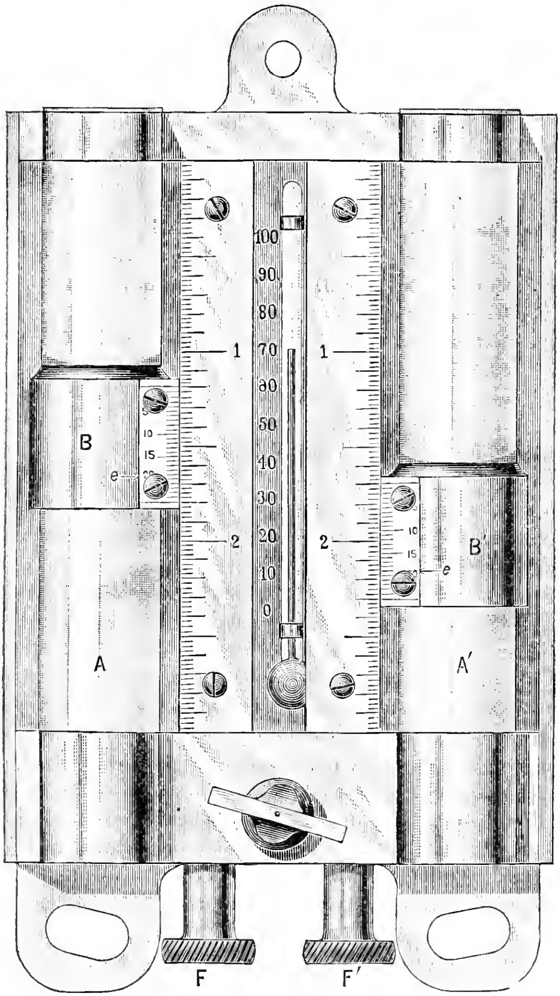
NEW SERIES—VOL. V. HARTFORD, CONN., MAY, 1884. No. 5.

An Improved Draught Gauge for Chimneys.

The influence of the chimney upon the working and economy of a steam-power plant is a factor of the greatest importance, and is one which, in too many cases, does



not receive, in its design, location, and execution, the consideration which should be given to it.

The function of a chimney is, primarily to furnish sufficient draught to properly burn the fuel; secondly, to carry off the products of combustion. If the chimney is so constructed that, the first of the above named conditions is *properly* fulfilled, the second will, in general, follow as a natural consequence.

In designing a chimney for any given boiler plant, due regard should be paid to its location with regard to the surrounding buildings or adjacent hills, if there are any, the general direction of the prevailing winds, etc., as all these conditions have a direct and often very great influence upon the proper working of the chimney. The chimney should be well constructed, the foundation should be firm enough to prevent any unequal settling which would be liable to crack the walls, the bricks should be carefully laid, care should be exercised that no air-holes exist in the shaft of the chimney, or the flue leading to it. The chimney, if of considerable size, should be built with double walls, the inner stack or core should be entirely independent of the outer one; this construction serves two important purposes, it prevents undue loss of heat by radiation, and prevents the excessive, unequal expansion and contraction of the outer stack, which might occur if it were a single shaft exposed on the inside to the heat of the escaping gases, and on the outside to the atmospheric temperature, the difference of which in some cases is as great as 600 degrees F. This adds greatly to the very important element of the strength and durability of the outer shell of the chimney.

The cause of the draught power of a chimney may best be illustrated by assuming a particular case and following its working. Let us suppose we have a chimney 100 feet high from the top of the grate bars, the point from which the height of a chimney should always be reckoned. Suppose the temperature of the external air is 60° F., the temperature at the bottom of the chimney 400° F., which is about right in a well-arranged plant, and the barometer stands at 29.92 inches.

Then it is evident that we shall have in the chimney a column of the hot gases, the temperature of which is 400° Fahr., and the height 100 feet. The density or weight per cubic foot of these gases, when 24 pounds of air are supplied to each pound of coal burned, will be about .0482 pounds, while the density of the external air will be about .0764 pounds per cubic foot. Now it is plain that in this case the pressure of a column of the atmospheric air 100 feet high will be 7.64 pounds per square foot, while the pressure of a similar column of the chimney gases would be but 4.82 pounds. Now as the pressure of that portion of the atmosphere above the chimney-top is evidently the same on the top of the column of hot gases as it is on the surrounding air at the same height, it may be neglected, and we need consider only the gases for the given height of chimney and the same height of the external air. Now in the case we are considering, the difference in the weights of the column of atmospheric air at 60° and the chimney gases at 400° is for a height of 100 feet 7.64—4.82=2.82 pounds per square foot, and it is this excess of pressure of the external air over that in the chimney which causes it to flow into the chimney through every opening into it. In properly-arranged boiler furnaces the only available opening is, of course, through the layer of incandescent fuel on the grate; in its passage through the fuel all the incoming air is heated and forced upward in its turn, and thus the process goes on continuously.

Now it is evident that if we can measure this unbalanced pressure in the chimney, we have a means of determining whether the chimney is "drawing" as well as its height should indicate, and if it is not, it may aid us in discovering where the fault lies, and so remedy it.

This the instrument shown on the first page of this issue enables us to do with very great accuracy.

It has been designed and made by this company, who felt the need of something for their own use, which would give more accurate and reliable results than the crude siphon gauges heretofore used. We are not aware that anything at all approaching it, in accuracy or completeness, has ever been made or used for this purpose.

The cut shows the instrument full size. A and A′ are glass tubes suitably mounted, as shown, and communicating with each other by means of a passage through the base, which passage may be closed by means of the stop-cock shown. Surrounding the glass tubes are the two brass rings B and B′. These rings are attached to blocks which slide in dovetailed grooves in the body of the instrument, back of the three-inch scales, and may be easily moved up and down by screws, the milled heads of which are shown at F, F′. The three-inch scales are divided into fortieths of an inch, and read to thousandths of an inch by the verniers *e* and *e′*, which are attached to the sliding rings B, B′. This arrangement of scale and vernier is exactly the same as that of the ordinary Browne & Sharpe vernier caliper, with which every machinist is familiar, and is so adjusted that when the instrument is perpendicular, and the tops of the brass rings B and B′ are at exactly the same height, the reading of each is precisely the same. This being the case, it is evident that if the two short rings are set at different heights, as shown in the figure, the difference in their readings will give the difference of level between them. The thermometer shown in the center of the instrument is for the purpose of noting the temperature of the external air at the time of making observations, without the trouble of taking along an extra thermometer. The method of using the instrument is as follows:—

At any convenient point, as near the base of the chimney as possible, a hole is made large enough to insert a thermometer to ascertain the temperature of the chimney. (This is something that it is extremely important to know, for other reasons than those connected with the use of the above instrument, and facilities for so doing *should always be provided* when a chimney is built.) The most available place is generally in the main flue leading from the boilers to chimney, and about 12 inches from the side of the chimney. The height from this opening to the top of chimney, and also to top of grates, should be noted for reference.

The chimney gauge is then attached to some convenient wall by means of small screws, the holes for which are shown in the cut. The tubes are then filled about half full of water, when the verniers afford an easy means of setting it exactly perpendicular. One end of a flexible rubber tube is then inserted into the upper end of one of the glass tubes (which are both open at the upper end) and the other end of the tube is inserted in the chimney flue. Then it is evident that the surface of the water in one of the tubes is open to the atmosphere, and that in the opposite tube is in communication with the somewhat lesser pressure of the hot gases in the chimney, and consequently the water in the tube communicating with the chimney will *rise* to an amount dependant upon the difference of pressure inside and outside of the chimney. The tubes B, B′ are then adjusted by means of the screws F, F′, until their upper ends are just tangent to the surface of the water in the two tubes. As the surface assumes a curved form in consequence of the capillary action of the sides of the tubes, this may be done with very great accuracy. The reading of the two scales is then taken and their difference gives the height to which the water has risen. At the same time the temperature of the flue is noted, as well as that of the external atmosphere. Comparison may then be made with the following table, which has been computed by us for use in connection with investigations of chimney draught. The calculations have been made for a chimney 100 feet high, with various temperatures outside and inside of the flue, and on the supposition that the *temperature of the chimney is uniform from top to bottom.* This is the basis on which all calculations respecting the draught-power of chimneys have been made by Rankine and all other writers, so far as we know, but it is *very far from the truth* in most cases. The difference will be quickly shown by comparing the reading of the above-described gauge with the table given. For other heights than 100 feet, the theoretical height is very easily found by simple proportion, thus: suppose the external temperature is 60°, temperature of flue 380°, height of chimney 137 feet, then under 60° at the top of the table, and opposite to 380° in the left hand margin, we find .52″.

Then 100 : 137 :: .52″ : .71″, which is the required height for a 137-foot chimney, and similarly for any other height.

Some interesting facts relative to the cooling of the gases in chimneys have been developed by us, of which we shall give an account in a month or two. For instance, in one chimney, 122 feet in height, we noted the following:

Temperature at the base, - - - - - - 320°
" " top, - - - - - - 230°

and the amount by which the height of water column in the gauge fell short of the theoretical, as given in the above table for uniform temperature, was accounted for to less than the thousandth of an inch.

Height of Water Column due to Unbalanced Pressure in Chimney 100 feet high.

Temperature in the Chimney.	Temperature of the External Air—Barometer, 14.7.										
	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
200	.453″	.419	.384	.353	.321	.292	.263	.234	.209	.182	.157
210	.470	.436	.401	.371	.338	.309	.280	.251	.227	.200	.175
220	.488	.453	.419	.388	.355	.326	.298	.269	.244	.217	.192
230	.505	.470	.436	.405	.372	.344	.315	.286	.261	.234	.209
240	.520	.488	.451	.421	.388	.359	.330	.201	.276	.250	.225
250	.537	.503	.468	.438	.405	.376	.347	.319	.294	.267	.242
260	.555	.528	.484	.453	.420	.392	.363	.334	.309	.282	.257
270	.568	.534	.499	.468	.436	.407	.378	.349	.324	.298	.273
280	.584	.549	.515	.482	.451	.422	.394	.365	.340	.313	.288
290	.597	.563	.528	.497	.465	.436	.407	.379	.353	.326	.301
300	.611	.576	.541	.511	.478	.449	.420	.392	.367	.340	.315
310	.624	.589	.555	.524	.492	.463	.434	.405	.380	.353	.328
320	.637	.603	.568	.538	.505	.476	.447	.419	.394	.367	.342
330	.651	.616	.582	.551	.518	.489	.461	.432	.407	.380	.355
340	.662	.638	.593	.563	.530	.501	.472	.443	.419	.392	.367
350	.676	.641	.607	.576	.543	.514	.486	.457	.432	.405	.380
360	.687	.653	.618	.588	.555	.526	.497	.468	.444	.417	.392
370	.699	.664	.630	.599	.566	.538	.509	.480	.455	.428	.403
380	.710	.676	.641	.611	.578	.549	.520	.492	.467	.440	.415
390	.722	.687	.652	.622	.589	.561	.532	.503	.478	.451	.426
400	.732	.697	.662	.632	.598	.570	.541	.513	.488	461	.436
410	.743	.708	.674	.643	.610	.583	.553	.524	.499	.472	.447
420	.753	.718	.684	.653	.620	.591	.563	.534	.509	.482	.457
430	.764	.730	.695	.664	.632	.602	.574	.545	.520	.493	.468
440	.774	.739	.705	.674	.641	.612	.584	.555	.530	.503	.478
450	.783	.749	.714	.684	.651	.6 2	.593	.564	.540	.513	.488
460	.793	.758	.724	.694	.660	.632	.603	.574	.549	.522	.497
470	.802	.768	.733	.703	.670	.641	.612	.584	.559	.532	.507
480	.810	.776	.741	.710	.678	.649	.620	.591	.566	.540	.515
490	·820	.785	.751	.720	.687	.659	.630	.601	.576	.549	.524
500	.829	.791	.760	.730	.697	.669	.639	.610	.586	.559	.534

Inspectors' Reports.

MARCH, 1884.

The work done by the Company's inspectors, during the month of March last, is as follows:

Visits of inspection made,	2,610
Boilers examined,	5,368
" " internally,	1,850
Boilers tested by hydrostatic pressure,	306
" condemned,	37
Defects reported, total,	3,691
" " dangerous,	571

The tabular statement of defects is as follows:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	341	21
Cases of incrustation and scale,	456	29
Cases of internal grooving,	16	5
Cases of internal corrosion,	119	20
Cases of external corrosion,	155	24
Broken and loose braces and stays,	61	42
Settings defective,	141	18
Furnaces out of shape,	99	15
Fractured plates,	166	42
Burned plates,	91	15
Blistered plates,	240	39
Cases of defective riveting,	732	52
Defective heads,	27	15
Serious leakage around tube ends,	423	97
Serious leakage at seams,	235	68
Defective water-gauges,	111	7
Defective blow-offs,	54	10
Cases of deficiency of water,	13	6
Safety-valves overloaded,	27	8
Safety-valves defective in construction,	18	11
Pressure-gauges defective,	166	27
Total,	3,691	571

WE are sorry to see that relics of barbarism still exist in the form of flues running over the tops of boiler shells. One would naturally suppose, that when the number of boilers that have been ruined, and the still greater number that have been seriously injured by this form of setting, is taken into account, no one would think of setting new boilers in this manner. Yet it is done every day, and by intelligent and experienced men too. The argument used in its favor, that the passage of the hot gases over the steam space superheats the steam, and thereby renders it more economical, is a plausible one, and doubtless leads many steam-users to adopt this form of setting, but if the circumstances are carefully examined, the argument will be seen to be fallacious. It will be impossible to superheat steam when it is in intimate contact with such a large surface and body of water as it is in the case of a tubular boiler. Moreover, it will be difficult for any one who has in mind the poor conductivity of *ashes*, to see (when looking into one of these flues after it has been running a few months) how superheating of the steam *can* occur. Our experience with this form of setting (and it is a somewhat extensive one) points to this: So long as the brick-work at the sides of the boiler is perfectly intact, so as to *compel* all the gases of combustion to pass through the tubes before they reach the top of the boiler, and the water is good, the influence of the flue is *nil*, because if the boiler is properly proportioned, the temperature in the flue cannot much exceed that of the steam in the boiler, and if the boiler is badly proportioned, the deposit of ashes which soon collects on top of the shell protects it, in a great measure, and this very protection is sufficient to prevent any superheating of the steam. But as soon as the side walls begin to heave, as they almost always do, and crowd away from the boiler shell, *then* the fire takes a short cut up past the side of the boiler into the flue, the draft is sufficient to carry away the ashes at the points where the openings are, and the exposed portion of the shell gets "scorched." Sometimes, when the feed-water is very acid, the overheating, while hardly violent enough to burn the plates, is just sufficient to bake all scum on the surface of the water on to the shell above the water-line, beneath which coating corrosion goes on with surprising rapidity. We have seen boilers set in this way, with a coating several inches thick above the water-line, after they had run only a year, beneath which the plates were eaten nearly half-way through, while other boilers in the same room had been running under the same circumstances, with the single exception that the flue did *not* pass back over the shell, for upwards of fifteen years, and only showed very slight traces of this action. This seems to us to be conclusive evidence of the injurious action of this form of setting, aside from the liability, at any time, of the side walls becoming so badly disarranged that actual overheating and fracture therefrom may occur.

Boiler Explosions.

MEDICAL ESTABLISHMENT (25).—At a little before 11 o'clock Sunday morning, March 2d, a boiler explosion occurred at Battle Creek, Michigan, at the Sanitarium. Lewis Holser, the engineer, his brother Henry, and Wm. Potter, fireman, were working about the boilers when the explosion occurred. It knocked them all some distance, but they were not fatally injured. In the gymnasium above there were only two patients, both of whom were ministers, viz.: Elder J. D. Rice, of Oakland, Cal., and Rev. W. Wilson, of Jonesboro, Ind. They were on their feet at the door, about to leave the room, when they were sent up, and then came down in the debris below. They were nearly suffocated, but not dangerously hurt. The main building was but slightly damaged. Loss, $3,000.

SAW-MILL (26).—A disastrous explosion occurred March 3d, at one of the lumbering mills of Albert Lewis, near Bear Creek, Pa., by which three men were killed and two injured. The mill was completely destroyed, its timbers and machinery being hurled in every direction. The three men who were in the mill were instantly killed, their bodies being frightfully mutilated. Rudolph Sipter, shipper, Whitney Whitehead, engineer, and Jesse Knecht, a laborer, were killed outright. Joseph Stiver and William Hendrick were just about to enter the mill when the explosion occurred, and they were knocked down and painfully bruised.

COTTON COMPRESSOR (27).—A large cotton-compress, belonging to the Virginia Compress Company, was completely wrecked March 3d, by the explosion of the boiler. A dozen men working about the press escaped without injury. The compress belonged to Harway & Co., and cost originally $96,000.

FLOUR-MILL (28).—The boiler in W. Reynolds & Co.'s flour-mill, Stayner, Ont., exploded March 5th, wrecking the boiler-house and badly shattering the mill. John Reynolds, one of the proprietors, was killed, and William J. Panton, a fireman, was terribly scalded, and cannot recover. Joseph Knox, a miller, was badly injured. The damage to the property is $10,000.

SAW-MILL (29).—A boiler explosion occurred at Onondaga, eighteen miles north of Jackson, Michigan, March 5th, blowing up Porter's saw-mill, and killing William Ward, engineer, and John Porter, brother of the proprietor. William Young had an arm blown off. He will die. The accident resulted from low water in the boiler. There was no insurance on the mill.

DYE-HOUSE (30).—The boiler of J. T. Trees' dying establishment, Lawrence, Mass., exploded March 6th, killing the engineer, John Trees, Jr., and fatally injuring William Moreland and Michael Cronin, two employees. The force of the explosion was so great that three buildings were shattered into splinters. Pieces of the boiler were thrown four hundred feet, crashing through the roofs of dwellings, but fortunately injuring no one.

SAW-MILL (31).—The boiler of the Boston mill at Bryant's Pond, Maine, exploded March 7th. Four men were killed, and another badly injured. Three of the killed were boiler-makers from Boston, who had just repaired the boiler, which burst while they were gathering up their tools.

LOCOMOTIVE (32).—Freight engine No. 6, on the C. & W. M. Railway, exploded her boiler March 13th. Fireman Charles Cooper was badly injured, and it is feared will lose his sight.

FLOUR MILL (33).—Lesner & Sons' grist-mill, at Charlton, N. Y., was wrecked March 14th, by the explosion of the boiler. The proprietors were killed, and two farmers wounded.

SAW-MILL (34).—A terrific boiler explosion took place in the saw-mill of Moses Roland, near Albion, March 20th. The mill was totally demolished, and the machinery ruined. Walter Mish was hurled several rods from where he was at work, inflicting serious injuries and breaking one of his arms. Mr. Charles Morley's little son was seriously scalded, but will live. Other employees were more or less injured.

SAW MILL (35).—The boiler in Ratman's saw-mill, six miles from Augusta, Ark., exploded March 20th, killing the firemen and three children. A sawyer was blown a distance of 40 feet, but was only slightly injured.

LOCOMOTIVE (36).—Locomotive 308, Pittsburgh, Fort Wayne & Chicago Railway, drawing the through express, exploded four miles west of Leetonia, Ohio, March 20th. Engineer James Richards, and fireman Charles Rhodes, were thrown four hundred feet, and instantly killed. Eleven others were more or less severely wounded, including a brakeman and Conductor Halloway. Three Pullman sleepers and one baggage-car were derailed. The track was torn up for two hundred feet.

ROCK DRILL (37).—The boiler of a diamond drill at work at Lake Antoine, exploded March 22d. Daniel Doherty, drill runner, was instantly killed. Arthur Parks had a leg broken and was injured internally, and Daniel McIntyre received slight injuries. The cause of the explosion is unknown. The drill was run by a New York company, whose damages are slight.

TALLOW WORKS (38).—At the works of the Youngstown Tallow Company, Youngstown, Ohio, in the southeastern part of the city, a new boiler was being tested, March 25th. It was guaranteed to carry a pressure of one hundred pounds, but when eighty pounds was reached, it exploded, and was hurled several hundred feet, landing in a field. Charles Eckert, Engineer Knox, and a boiler-maker were in close proximity to it, watching the steam-gauge, when the boiler let go. All were thrown down by the shock, but escaped any serious injury. The building in which the boiler was located is a total wreck. The report caused great excitement, as it was rumored several persons had been killed, but fortunately no one was injured.

SAW-MILL (39).—James Williams was killed by a boiler explosion in Meyer & Co.'s mill on the Texas & St. Louis railroad, near Paragould, Ark., March —.

The Locomotive.

HARTFORD, MAY, 1884.

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

Insuring the Lives of Engineers and Employees.

In the year 1868 the Board of Directors of the *Hartford Steam Boiler Inspection and Insurance Company* discussed the question of having the charter of the Company so amended as to allow its policies to cover the lives of engineers and firemen in the event of death from the one accident of boiler explosion. This discussion resulted in a petition to the Legislature for such amendment to its charter, which was granted and duly approved by the Chief Executive of the State. Some inquiry was made for this class of insurance, but it was generally regarded by manufacturers as belonging more particularly to the province of accident insurance companies; for, while the insurance contemplated covered only loss of life from the one accident of boiler explosion, the accident insurance companies were issuing policies for about the same rate, covering damages to person and loss of life from all kinds of accident. For instance, a man may be caught and mangled or killed in the machinery or belting of a manufactory, which would not be covered by such a policy as was contemplated by us, but was covered under their general accident policy. Hence manufacturers who desired to insure their engineers or firemen found it for their interest to secure a general accident policy. Inasmuch as this form of insurance was not much sought, it was not pressed, and comparatively few policies were issued covering the lives of engineers and firemen. Renewed attention having been called to the subject of late, this Company has had the matter under further consideration, and the plan of operations decided upon will be explained further on.

We have recently seen forms of insurance policies, written by a boiler insurance company, in which the life liability was blanketed in with boilers, building, and machinery, in which the "loss or damage to life" was *limited to the liability of the assured.* We will suppose that an accident occurs under such a policy, and several persons are killed. It would be found that the insurance was only against the assured's liability, and this question of liability could only be established by the courts, and it would not become a liability on the insurance company until such liability had been decided by the courts. This might involve a long and expensive trial, and it would seem to us that the assured would go into court under some embarrassment; for, in defending himself against liability, he would be vitiating his claim against the insurance company. It should be remembered that the killed and injured are not insured, but the employer is insured against his liability to their representatives; hence these representatives must bring suit against the employer before they can recover damages from him. We will suppose that the insurance company is willing to admit liability, and pay to the employer the amount insured. Can he accept such payment and not establish his own liability to the killed and injured employees, which by the award of the court may be far in excess of the amount insured? The loss to his property would be borne by himself in addition.

We are of the impression that a form of policy which insures the employer against "loss or damage to life, for which he may be liable," blanketed in with insurance on property, is neither good for the employer nor for the employed. For it is liable to be the occasion of numerous and vexatious law suits, and the employer assumes possible serious consequences. We will further add that "insurance or damage to life," based on the legal liability of the assured, even if written in a separate item, would be open to all the objections enumerated above, save complication with the property items.

The liability of employers to employees in this country is decided in the courts, and such cases are based on the alleged negligence of the employer to provide proper safeguards, legal and customary, against the dangers incident to his business. If negligence is not proved, there is no liability.

We regard it as unjust and injurious to the interests of manufacturers, and employees as well, to use this argument of liability in securing business, unless the basis of such liability is stated.

It has always been the purpose of the Hartford Steam Boiler Inspection and Insurance Company to so word its policies that there shall be no ambiguity nor question as to their bearing upon the property covered. And in the insurance against loss of life or damage to person this is especially important. After full and careful consideration of the subject, and under the advice of eminent counsel, the Company decided to cover loss of life under the following form:

"Against loss of life or personal injury of engineer or fireman, or other persons in the employ of the assured, by the explosion of the above-insured steam boiler, payable to the assured in trust for the benefit of such person or persons, or their legal representatives."

By this form of policy it will be seen that the assured is not insured against a contingent liability, but the employees are insured direct, and in case of accident the money would be at once paid over to the assured, and by him distributed to the proper claimants.

There would be no occasion to go into the courts, for there would be no legal question involved. The employer would admit no liability, but knowing that boilers did explode from carelessness or otherwise, he provides for such a possible contingency, and his act would be a beneficent one towards his employees.

We commend these views to the thoughtful consideration of manufacturers, desiring that they shall not be misled on this important question.

We notice an insurance journal intimates that we were instrumental in securing the publication of certain affidavits relating to the management of a Boiler Insurance Company of another state. All we have to say is, that we never saw or knew of any such affidavits until we read them in the scientific paper in which they were published. The editor of the insurance journal alluded to called upon us to obtain an advertisement for his paper, which we declined to give him. Further comment is unnecessary.

The Locomotive.

We frequently receive letters inquiring how the Locomotive can be obtained. The Locomotive is intended for free distribution through our various agents and inspectors, and can always be obtained by calling at any of the offices of the *Hartford Steam Boiler Inspection and Insurance Company.*

If parties desire to have us mail the numbers as they are issued from this office, we charge fifty cents a year to cover expense of mailing and postage.

If any of the Associations of Stationary Engineers in the country desire copies, we will mail a package of six (6) free on application.

The bound volumes, indexed, are issued for mechanical and other libraries. In some cases they are sent complimentary. We bind only a limited number, and for these we charge one dollar a volume.

Discharge of Steam through Orifices.

It is often important to know how much steam at various pressures will flow out of an orifice or through a given length of pipe of any required size in a certain time. While this question has been ably investigated from a theoretical stand-point by men like Zeuner and Rankine, there is a lamentable deficiency of experimental data on the subject. The following is a brief summary of the most reliable experimental data which is readily available, with tables calculated in accordance therewith.

From the *Report on Safety-Valves* in the Transactions of the Institution of Engineers and Shipbuilders in Scotland, vol. xviii, page 30, we find the following formula, by Mr. Brownlee, for the discharge of steam of varying initial pressures through an orifice into the atmosphere:

$$v = 3.5953 \sqrt{h} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

in which v = the velocity of outflow in feet per second as for steam of the initial density: and h = the height in feet of a column of steam of the given absolute initial pressure of uniform density, the weight of which is equal to the pressure on the unit of base.

The following example shows the application of this formula:

Boiler pressure, 80 pounds per square inch above the atmosphere,—with what velocity will steam flow out of an orifice in the shell, for example, a safety-valve?

Here the absolute pressure = 80 + 14.7 = 94.7 lbs. per square inch. The volume of *one pound* of steam at this pressure = 4.56 cubic feet; consequently, the height of a column one inch square of this steam, weighing 94.7 pounds will be,

$$4.56 \times 144 \times 94.7 = 62183.81 \text{ feet}, = h.$$

Then by the foregoing formula (1), the velocity of outflow will be,

$$v = 3.5953 \sqrt{h} = 3.5953 \sqrt{62183.81} = 3.5953 \times 249.37 = 896. + \text{ feet per second.}$$

To find the amount of steam discharged from an orifice of any given size in a given time, we have merely to multiply the area of the orifice by the above velocity, and this product the time in seconds, to obtain the volume of steam discharged, from which it is easy to calculate its weight by reference to a steam table such as that given in The Locomotive, page 120, August, 1882.

The following table has been calculated by the above formula for pressures ranging from 10 to 150 lbs. per square inch above the atmosphere. It may be stated here that the formula does not apply with accuracy to pressures lower than 10 lbs. per square inch. Above this, however, it is stated that it agrees with the results of experiment with "a surprising degree of exactness." See D. K. Clark's *Manual*, page 894.

Velocity of Efflux of Steam into the Atmosphere.

Pressure per gauge.	Velocity of discharge in feet per second.	Lbs. of steam discharged per minute per sq. inch of opening.	Pressure per gauge.	Velocity of discharge in feet per second.	Lbs. of steam discharged per minute per sq. inch of opening.	Pressure per gauge.	Velocity of discharge in feet per second.	Lbs. of steam discharged per minute per sq. inch of opening.
10	861	22.2	50	886	56.5	90	899	90.3
15	867	26.6	55	888	60.7	95	900	94.4
20	871	30.9	60	890	65.	100	902	98.6
25	874	35.3	65	892	69.3	110	904	106.9
30	877	39.5	70	894	73.5	120	906	115.2
35	880	43.8	75	895	77.6	130	908	123.5
40	882	48.	80	896	81.9	140	910	131.9
45	884	52.3	85	898	86.	150	912	140.2

For the flow of steam through pipes the usual formula is:

$$v = 50 \sqrt{\frac{h}{l} \times diam.} \qquad (2)$$

where v = velocity of flow in feet per second;
h = the head as in formula (1);
l = length of pipe in feet.

This is, probably, only an approximation, and for the smaller sizes of pipe from 2 to 4 inches in diameter, the coefficient should range from 40 to 50 instead of being always taken = 50. It is much to be desired that a full and complete series of experiments might be made under varying steam pressures with pipes of different sizes, lengths, and under circumstances to determine the influence of elbows, branches, etc. The expense of making such experiments would not be excessive, and the results would be of the utmost importance.

In determining l, in the above formula, we must add to the actual length of the pipe,—

60 times its diameter for the resistance to flow of the steam where it enters the pipe.

40 times its diameter for each elbow in the pipe.

60 times its diameter for each globe valve.

For obvious reasons it is impossible to give any table calculated by this rule, for no two cases in practice would have the same length of pipe. Mr. Robert Briggs, however, in his *American Practice in Warming Buildings by Steam*, gives quite extensive tables calculated for different conditions, and to this article we refer our readers for further information on the subject.

Physiology in Brief.

The average number of teeth is 32.

The average weight of an adult is 140 pounds 6 ounces.

The weight of the circulating blood is 28 pounds.

The brain of a man exceeds twice that of any other animal.

A man annually contributes to vegetation 124 pounds of carbon.

One thousand ounces of blood pass through the kidneys in one hour.

A man breathes about 20 times a minute, or 1,200 times in an hour.

The average weight of a skeleton is about 14 pounds. Number of bones 240.

The average weight of the brain of a man is three and one-half pounds; of a woman, two pounds and eleven ounces.

A man breathes about 18 pints of air in a minute, or upward of seven hogsheads a day.

Five hundred and forty pounds, or one hogshead and one and one-quarter pints, of blood pass through the heart in one hour.

Twelve thousand pounds, or 24 hogsheads 4 gallons, or 10,728½ pints, pass through the heart in 24 hours.

The average height of an Englishman is 5 feet 9 inches; of a Frenchman, 5 feet 4 inches; of a Belgian, 5 feet 6¾ inches.

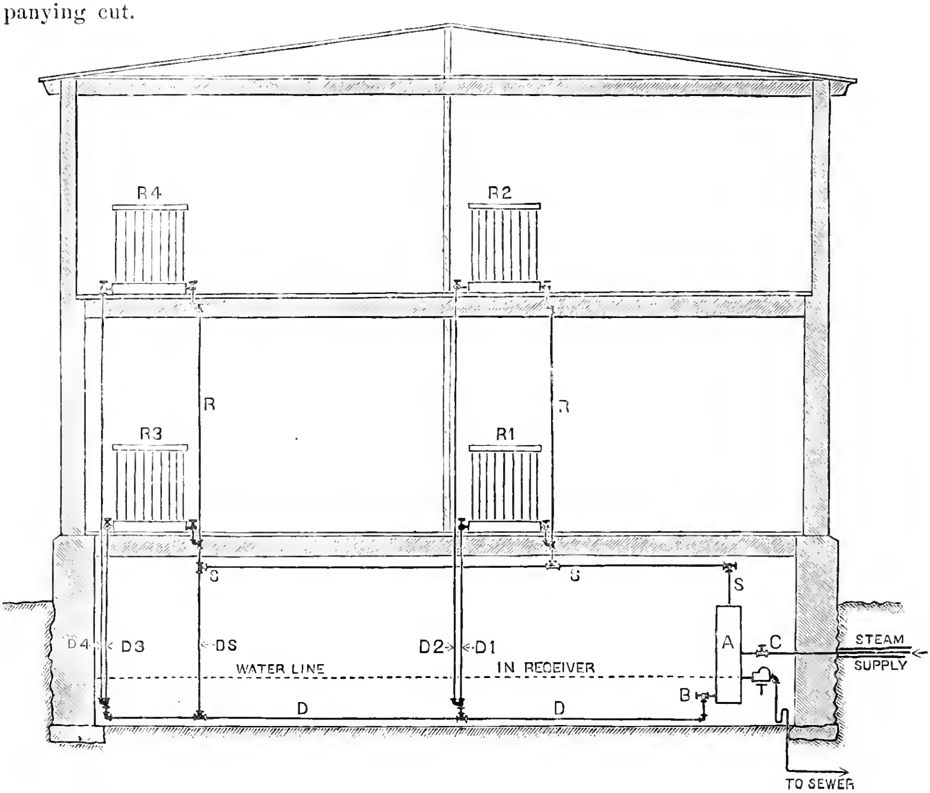
The average of the pulse in infancy is 120 per minute; in manhood, 80; at 60 years, 60. The pulse of females is more frequent than that of males.

One hundred and seventy-five million holes or cells are in the lungs, which would cover a surface 30 times greater than the human body.

The heart sends nearly 10 pounds of blood through the veins and arteries each beat, and makes four beats while we breathe once.—*Exchange.*

Arrangement of Pipes for Heating.

Heating buildings by steam has now become quite common, and when the steam generator is in the same building it is desired to heat, it is quite a simple matter, if a few general principles are followed, to so arrange the details of the system that its working shall be perfectly noiseless and satisfactory. When, however, steam is brought some distance from another building, it not unfrequently happens that the apparatus gives rise to serious annoyance from snapping or pounding, which is due to the presence of water in the pipes, and in such cases more skill is required to make a system which will work well and give no trouble. This, however, can *always* be done, if sufficient care is bestowed upon the design and execution of the work. We give an illustration of a system put in where the distance, location, and low pressure of steam used, made it impossible to return the water of condensation to the boiler. In this case a receiver was used, the arrangement of which will be easily understood by reference to the accompanying cut.



The receiver, A, may be a common kitchen boiler, or it may be made of a piece of large pipe with its ends capped. The main pipe from the boiler, wherever it may be located, enters it as shown by the pipe marked steam supply, and discharges the steam and its water of condensation directly into the receiver. The main distributing pipe, S, is taken out of the top of the receiver and is carried in the usual manner to any point desired. The steam risers, R, R, are connected to it as usual at the proper points, to supply the radiators, R_1, R_2, R_3, R_4, etc. The main return, D, D, is located near the floor, and the drip pipes from radiators, D_1, D_2, D_3, D_4, etc., are connected to it in the manner shown. The extreme end of the distributing main, S, should also be dripped into the return main, as shown at DS. These drip connections should always be kept strictly independent and separate from each other until they are below the water-line of the receiver, or more or less snapping will result. They may be brought together below the water-line in any convenient manner, as shown. The main distributing steam-pipe should pitch *downward* after it leaves the receiver; and the main return should pitch *toward* the receiver, so that the water of condensation will always flow in the *same direction* that the steam does.

A trap, T, set at the proper height to maintain the desired water level in the receiver, is connected in the manner shown, to draw the water from the receiver and discharge it into the sewer. It will be seen by the illustration, that the action of the receiver in relation to the distribution of the steam and the return to the water of condensation is the same as a boiler placed in the basement of the building. If the pressure were sufficiently high, a return pipe could be attached to the discharge pipe of the trap, and the hot water returned to a tank in the boiler room.

This arrangement could also be used to good advantage with high pressure steam at the source of supply, by putting a reducing valve in the main steam-pipe at C.

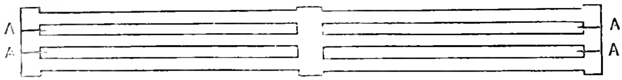
E. C. Roberts, who has for several years been connected with the home office of this Company as special agent, has been transferred to the Boston office, and appointed General Agent of the Northeastern Department of the Company's business. Office, No. 10 Pemberton Square.

The employees at the Dry Dock saw-mill at Mobile, were badly frightened not long since by a blaze of fire suddenly enveloping a log that was being ripped in two. When the machinery was stopped it was found that the teeth were all knocked off the saw. On cutting into the log a 6-inch iron shell was found near the center. The tree from which the log was taken grew in the vicinity of the Spanish forts, near New Orleans, and it is not certain whether the shell was embedded there during Jackson's famous battle, or at the capture of the city by Farragut, in 1862. The fuse and powder were found to be in good condition, and it is considered remarkable that an explosion was averted. —*The Iron Age.*

At the meeting of the Royal Meteorological Society, held on March 19th, the President, Mr. R. H. Scott, F. R. S., read a paper entitled "Brief Notes on the History of Thermometers," in which he said that the name of the actual inventor of the instrument is unknown. The earliest mention of it, as an instrument then 50 years old, was in a work by Dr. R. Flood, published in 1638. Bacon, who died in 1636, also mentions it. The earliest thermometers were really sympiesometers, as the end of the tube was open and plunged into water, which rose or fell in the tube as the air in the bulb was expanded or contracted. Such instruments were, of course, affected by pressure as well as temperature, as Pascal soon discovered. However, simultaneously with such instruments, thermometers with closed tubes had been made at Florence, and some of these old instruments were shown at the loan collection of scientific apparatus at South Kensington, in 1876. They are in the collection of the Florentine Academy, and in general principle of construction they are identical with modern thermometers. Passing on to the instrument as we now have it, Mr. Scott said that most of the improvements in construction in the earliest days of the instrument were due to Englishmen. Robert Hooke suggested the use of the freezing point, Halley the use of the boiling point, and the employment of mercury instead of spirit, and Newton was the first to mention blood-heat. Fahrenheit was a German by birth, but was a protégé of James I., and died in England. Réaumur's thermometer, in its final form, owes its origin to De Luc, while the Centigrade thermometer, almost universally attributed to Celsius, was really invented by Linnæus. Celsius's instrument had its scale the reverse way, the boiling point being 0°, and the freezing point 100°.—*The Iron Age.*

Preventing the Breakage of Grate Bars in Casting.

A style of grate-bar which is preferred by many, is the so-called block or gang-bar. It consists of three or four bars cast together, and generally used in double lengths for ease in removal and repairs, and in order that they may be made lighter. The main objection to this form of bar seems to arise from their liability to break at the ends.



This difficulty can be obviated in the casting of the bars by simply inserting thin pieces of iron (pieces of old cotton-bale ties are good for this purpose) in the mold at the point shown, at A, A, A, A, in the accompanying cut, so as to separate the ends of the bars. After the bar is cast these pieces can be removed by slightly springing the ends apart with a cold chisel, or they may be allowed to remain. It will be seen that bars made in this way are free to expand and contract independently of each other, and the trouble arising from their breakage is avoided.

IN San Francisco bay the angler sometimes hooks a salmon that has had a piece bitten out of the shoulder by the rapacious seal, and certainly the seal lives by masticating fish in whole or part. Recently, the passengers on the 10.00 A. M. boat from Oakland witnessed a tough fight between a sturgeon and a sea-lion. The seal bit viciously at the gill openings of its adversary, and showed superior finesse in planning the campaign, while the sturgeon lashed the water powerfully with its unequally lobed tail, and occasionally administered a stunning blow to the seal. Blood flowed profusely, and the water was dyed for yards around, but eventually the sturgeon yielded up the ghost, being seized by the tail and paralyzed in movement by having its only propeller nearly bitten off. Thus wounded and circumvented, it speedily desisted from the battle, and the seal administered the *coup de grace*, and towed his dinner beneath the waves. The spectacle was an exciting one.—*San Francisco paper.*

MR. QUINCKE, in a recent paper presented to the Berlin Academy of Sciences, gave the results of some very interesting experiments on the compressibility of liquids under comparatively slight increases of pressure. The liquids subjected to test were contained in glass bulbs furnished with capillary tubes and placed in the chamber of an air pump, the method of observation being that of noting the decreased volume from increased pressure, instead of the more common one of watching the expansion under diminished pressure. Water carefully freed from air by continuous boiling was compressed by $\frac{49}{1000000}$ of its original volume under a total pressure of two atmospheres. The following figures were obtained for the compressions of some liquids resulting from 1 mm. additional pressure, also in millionths of the respective volume: Glycerine, .03; olive oil, .07; and alcohol, .12. The observations extended over a large number of liquids, and were found to agree well with observations of former investigators. Within the limits of pressure of one additional atmosphere, the compression remains proportional to the pressure. The experiments further confirm the theory that a certain relation exists between compression and the co-efficient of refraction, but thus far they are not sufficiently decisive to warrant a definite conclusion.—*The Iron Age.*

Diamonds that Falsely Gleam.

While the attempts of chemists to manufacture genuine diamonds have always ended in failure—except, in the production of carbon atoms too minute to have any commercial value—the many efforts to immitate the diamond have resulted in considerable success, and all previous imitations have been surpassed through a process lately introduced in France. Large quantities of the artificial gems thus made have recently been imported into this country, where they are sold in the trade under the name of "heliolas," a diminutive of the Greek word helios, the sun.

They are manufactured from the colorless glass known as strass, which has long been extensively used as a basis for artificial jewels, but which in this case is subjected to a new treatment. After the application of great heat this substance is plunged into cold water, and the consequent sudden chilling has a powerful contracting influence, so that the grain of the strass becomes exceedingly close and fine. Hence the glass is made very clear and transparent and given a remarkably hard surface, which is susceptible of a high polish. Then it is cut and polished like a real diamond, the cutter using a leaden wheel with oil and diamond dust; but, while the genuine stones are always cut singly, a number of the heliolas are fastened with wax in a row upon a stick and are all cut at the same time. For the original foil backing to give brilliancy to an artificial gem a very small bit of foil is substituted, which is attached to the culet or centre of the back. In this way the transparency of the stone is preserved, while the light is reflected into its heart.

When first made in Paris, about two years ago, the heliolas were produced in comparatively small numbers and, being sold by but few establishments, were introduced at first among the better class of people, for whom they were set in silver combs, tiaras, and other ornaments for the hair. Their brilliancy and close resemblance to genuine diamonds gradually caused a large demand for them and the Paris trade in them became extensive about a year ago. Their importation to this country began some seven or eight months since and is, rather singularly, controlled by a Maiden Lane firm of dealers in genuine diamonds. They are used for a variety of purposes. Besides being admirably suited for stage jewels they are largely taking the place of Rhine stones in back combs, and they are set in rolled plate or low-caret gold for jewelry of every form.

The heliolas are cut in both brilliant and rose forms, and are of all sizes, shapes, and colors. Generally they are pure white. The unset stones are graded in certain sizes, to conform to the caret sizes of genuine diamonds, and are sold, according to size, at from $20 to $50 per gross. When set and worn their resemblance to the real gems is such that they are likely to be mistaken for them by all but experts. The latter, however, can not be deceived, as there is a peculiar light in the flash of the true diamond which even this imitation does not reproduce.—*N. Y. Evening Post.*

The oldest American firm manufacturing gunpowder has been in existence nearly ninety years, during which time its name has not changed. Its founders were Frenchmen. It is not a partnership nor a corporation—simply a family. It is worth, probably, $30,000,000. The sons are educated to various occupations or professions in which they will be of use to the company. At the age of 21 they are taken into the business, but must sign agreements binding them to never ask for a division of the proceeds or estate. During their lives they are given all the money they require, and at their deaths the widows are handsomely pensioned until they remarry. Some of the young men become civil engineers, some chemists, some lawyers. A famous American admiral was of this family. An employee is rarely discharged.—*The Mechanical Engineer.*

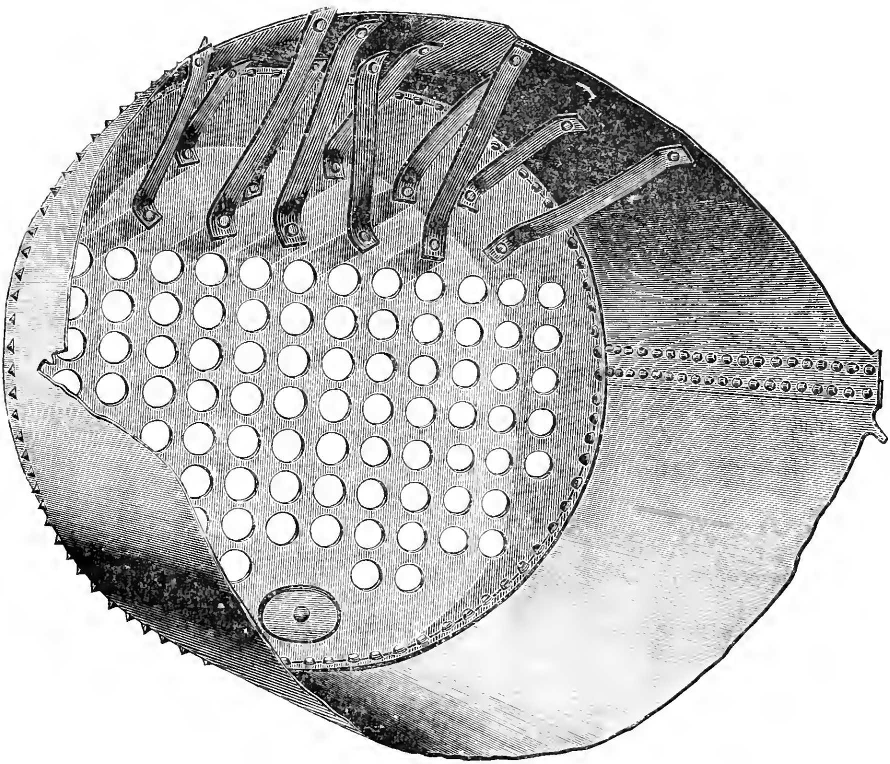
The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

NEW SERIES—VOL. V. HARTFORD, CONN., JUNE, 1884. No. 6.

About Bracing.

Our illustration shows a very cheap and inefficient manner of bracing the heads of a stationary tubular boiler. It was photographed from the wreck of a boiler which recently exploded with disastrous effects. I shall describe this boiler more particularly hereafter, making it the text for a few practical notes upon the subject of bracing.



If we should construct an elastic model of an ordinary cylindrical boiler, apply pressure to it and carefully watch the effect, we should speedily observe the weakness of the heads by deflection or bulging. In some experiments made near Leeds, England, in 1876, described in "Nicholls' Practical Boiler-maker," upon an unstayed wrought-iron boiler head, 30 inches in diameter, and $\frac{3}{8}$ of an inch thick, the deflection carefully measured and recorded was as follows:

10	pounds	pressure	deflection,	$\frac{1}{16}$	of an inch.
50	"	"	"	$\frac{1}{4}$	" " "
100	"	"	"	$\frac{9}{16}$	" " "
150	"	"	"	$\frac{13}{16}$	" " "
200	"	"	"	$1\frac{1}{4}$	inches.
250	"	"	"	$1\frac{3}{8}$	"
300	"	"	"	$1\frac{1}{2}$	"

At this latter pressure a loud report was heard and rupture occurred in several places about the flange.

There are various formulas by which the number and size of braces for any given flat surface may be determined, but they are generally so intricate as to be of little service to those engaged in the work of building or caring for steam boilers. Fortunately, we may make all the calculations referred to here by the simple rules of arithmetic.

Referring to our illustration we assume that portion of the head which is tubed to be sufficiently stayed by the holding power of the tubes, and we have practical demonstration of its ability to do so every day, that is, when the work is properly done. We need then only provide sufficient reinforcement for the part remaining above the tubes, to make it as strong as any other part of like area. For the purpose of this calculation we may disregard the strength imparted to the head by a properly-turned flange, and compute by well known rules the area of the segment above the tubes, which we find to be in this case 813 square inches.

The shell of the exploded boiler was 60 inches in diameter,—$\frac{3}{10}$ of an inch thick—double riveted. As no stamps were found upon the plate we will assume its tensile strength to have been 45,000 lbs. per square inch of section. Under the rules of the United States Steamboat inspection service, this would allow a safe pressure of 90 lbs. per square inch. To that pressure we must brace the head to make it equally strong with the shell.

The practice is to assume the whole load to be upon the braces, not taking into consideration the thickness of the head, or the strength of the rivet-seam which joins the head to the shell.

Employing that method of calculation here, the area of the segment above tubes being 815 square inches and the pressure 90 lbs., this part of the head will have to sustain a load of $815 \times 90 = 73,350$ lbs.

Our next step will be to ascertain the number of braces required to sustain this load. Braces when made of inch round iron of selected quality, with no welds, may safely be allowed a maximum strain of 10,000 lbs. per square inch of section. This would give us $10,000 \times .7854 = 7,854$ lbs. as a safe load for a brace of this sectional area (one inch in diam.) 73354 divided by 7854 would give 9 for the number of braces required in the example we have chosen.

These braces should not all attach to the first course of shell-plates, as they did in the exploded boiler, but be distributed so that at least three of the number should attach to the second course from each head. And no brace should be less than three feet in length, and each should be properly fastened to the *head* of the boiler with good, solid crow-feet, or by pieces of T iron secured radially thereon,—and on the shell by two suitably-sized rivets well driven, so as to realize the full strength of the braces.

Counting the number of braces upon the head of the boiler shown in the illustration, it will be found that they are eleven in number. Six were 28 inches long, and the remaining five 20 inches long, all of flat iron, $\frac{3}{8} \times 2$ inches with one rivet in each end. The objection to this form of brace is that under a heavy strain it would gradually straighten out at the hinged part on each end. The boiler-head would bulge and shear off the heads of the brace-rivets, and the ends would be blown out, probably with fatal results.

That this boiler did not fail in the manner described, was, I think, because it was even weaker and more defective in another part.

An excellent plan in staying boiler-heads, and one that is growing in favor among the trade, is to rivet pieces of T iron radially upon the heads and attach the braces to the web of the T iron. Dependence should not be placed upon T or angle iron alone unless the surface is comparatively small, for their office is but to stiffen and prevent buckling. If reinforcement of the head is required, it must be obtained by bracing it to some stronger part.

The crow-foot appears to be the most popular brace among boiler-makers. There are several modifications, but when properly made and attached in a workmanlike manner, it is a very efficient brace. The quarter twist brace as a rule cannot be recommended except in short lengths between surfaces where no other brace is admissible or as convenient.

Horizontal braces or rods tying the heads of the boiler together are another excellent form of brace. Under like conditions a horizontal brace is more effective than a diagonal one, the efficiency lessening as the angularity of the brace is increased.

A disadvantage in the use of this form of brace is that in many cases the interior of a boiler is not as accessible, nor can it be inspected or cleaned with the same facility as one having diagonal braces, without disconnecting the braces, and that is a very hazardous business, should it be forgotten to replace them again, as is sometimes the case.

It is but a few years since that in looking over a battery of exploded boilers, I found that a number of the braces were disconnected. Upon careful inquiry it was learned that a few months previous, a gang of boiler-makers had been at work upon these boilers putting in some new tubes, and they had undoubtedly loosened the braces to do their work, and forgotten to replace them again when they got through.

The writer had a singular experience related to him by a boiler braced with horizontal rods lying along the water-line. They were about 26 feet long without supports. While under, inspection, one of the braces was struck a light blow with the hammer, as is customary, and it snapped off like a pipe-stem. The remaining braces, when struck, acted in a like manner.

The fractures were said to have been crystalline, showing scarcely any fibre, while of course I do not know what the quality of the brace iron was. I do know the builders of the boiler to have been a firm of good repute, who had the reputation of using the best materials in their construction. My informant attributed the crystallization of the iron to the vibration of the braces, which was not improbable, owing to the omission of supports which are necessary in braces of considerable length, and there may have been other causes which he did not notice.

Many feed-waters contain ingredients which are very destructive to the braces, and they are often found by the inspectors dangerously corroded, sometimes reduced to a skeleton. It is essential that they should be periodically examined and repaired or renewed as they may require it. In short, if I may be allowed to paraphrase a popular and patriotic expression, and apply it to this case, I should say "Eternal vigilance is the price of safety."

F. B. A.

Inspectors' Reports.

APRIL, 1884.

The work done by the Company's inspectors, during the month of April last, is as follows:

Visits of inspection made,	2,827
Boilers examined,	5,691
" " internally,	2,158
Boilers tested by hydrostatic pressure,	347
" condemned,	42
Defects reported, total,	4,085
" " dangerous,	759

The tabular statement of defects is as follows:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	394	36
Cases of incrustation and scale,	639	34
Cases of internal grooving,	18	6
Cases of internal corrosion,	156	11
Cases of external corrosion,	209	31
Broken and loose braces and stays,	61	25
Settings defective,	155	24
Furnaces out of shape,	105	12
Fractured plates,	143	58
Burned plates,	166	38
Blistered plates,	249	38
Cases of defective riveting,	404	122
Defective heads,	39	14
Serious leakage around tube ends,	737	167
Serious leakage at seams,	178	58
Defective water gauges,	75	12
Defective blow-offs,	64	14
Cases of deficiency of water,	19	2
Safety-valves overloaded,	20	10
Safety-valves defective in construction,	56	15
Pressure-gauges defective,	203	32
Boilers without pressure gauges,	4	0
Total,	4,085	759

NO ONE needs to be told that a deficiency of water is a dangerous thing in a boiler, and it seems strange that any one should spend time, money, and brains to invent an apparatus to bring such a state of affairs about, but such it seems is the case, in proof of which read the following item, which we have clipped from a contemporary:

New Safety (?) Device for Steam Boilers. An English engineer proposes an additional safety-valve on the lower part of the boiler, to be constructed in such a manner that an excess of pressure will open it and allow the boiling water to escape. A boiler constructed on this principle was tested in Birmingham, England. It was heated to redness, and cold water pumped into it, which produced in half a minute a pressure of 50 to 60 pounds with less than 5⅜ quarts of water. Although all the safety valves are equally secured, the one at the lower part of the boiler came first into action, and *the result was entirely satisfactory*."

The italics are ours. We have no doubt that the result was satisfactory, eminently so. Although the item does not state expressly that the inventor was killed, we take it for granted that he was, for "the result was entirely satisfactory."

The above is a fair sample of about half of the notions that are patented for the purpose of promoting safety in the use of steam-boilers. How such things originate is a mystery to us. And that a man who is idiot enough to devise such a piece of foolishness should be dignified with the title of engineer is a libel upon the respectable members of the profession. It is about on a level with the American engineer, who, a short time ago, proposed to test boilers by hydrostatic pressure, and combine the advantages of the cold and hot water tests in the following manner: He first proposed to get up steam to the desired working pressure, then open the safety-valve and blow off the steam, *leaving the water in the boiler at the temperature due to the pressure of the steam before it was so blown off*. Then pump in cold water until the required test pressure was attained. Thus he got the combined advantages of the test by cold water and the high temperature due to the steam pressure (in *his* mind). This was a most wonderful "straddle," and would doubtless have delighted the simple heart of Ah Sin.

And yet the above was proposed by an engineer whose name is well known, who is a graduate of one of our best technological schools, and is at present editor of an engineering journal which aspires to lead the country in engineering matters and methods.

Boiler Explosions, April, 1884.

Dry Dock (41).—A boiler on the Marine Dry Dock, New Orleans, La., exploded April 3d, fatally scalding Mathews, the engineer. Several workmen were blown into the river and more or less injured.

Flour Mill (42).—A boiler explosion at W. H. Healey's flouring mill, Blairsville, Pa., April 3d, wrecking the building and seriously injuring Peter Stump, the fireman; Captain Healey, the proprietor, was badly scalded about the legs and feet. The boiler was considered unsafe for a long time.

Tug Boat (43).—The tug Pat Smith, owned by Patrick Smith, of Cleveland, while towing a fleet of lighters to Toledo, burst her boiler off Vermillion, April 6th, and sank to the bottom of the lake. Capt. James Smith of Buffalo, Assistant Pilot, James Perue, engineer, and James Ranco, deck-hand, of this city, were killed. Capt. John Hopson, Dennis Sullivan, John Sullivan, and Thomas Dwyer, the remainder of the crew, were saved.

Flour Mill (44).—Two brothers named Spencer were killed April 13th, at Ford, Ia., a small station on the Wabash Road, by a boiler explosion. They were at work in a flouring-mill. One was killed instantly, and the other died within a few hours.

Saw-Mill (45).—The boiler in a steam saw-mill at Easton, Md., exploded April 14th, killing Carl Engerman, the engineer, and badly scalding the fireman. Engerman's head was entirely blown off.

Salt-Works (46).—The boiler in one of Dolsen, Chapin & Co.'s drill-houses, Bay City, Mich., exploded May 16th, instantly killing Xavier Sovey and William McCauley, and fatally injuring John Lafountain, John Kelley, and John Connelly, badly injuring John Finlan, Thomas Mahony, and Anton Keifer, and slightly hurting Elijah Keifer.

Grist-Mill (47).—The boiler of Batherick's grist-mill, at Davison Station, in Genesee County, Mich., exploded April 17th, instantly killing engineer John Miller, terribly injuring the proprietor, John Batherick, and seriously injuring Cornell, the ticket agent. The mill was wrecked. The damage is $3,000.

Pumping-Boiler (48).—A boiler explosion in the garrison at Brownsville, Texas, April 17th, doing considerable damage and seriously injuring Sergt. McNally of Company G, 9th Infantry, and Private Mooney. McNally was scalded in the face and eyes, and otherwise injured; Mooney was scalded on the breast and injured internally. Both will probably die. The building was completely wrecked. Pieces of the boiler were found half a mile distant from the scene of the explosion.

Wood-working Shop (49).—The boiler at the hub and spoke factory of L. Bruner, Wabash, Ind., exploded April 22d, tearing out the boiler-house, and doing considerable damage. The engineer stood only a few feet distant when the explosion took place, but was not injured.

Locomotive (50).—Engine No. 5, on the B., N. Y., & P. R. R., exploded its boiler while standing on the track at New Castle, Pa., April 24th. The engineer and fireman were injured, but not fatally.

Saw-Mill (51).—The boiler in the saw-mill of J. R. Lamb, at Liberty Center, Ohio, exploded April 25th, instantly killing Wallace Hackett, the engineer, and William Howe, the head sawyer. Both leave families. Three other men in the building were uninjured. The building and machinery were damaged $1,500.

—— Mill (52).—The boiler of the engine of the Hammond Mill, Springfield, Mo., burst April 29th, and rendered the building and machinery nearly a total wreck. Hiram Sullivan, employed in driving a wagon for the mill, happened to be in the yard, and received injuries from which his death resulted soon after. Fortunately none of the other employees were seriously injured. The loss is about $10,000, with no insurance against boiler explosions.

The following account of an explosion which occurred recently in England, at the Wellbeck Print Works, Kilmarnock, would seem to indicate that the English engineers and boiler-makers do not possess all the skill and conscience that is sometimes claimed for them. We do not recall an instance in our whole experience when a more complete ignorance of the first principles of workmanship was shown than that described below. Our account is taken from *Engineering*.

"The explosion was caused by severe local corrosion of the external shell. Alongside the boiler and over the flue (the boiler was of the Cornish type) stood a large cistern containing chloride of lime in solution. The fabrics to be prepared for printing, and which were previously saturated with a solution of dilute sulphuric acid, were passed over rollers and dipped in the cistern. During this operation droppings fell, and soaked into the ground over the flue. Large portions of the shell in this flue were found after the explosion to be no thicker than paper, and the fact that the boiler exploded at a pressure of about 22 pounds cannot be wondered at. The boiler was one which had been bought second-hand about eleven years ago, and it had been several times repaired, while, as recently as April last year, some extraordinary internal patches were bolted to the shell by Messrs. Watson & Co., of Kilmarnock. These patches were $8\frac{1}{2}$ inches by 6 inches, $27\frac{1}{4}$ inches by 10 inches, and $27\frac{1}{2}$ inches by 15 inches respectively, and they were made of $\frac{5}{16}$ inch iron and secured by $\frac{1}{2}$ inch bolts, sheet India-rubber being placed between them and the shell. Even when these patches were fitted, the shell does not appear to have been deemed thick enough to bear the pull of the bolts, for external strap pieces were put on where the bolts occurred. There were, we may add, but ten $\frac{1}{2}$ inch bolts for fixing the largest of the patches. Messrs. Watson & Co., who fitted these patches, are stated to be engineers but not boiler-makers, but it is difficult to understand how any firm of engineers could have carried out such a 'repair.' Competent inspection would, of course, have at once shown the dangerous condition of the boiler."

Another case mentioned by *Engineering* has a rather amusing aspect. A second-hand boiler was purchased by a Mr. York, who stored it for about eighteen months in the yard of a Mr. Taylor, and then gave it to Mr. Taylor in lieu of rent for storage. Mr. Taylor then sold it for £10 or £12 to a Mr. Picken, who worked it for some time and then sold it to Mr. Wilkes for £18. Mr. Wilkes, after working it a while, sold it to Mr. Hunt for £20. Mr. Hunt would probably have sold it at an advance after working it awhile, but fortunately (or unfortunately) it burst while on his hands. It seems that this boiler was of the locomotive type, and the flat furnace sides and ends of the fire-box were wholly without stays. Comment in this case seems unnecessary.

The Bolt, for 1884, published by the students of the Stevens Institute of Technology, has been received. It is well edited, and is a gem of the printers' art.

The Locomotive.

HARTFORD, JUNE, 1884.

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

THE methods resorted to in order to "work up" an insurance business are numerous and sometimes unique. The stereotyped plan for a new company is to *cut rates*, and try to persuade the assured that the older companies have been committing a heartless robbery in charging such rates as have been commensurate with the risk carried and service performed. An effort is made to run the business of Steam Boiler Inspection and Insurance on this basis, as though it were a fire insurance business. The profits of companies that have been for years in the business have been picked out of the Insurance Commissioner's reports, and paraded in circulars, to induce persons to take stock in the new enterprize, promising enormous returns. It is not stated in these circulars that out of five or six companies which have been organized for the sole purpose of inspecting and insuring boilers, only one has been a success. If we remember correctly one of these defunct companies was obliged to close up its business because of the questionable quality of its assets, and the financiering of its officers, some of whom, if we are correctly informed, subsequently became boarders at the State's expense. Success is not generally considered among business men as a crime, and because some manufacturers succeed while others fail, they should not be characterized as robbers. Some of the large manufacturers of this country have paid large returns to their stockholders, while others with the same surroundings and opportunities have made a miserable failure. Throwing their goods on to the market at a less cost has not saved them. The whole trouble was in the management or mis-management. They did not understand the business, nor did they apply themselves studiously to become masters of the fundamental principles on which success depended.

Every manufacturer will recall numerous instances of this kind which have occurred under his eye during his business life. The fact that Smith went into the market and finding that Jones was selling his goods at 10 cents a yard, and offered his for 6 cents, at once created suspicion; something was wrong.

The principle involved here is as applicable to insurance as it is to manufacturing. But it should be borne in mind that there is a vast difference between boiler inspection and insurance, and fire insurance. In the former case, a corps of competent engineers must be constantly employed, and the boilers must be carefully inspected, externally and internally, also, their attachments and connections. This expense is not required in the fire insurance business,—and besides this there must be constant supervision over the boilers insured.

In the office of the *Hartford Steam Boiler Inspection and Insurance Company* are draughting rooms, a chemical laboratory, and apparatus for experimenting on iron and steel, in order to ascertain its fitness for boilers. The company is in daily receipt of letters from its patrons asking information as to the adaptability of this or that type of boiler to their wants, or asking for specifications for boilers, and plans for settings, also plans for chimneys. In many cases, when requested, the company lays out the entire plant, making full detail drawings of building, boilers, and all attachments, and pipe connections. If the parties insured have trouble with the water used in their boilers, or if it makes a hard deposit or corrodes the plates, they send a sufficient quantity to this office for a careful analysis, and a report is made advising them how to overcome the difficulty. Such work is done free for those who are insured. If we are called upon to lay out a boiler plant and superintend the work of setting and connecting the boilers, a reasonable charge is made, but for advice as to new boilers or repairs of old boilers, specifications, when called for, and analysis of water for our patrons, no extra charge is made. We have on file numerous letters from those who have been thus benefited, and who express much satisfaction that there is an institution where valuable and disinterested advice can be obtained.

The ability to give this advice has required much expensive apparatus. But if we can aid those insured with us in attaining greater safety and economy in the use of steam, we are amply repaid. This is the way we rob our patrons. Let it not be forgotten that good management has much to do with the success of any business.

PROF. PASTEUR claims that he has discovered a specific for the prevention of rabies, or hydrophobia in the human being, the remedy being the inoculation of the person with virus originally taken from a rabid animal, and weakened by a scientific process of transfusion through other animals of inferior size and lower vitality. Mr. Pasteur is enthusiastic over his discovery, and claims to have made such thorough experiments as to be absolutely certain of his hypothesis. It is reported in Paris that the eminent professor proved his devotion to science, and his faith in the efficacy of his discovery, by experimenting upon himself, by first inducing a mild form of rabies by inoculation, and then allowing himself to be bitten by a rabid dog. Mr. Pasteur has urged the French Academy to memorialize the Government to appoint an official commission to thoroughly investigate the subject by means of experiments upon voluntary subjects or condemned prisoners. He insists that the process will be without peril, and almost without pain; that the boon to humanity in conquering hydrophobia would far outweigh the small risk which would be incurred.

THE wheat crop of the United States will be this year, according to careful estimates, about five hundred and four millions (504,000,000) of bushels. This is equal to six hundred and twenty-seven million two hundred and two thousand eight hundred cubic feet (627,202,800); or enough to fill a box 855 ft. 11 ins. long, 855 ft. 11 ins. wide, and 855 ft. 11 ins. deep. This would cover a piece of ground 1 mile square to a depth of 22½ feet; or a piece 4¾ miles square to a depth of one foot. And yet, judging from the size of the ordinary hotel biscuit, we would never have suspected that so much wheat was raised in this country.

"A PRACTICAL Solution of the Perfect Screw Problem," a paper read by Professor Wm. A. Rogers, before the Pittsburgh meeting of the American Society of Mechanical Engineers, and now being published in *Mechanics*, is an essay of the greatest interest and value to machinists, and all who are interested in fine work, and they should procure copies of it to preserve for future reference.

ACCORDING to the Chinese, cask-making has been known to them for many thousand years. They labored, however, under this drawback; they did not know how to give the final touch by which the lid is fastened in, the only method that struck them as feasible being to place a boy inside while the cooper tightened the hoops and secured the lid in its position. But how was the boy to get out? This remained an unsolved problem for three thousand years.

The White-Pine (Cal.) *News* feelingly remarks as follows: "All the old bull-teams of the country are being turned into beef this spring. The meat looks well, but it takes a terrible lot of jaw power to reduce it to swallowing fineness."

A Bad Case Stated.—A gentle Miss., once seized with a chill, was feeling most infernal Ill., when came an Md. for to know if N. Y. service he could do. "O," cried the maid (for scared was she), "do you Ind. Tenn. to murder Me.?" "La.," said the doctor, "I Kans. save you from a most untimely grave, if you will let me Conn. your case and hang this liver-pad in place." "Am Ia. fool?" the patient cried—"I cannot Dell." the brute replied, "but no one can be long time Ill. who Tex. a patent blue Mass. pill." "Ark.!" shrieked the girl, "I'll hear no Mo., your nostrums are N. J.—no go."—*Ex.*

The doctor evidently "sensed" the situation for he inquired, Alas. Wy. Kan. N. E. Md. Del. a Ga. Miss. like Utah take R. I. Wis. Ky. for chills?

One of the most annoying things to an inspector is to find some of the fittings around boilers made of odd sizes. This is especially so in the case of steam gauges. Long custom and use has demonstrated the fact that if connections are properly designed, a $\frac{1}{4}''$ pipe is of ample size, and nearly all gauges are made with this size of nipple, and fittings are carried by the inspector for this size only. When, therefore, he finds in some out-of-the-way place where it is impossible to pick up fittings of the different sizes, a steam gauge with a $\frac{3}{8}$ inch nipple and no $\frac{3}{8} \times \frac{1}{4}$ inch reducer is to be had, it is very exasperating, and his expressions on the subject are apt to be much more forcible than elegant or refined.

Regularly about every decade some enthusiastic and sanguine but ignorant person of a mechanical turn of mind, comes before the public with a new sort of motor which is going to revolutionize the motive power question, and do away with the use of steam. These vagaries take various forms, prominent among which is the substitution of some other fluid than water as the working medium. That these various attempts have uniformly failed to fulfill the inventors' claims and expectations does not seem to dampen the ardor of those who come after in the least, and they invent and re-invent the same thing with a regularity, ingenuity, and persistence worthy of a better cause. The latest thing in this line to claim public attention and confidence is a form of the bisulphide of carbon engine, which is claimed by its inventor to possess great merit. Of course those who are acquainted with the principles of thermodynamics do not need to be told that no saving can be made by the substitution of any other fluid for water, but those who are not so informed are easily led away by false reasoning on the subject. We shall have something to say on this subject in a future number. While the inventor through ignorance of the principles of thermodynamics may be honestly enthusiastic in his belief that it possesses great merit and that its adoption and use will result in a very large saving of fuel as compared with the steam engine, it must be confessed that the methods used to dispose of the stock of the company which has been organized to introduce the machine, are not those, if current rumor can be relied upon, which are usually adopted by our honorable and conservative business men; and moreover are not those best calculated to inspire confidence in the minds of cautious people, that a really honest attempt is being made to introduce the thing on its own intrinsic merits.

PROBABLY every man who owns or has run a boiler has experienced a vast deal of trouble with the cast-iron mouth-pieces around the furnace-doors. These pieces invariably warp, crack, and burn out in a short time, and the fire-brick lining falls down, the cast-iron front becomes burned, and where the boilers are set with the flush front setting, the portion of the shell which projects beyond the front tube-sheet gets overheated, which generally results in its fracture, and in many cases the longitudinal seam where the head is attached to the shell is so severely strained that it begins to leak, and sometimes this leakage is very difficult to stop, owing to the joint being permanently strained. This warping and burning away of these castings may be prevented by simply slitting them back from the edge for about one-half their depth. The slots should be from one-half to three-fourths of an inch in width, and may be from eight to twelve inches apart over the furnace door. This width is necessary as they close up gradually under the influence of the intense furnace heat. We shall endeavor to illustrate this point at an early day, to make the method of doing the work somewhat plainer.

AMONG the various things which are calculated to shake one's faith in human nature, are the statements put forth by the makers of various feed-water heaters that, by means of *their* heaters an unlimited amount of cold water may be raised to a temperature far above 212 degrees Fah., by exhaust steam from an engine without causing back pressure on the piston. The statement is, of course, simply absurd, but as many who use engines may have so limited a knowledge of steam that they do not know how hot a good heater *should* deliver its water, we would say that the temperature of exhaust steam at the atmospheric pressure is 212 degrees and no more, that water cannot possibly be heated above this point with its use, and that from 200 to 210 degrees are good results. Where higher temperatures are claimed to have been attained by the use of exhaust steam it is morally certain that either there *was* back pressure to a corresponding extent on the engine piston, or—the heater-man lied.

A CORRESPONDENT of *Engineering* in a recent issue calls attention to a curious practice which is prevalent in the delightful country of Free Trade, whereby civil engineers are ground out without their taking the trouble to learn anything about their business. It seems that engineers there are in the habit of taking into their offices any number of young men who serve three years as office boys merely, and then go forth to practice the profession of civil engineering. We give extracts from the correspondent's letter to *Engineering*, believing it will be of interest. He says: "I may here, on public grounds, crave the attention of your readers, hoping to see in your columns the sentiment of others as to laying down a method for examination before these young gentlemen are permitted to practice . . . . The practice of engineers taking into their offices unlimited numbers of pupils is appalling and disastrous. I know of several cases of engineers without practice or business of any kind who have pupils learning nothing, and filling the position of only office boys, and at the present time a firm have a dozen young gentlemen on the three years' system, price 500 guineas each, and an odd one or two for a less term, paying 300 guineas. . . . . And now, I would like to ask, what knowledge is it possible for these young gentlemen to have acquired, as civil engineers, on completion of this three-years' system of articleship? . . . . I have taken out to foreign countries engineers, chiefly young men, and I have found that not more than one in seven could survey level, or traverse a country for irrigation or railway projects, and with regard to general construction *nil*, and all of this owing to the want of more practical training. . . . . The professor should endeavor to remove and alter this growing evil, and

I hope that our leading members will take up the matter earnestly, and so keep England to the front, instead of having to act, as eventually we must, as second to foreign and American engineers."

We are strongly inclined to believe that, unless they do things in a manner different from that described above, sooner or later, they will be compelled to act as second to American engineers.

THE New Orleans *Times-Democrat*, after a careful observation of the system for several years, is satisfied that the policy of issuing rations by wholesale during times of overflow is a mistake. There are instances of special and urgent necessity in remote and thinly settled districts, where, perhaps, it is advisable, but as a general rule, and especially in the case of river banks and thickly populated regions, the Government could not pursue a more unwise and mischievous policy than that of distributing provisions broadcast among the laboring classes. The system has a tendency to demoralize them, to accustom them to dependence, and to reconcile them to disaster from flood. The *Times* says: "They are being taught that overflows mean Government support, free food, idleness, and irresponsibility. The floods possess no terrors for them; in fact, they are getting to be welcomed-visitors in the eyes of the indolent. They are looked forward to without apprehension and met without regret." A few years' continuance of this policy will produce a community of spiritless and degraded mendicants. They should be fed, but be obliged to work for their rations, and their labor should be expended in erecting levees to prevent future overflows.—*The Manufacturer's Gazette.*

How a Locomotive Boiler Exploded.

In a paper read before the Engineers' Society of Western Pennsylvania, Mr. L. C. Burwell gives interesting particulars about the locomotive boiler which exploded last March, when the engine was running the Chicago limited express. The boiler was built at the Alleghany shops, Pittsburgh, and put to work in the beginning of 1880. Some time after, a crack developed in the angle of the throat-sheet, in the same place on both sides of the boiler. These were repaired by putting copper-plates over the cracks, fastened with screw-rivets. The rupture which caused the explosion originated at this throat-sheet crack on the right-hand side, and it extended from these into the seam joining the wagon-top to the barrel of the boiler. The rupture also ran down into the fire-box leg, making the whole length of the opening about twenty-eight inches, and opening to a width of six inches. This had the effect of stripping four stay bolts in the side of the fire-box immediately adjoining the rupture, and resulted in stripping or breaking every stay-bolt in the right-hand side of the fire-box. Thus freed from its fastenings, the right side of the fire-box was thrown violently against the left, carrying with it part of the tube-sheet, and doubling down the crown-sheet. At the same time the force of the explosion tore up the track, and lifted the rear end of the locomotive, turning it completely around.—*American Machinist.*

Tea Culture in the South.

Mr. C. Menelas, a cotton exporter of Savannah, and a large planter in Mississippi, has experimented successfully for a number of years in the cultivation of tea. He is satisfied from the results of his experiments that this industry will in time become so extensive as to do away almost entirely with the importation of teas. Mr. Menelas recently visited the tea garden of Mrs. A. M. Forster, at Georgetown. She has now 4,000 plants, from one to five feet high, that are growing beautifully. They all came from a dozen tea plants that were "set out" by her husband in 1868. A few of the first plants growing in bushes measure over twenty feet in circumference. Some are in rows six by four, but the majority are in nursery rows, and although the soil is very sandy and poor, the plants show a remarkably vigorous growth. Mr. Menelas tasted some tea prepared from the plant by Mrs. Forster, and found its aroma delicious, and its color beautiful, but deficient in taste for want of better knowledge to cure it. Mr. Menelas also visited the Government tea farm near Summerville. In regard to this costly experiment he says: "Had the selection of the spot for an experimental tea farm been as fortunate as the conception of the idea to raise our own tea was excellent and practicable, that all-important question would have been satisfactorily solved by this time. The Government has decided to abandon the farm, and nothing has been done since last July. The plants remain in nursery rows, and failing to find moisture enough, they send their tap roots to an enormous depth and present a miserable existence. Had only one-quarter of the money been spent on a richer soil, and in a section of the country where the rainfall is copious during the spring and summer months, the results would have been most encouraging." Mr. Menelas thinks that the phantom of cheap labor in the Asiatic countries should not unnecessarily disturb the people here, as it cannot stand in the way of the successful cultivation of tea in America. He thinks that the profit of a first quality of tea per pound should be twenty-five cents. He says that the greatest difficulty in tea culture in this country, is not in its growth, but in its manufacture. The various processes of steaming, firing, assorting, and fanning employed in the tea-growing countries will have to be learned by experience, and when this is accomplished, there will be nothing to prevent the preparation of a tea as fine as the finest from India or Japan.—*Charleston News and Courier.*

The House that Jack Built.

Behold the mansion reared by daedal Jack.

See the malt, stored in many a plethoric sack,
In the proud cirque of Ivan's bivouac.

Mark how the rat's felonious fangs invade
The golden store in John's pavilion laid.
Anon, with velvet foot and Tarquin strides,
Subtle Grimalkin to his quarry glides—
Grimalkin grim that slew the fierce rodent
Whose tooth insidious Johann's sackcloth rent.

Lo! now the deep mouthed canine foe's assault,
That vexed the avenger of the stolen malt,
Stored in the hallowed precincts of that hall
That rose complete at Jack's creative call.

Here stalks the impetuous cow with the crumpled horn,
Whereon the exacerbating hound was torn,
Who bayed the feline slaughter-beast, that slew
The rat predacious, whose keen fangs ran through
The textile fibres that involved the grain
That lay in Hans's inviolate domain.

Here walks forlorn, the damsel crowned with rue,
Lactiferous spoils from vaccine dugs who drew,
Of that corniculate beast whose tortuous horn

Tossed to the clouds, in fierce vindictive scorn,
The harrowing hound, whose braggart bark and stir
Arched the lithe spine, and reared the indignant fur
Of puss, that with verminicidal claw
Struck the weird rat in whose insatiate maw
Lay reeking malt, that erst in Ivan's courts we saw.

Robed in senescent garb that seemed, in sooth,
Too long a prey to Chronos's iron tooth,
Behold the man whose amorous lips incline,
Full with young Eros's osculative sign,
To the lorn maiden whose lac-albic hands
Drew albu-lactic wealth from lacteal glands
Of the immortal bovine, by whose horn,
Distort, to realms ethereal was borne
The beast catulean, vexer of that sly
Ulysse-quadrupedal who made die
The old mordacious rat that dared devour
Antecedaneous ale in John's domestic bower.

Lo! here with hirsute honors doffed, succinct
Of saponaceous locks, the priest who linked,
In Hymen's golden bands, the torn unthrift
Whose means, exignous, stared from many a rift,
Even as he kissed the virgin all forlorn,
Who milked the cow with implicated horn,
Who in fine wrath the canine torturer skied,
That dared to vex the insidious muricide,
Who let auroral effluence through the pelt
Of the sly rat that robbed the palace that Jack built.

The loud, cantankerous Shanghai comes at last,
Whose shouts aroused the shorn ecclesiast,
Who sealed the vows of Hymen's sacrament
To him who, robed in garments indigent,
Exosculates the damsel lachrymose,
The emulator of that horned-brute morose
That tossed the dog, that worried the cat, that kilt
The rat, that ate the malt, that lay in the
HOUSE THAT JACK BUILT!

—*The Hartford Evening Post.*

Snake Stories.

Professor L. R. Smith of Missouri, caught a rattlesnake while visiting in Texas this winter. He found it up an appletree and switched it off the limb with his riding whip. On the back of the snake is a well-defined tracing of the outlines of a woman's face.

Mr. E. F. Herdman, Government Geologist, engaged on a survey of Western Australia, saw a wounded snake which had been attacked by black ants, bite itself twice in the side, from the effects of which it soon died. He believes it to have been a clear case of deliberate suicide, in order to escape the pain and suffering it was compelled to bear.

A Georgia man was fishing near a rock, under which was a snake's den, the other day, when the reptile came gliding up from a foraging expedition and was disappearing in the hole under the rock, when, with a dexterous movement, the man seized him by the tail and threw him twenty feet away. The snake hardly knew what had happened, and again essayed to enter his domicile in the same manner. Again he was treated just as before. Never despairing, for a third time the wily serpent approached the rock. This time he came deliberately, as if contemplating the situation. Arriving at the mouth of the hole, he deliberately coiled himself up and put out his long tongue, as if to take in the full situation. For a while he remained in this defensive position, when he carefully began to uncoil, at the same time disappearing tail-foremost into the den, to the admiration of the man who had been amusing himself at his expense.

EXPERIMENTS are being made in England with what is termed limed coal for the production of illuminating gas. The coal is broken up into fine pieces and then mixed with about three per cent., by weight, of slaked lime. This mixture is distilled in retorts in the ordinary way. It is claimed that by the admixture of the lime the production of ammonia is about doubled, and that sulphur compounds are retained by the lime so that the gas is more easily purified. A slight increase in the yield of gas is also said to result. The presence of lime in the coke produced is stated not to be detrimental to its use as a fuel, it being claimed that the lime is a beneficial constituent, as it performs the office of an "oxygen carrier," and aids in the perfect combustion of the carbon.—*The Mechanical Engineer.*

Which Way do You Circle?

One generally reads that persons walking without landmarks perform a large circle and cut their old tracks again. This circling, as far as my present knowledge goes, is *to the left.*

My present theory is that in most persons the right leg is the stronger and the more forward to step over any obstacles, and hence that it slightly outwalks the left: this theory involving as further consequences that those in whom the left leg is the stronger, would circle to the right, while those whose legs are of equal strength would either keep straight on, or would wander either way indifferently. I imagine this "outwalking" of one leg by the other to be similar to the manner in which a body of troops wheels to one side or the other.

In the following I use the expression "*right-legged.*" By this I mean that the right leg is that chosen to kick with, jump from, etc.

My negative evidence is as follows:

1. I, myself, am right-legged, and in a mist I always circle to the left. I have only come across cases similar to my own in these respects. On the other hand, my left arm has been trained (by always rowing on the bow side) to be stronger than my right for rowing purposes; and in sculling I always circle to my right side.

2. Those savages of whom I have read that they could keep a straight course without any landmark, were also represented as using both arms (and legs?) impartially.

I have given the above evidence chiefly to show how weak it is, in the hope that some of your readers will try to collect data of the following nature from any of their acquaintance who have had experience in the matter:

(*a*) To which side, if any, do they circle?

(*b*) Are they right or left armed, right or left legged; or are the two sides equally strong?

It might also be interesting to learn from boating friends if they have observed any connection between the side on which they have been accustomed to row, and the side to which they circle in sculling; such connection as that indicated above.

Finally, I may suggest that more might be known on the question of the heredity of right or left sidedness; and as to whether persons are often right-armed but left legged, etc. But it must be remembered that tendencies of this nature are often "educated out" in childhood.—*W. Larden, in Nature.*

Heat Generated in a Converter.

The greater economy that competition forces the steel works to practice is rapidly reducing unnecessary waste to a minimum. Thus far improvements in the Bessemer process have mostly been planned with a view to economy in time rather than in material. Some years ago Professor Akerman of Stockholm worked out the problem of the heat generated during a Bessemer blow which has gained world-wide celebrity, but, owing to the weights and measures being expressed in metric units, the results he obtains do not convey any very definite idea. Thinking it may interest some of our readers, we present the following solution of the problem, which is suggested by a correspondent. The converter-charge assumed is 22,400 pounds of pig iron, the heat produced being due to to the oxidation of the following elements:

Carbon,...............	4½	per cent.,............	1,080 pounds.
Silicon,...............	2	"	448 "
Manganese,...........	½	"	112 "
Iron,.................	1	"	224 "

Not going into details in solution of the problem, it is unnecessary to give any further data except to assume that the right proportion of air is supplied and that the blow lasts 15 minutes. The next table gives the heat of combustion per pound, in British thermal units, of the elements oxidized:

Carbon (to C O),...............	4,453—Favre and Silbermann.
Silicon,........................	14,126—Troost and Hautefeuille.
Manganese,.....................	2,194—(assumed by Jordan).
Iron,..........................	2,194—Favre and Silbermann.

Hence the total heats of combustion will be:

Carbon,...................	1,008	×	4,453	=	4,488,624 B. T. U.
Silicon,...................	448	×	14,126	=	6,328,448 "
Manganese,...............	112	×	2,194	=	245,728 "
Iron,.....................	224	×	2,194	=	491,456 "
Total,............................					11,554,256 B. T. U.

Assume the initial temperature of the bath to be 2,500° F., and the final temperature to be 3,632° F. (2,000° C.) If the specific heat of molten iron be taken as .16, it will require 2,822,400 B. T. U. to raise 22,400 pounds of iron 1,132° F. the difference between the initial and the final temperature, no allowance being made for oxidation reducing the original weight of the charge. Knowing the amount of heat generated, 11,554,256 B. T. U., and the amount of heat used in raising the temperature of the bath, 2,822,400 B. T. U., the difference between them, or 7,487,168 B. T. U., will be the amount of heat absorbed, radiated and carried off by the escaping gases, which, since this amount of energy is dissipated in 15 minutes, may be reduced to another form, as 11,677 horse-power, which is the theoretical equivalent of 520 pounds of coal. This small amount of coal, which is hardly more than one-half of the carbon originally present in the pig iron, is due to the fact that the present calculation is based on the assumption that the carbon burns to carbonic oxide, while the heat equivalent of coal assumes that the carbon is oxidized to carbonic acid, in the latter case the heat generated being more than treble per unit of carbon. The only other point needing explanation is the heat combustion of manganese, which is here taken the same as iron, on the authority of Jordan, who assumes that the two metals are practically the same, from the near agreement of their atomic weights and other points of similarity.—*The Iron Age.*

The Locomotive.

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Experiments on Iron and Steel.

BY J. M. ALLEN.

The following illustration, Fig. 1, is from an engraving of a piece of steel in our possession which has been subjected to the etching process :

Our object in treating this specimen was to develop the lettering shown in Fig. 2, which will be described further on. To return to Fig. 1. After subjecting it to the action of the acid preparation for some time, we found that the central portion had been attacked much more vigorously than the portions nearer the surfaces. The specimen has the appearance of two pieces of steel laid one upon the other, with a distinct dividing line between. The central portion of the plate from which this specimen was cut was evidently softer than the portions near the surfaces, or the fiber or material was disturbed in the process of rolling, making it less homogeneous, and more readily open to the attack of acids. There has been considerable speculation by those who have examined the specimen as to what was the cause of this peculiar phenomenon. Steel plates are rolled from ingots, and inasmuch as the interior of the ingot is at a higher temperature than the exterior (unless "soaking" or some similar process has been resorted to, to equalize the temperature), it has been suggested that the interior softer mass was more crushed and broken up than the portions nearer the surface, from which the heat radiated more readily. Another theory advanced is that as the metal is passed back and forth between the rolls the central portion of the sheet would receive the pressure without the same opportunity to expand or elongate as uniformly and readily as the surfaces, and hence be less homogeneous. We know that plastic substances under heavy pressures adjust themselves in layers, and while it may seem far-fetched to attribute this peculiarity to the substance in question, it is not impossible that the principle involved in the peculiar behavior of clays under pressure may be true of a heated metal in a semiplastic state.

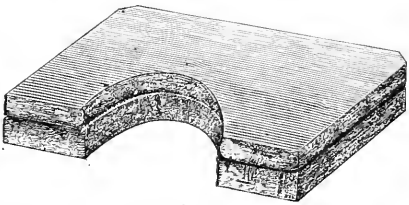

Fig. 1.

As has been said, the appearance of the specimen is as though two pieces of metal had been laid one upon the other, and that a blow or fall would separate them asunder. It is proper to add that other specimens similarly treated showed the same behavior though in some cases less marked. We shall be gratified to hear the opinions of others on this interesting subject.

The following Figs., 2, 3, and 4, are specimens on which the name of metals was plainly stamped. Figs. 2 and 3 are homogeneous boiler plate. They were prepared by first draw-filing the surfaces on which the names were plainly stamped until the names were entirely removed. The surfaces were then polished and there was not the faintest trace of a letter, even when examined with a glass of low power. These specimens were then submitted to the action of prepared acids, and in due time the lettering became very plain, and could be easily read.

The prints below are not very distinct, but they serve to show that the effect of a blow on metal penetrates farther below the surface than at first appears. The fiber was disturbed, and made it possible for the acids to act upon the disturbed portion. Fig. 4 was from a piece of ordinary iron pipe. It was treated in the same manner that the other specimens were, with similar results. These experiments show that the effect of a blow may be attended with serious results, even when its effect at first is not apparent.

Fig. 2.

Fig. 3.

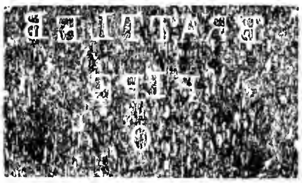

Fig. 4.

We were led to make these experiments by witnessing the rough and unnecessary manner in which the heavy hammer is often used in boiler work. One can never tell what the effect of a foolish use of the heavy hammer may be. It may start an incipient fracture which, from the strains to which the boiler is subjected in use, may develop into a dangerous defect. A machine sometimes breaks down under circumstances that seem mysterious, and it is next to impossible to account for it. But if in the process of construction the workman has been careless and reckless with his hammer, or in handling the parts of the machine, he may have done just the thing that located a weakness which eventually resulted in accident.

It is true that boiler-making is rough work, and the construction of such heavy machinery involves rough work, but this need not be carried beyond what is actually necessary. Young mechanics should be taught to use their tools legitimately, and not recklessly.

Inspectors' Reports.

MAY, 1884.

The summary of the work done by the inspectors of the Company during the month of May last is given below. From it we learn that there were made:

Visits of inspection,	2,953
Boilers examined, total,	5,188
" " internally,	2,330
" tested by hydrostatic pressure,	409
" condemned,	43
Defects reported, total,	3,465
" " dangerous,	651

The following exhibits the defects in detail:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	372	47
Cases of incrustation and scale,	555	73

Cases of internal grooving,	24	10
Cases of internal corrosion,	174	34
Cases of external corrosion,	164	29
Broken and loose braces and stays,	80	24
Settings defective,	108	18
Furnaces out of shape,	120	10
Fractured plates,	126	42
Burned plates,	59	16
Blistered plates,	207	31
Cases of defective riveting,	297	60
Defective heads,	38	11
Serious leakage around tube ends,	614	125
Serious leakage at seams,	138	33
Defective water-gauges,	43	4
Defective blow-offs,	56	8
Cases of deficiency of water,	15	8
Safety-valves overloaded,	26	15
Safety-valves defective in construction,	51	23
Pressure-gauges defective,	194	28
Boilers without pressure gauges,	4	2
Total,	3,465	651

Wealth in the Sea.—Seldom or never has the enormous importance of the harvest of the sea been more forcibly represented than it was the other day by Prof. Huxley, in the address which he delivered at the International Fisheries Exhibition. An acre of good fishing ground, he pointed out, will yield more food in a week than an acre of the best land will in a year. Still more vivid was his picture of the moving "mountain of cod," 120 to 130 feet in height, which for two months in every year moves westward and southward, past the Norwegian coast. Every square mile of this collossal column of fish contains 120 millions of fish, consuming every week, when on short rations, no fewer than 840 millions of herrings. The whole catch of the Norwegian fisheries never exceeds in a year more than half a square mile of this "cod mountain," and one week's supply of the herrings needed to keep that area of cod from starving. London might be victualed with herrings for a year on a day's consumption of the countless shoals of uncaught cod.

Gum Arabic and the Soudan.—According to the *Scientific American* the gum arabic supply appears to have been in a great measure cut off owing to the state of affairs in the Soudan. It says: "Gum arabic comes almost exclusively from the Soudan, and, owing to the operations of El Mahdi, there have been no receipts of any consequence for a year past. In confectionery it makes about 30 per cent. of the best quality of gum drops, marshmallow, and jujube paste, and the Government envelope factory at Hartford, Conn., is said to use a ton of gum arabic weekly. The annual supply from the Soudan has heretofore been from 20,000 to 25,000 bags, of 400 to 600 pounds each, and there is usually a stock held in London about equal to one year's receipts. This reserve is now about exhausted, and the gum has been steadily advancing in price from the ordinary figures of eight to ten cents a pound until it now commands from thirty to fifty cents, according to quality."

Boiler Explosions.

MAY, 1884.

PILE-DRIVER (53).—At Crow Island, Mich., the boiler in the steam pile-driver W. H. Smalley, owned by Maron & Wilson of East Saginaw, exploded May 1st, wrecking the upper works of the craft. The cook, Mrs. William Quinn, was badly scalded by the steam, and her child, a girl three years old, was blown into the river, and has not been seen since. No one else was injured. The damage is about $1,000.

LOCOMOTIVE (54).—About 11 o'clock A. M., May 4th, a terrible boiler explosion took place at La Monte, Mo., completely destroying all but the tender of locomotive No. 810, belonging to the Missouri Pacific road. The train went on a side-track to meet the east-bound mail-train. After the mail-train had passed and while the conductor and engineer were attending to some telegraph business in the depot building, the boiler exploded with terrible effect. The smoke-stack went down 400 yards north into a corn-field, while the steam dome was in a pasture 300 yards away. One piece is reported as having fallen about one mile north in the highway. The cause of the explosion is unknown.

LOCOMOTIVE (55).—A switching engine in the Maine Central freight yard at Portland, exploded its boiler May 6th. No one was injured.

MARBLE WORKS (56).—The boiler in the Whitney Marble Works at Gouverneur, N. Y., exploded May 8th, killing five men and fatally injuring two. Building total loss.

LOCOMOTIVE (57).—The boiler of engine No. 43 of the Missouri, Kansas & Texas Railway exploded in the round-house of the Missouri Pacific at Parsons, Kan., May 9th, killing two men outright, wounding several others, and completely demolishing four sections of the round-house. The engine was an old one, had been recently repaired, and was undergoing tests when the explosion occurred.

SALT WORKS (58).—A boiler in the salt works of Green, Ring & Co., at Saginaw City, Mich., exploded May 10th, wrecking the boiler-house and salt-block. John Clute, the fireman, was injured fatally, Frank Wilkin severely, and Rudolph Mill and J. W. Bacon slightly. The damage is about $6,000. The cause is unknown.

MACHINE SHOP (59).—One of the high-pressure boilers in the Pennsylvania Railroad machine shops, Altoona, Pa., of which there were six, located on Ninth avenue, between Twelfth and Thirteenth streets, and used for testing new engines and furnishing power to the machine department, exploded with terrific effect May 14th. Hayden O'Hara, the fireman, was blown to atoms. The other fireman has not been found yet, and nine other persons were more or less injured. The windows of the machine shops were riddled by the flying debris, as were the adjacent houses on the avenue opposite. A man very low with consumption in one of these houses was struck by a piece of iron, and his death is momentarily expected. Two little girls who were on the avenue were struck by the flying debris and seriously injured. The cause of the explosion is unknown.

GRIST-MILL (60).—The boiler in W. C. Stout's grist-mill, on Petit Grau Creek, near Lewisburg, Ark., exploded May 19th. Frank Weaver, engineer, and Capt. A. B. Thompson were instantly killed, the body of the latter being thrown one hundred feet, denuded of every particle of clothing. An eight-year-old son of Mr. Weaver has since died from his injuries. Ben Howard was also fatally injured, and E. C. Hopkins was severely scalded.

SAW-MILL (61).—The three boilers in the extensive planing-mill and sash-factory of Carr, Ryder & Wheeler, Dubuque, Iowa, exploded with terrific force May 24th. The boiler-room was completely demolished, and the adjoining buildings more or less damaged. Five persons were killed or fatally injured, including the engineer, M. M. Mellen; Fred. Wilder, fireman; Mike McLaughlin, assistant fireman; and two children of Charles Mayo, who were playing in the yard of their residence adjoining the engine-room. Several others were badly injured, including F. Tuegell, who worked about the yard, and Mrs. Walters, who had an arm broken, and sustained other injuries. The damage to the firm is about $10,000, a portion of which is covered by insurance.

Saw-Mill (62).—At Eden, in St. Clair county, Ala., the boiler of Ezell & Co.'s steam mill exploded, May 25th, killing James Robertson, a prominent citizen, and mortally wounding Pick Charlton, fireman.

Paper-Mill (63).—A bleacher in Wilson's strawboard mill, at Waterford, N. Y., exploded May 26th, and tore the building to pieces, killing James Reddish, Edward Kelly, M. Ashley, M. Creed, and John Hefferman. Four others were slightly wounded. Loss $15,000.

Saw-Mill (64).—The boiler in the Maybee mill, at Monroe, Mich., owned by Abram Maybee, blew up, May 30th, killing the engineer.

Saw-Mill (65).—Two boilers in the mill belonging to Wood & Thayer, one mile east of McBride's, Montcalm county, Mich., exploded, May 30th, literally demolishing the building. Wesley Ammon, foreman, Augustus Newman, and a man named Matthews were in the engine-room at the time of the explosion, and were instantly killed. Charles Sauers, head sawyer, is feared to be fatally injured. Peter Cramer was badly injured, but is likely to recover. Joseph McCullough and William Dyson were also badly injured.

Saw-Mill (66).—One of the boilers in the planing-mill of Howard, Purdy & Howard at Williamsport, Pa., exploded May 26th, doing serious damage.

Bleachery (67).—R. D. Mason & Co.'s Dye Works, on East avenue, Pawtucket, R. I., were blown up by a kier explosion, May —, very similar to the explosion at the same place in 1870. The dye-house, a brick building, about 80x50 feet, was knocked all to pieces, and is a complete wreck.

Locomotive (68).—A locomotive blew up on the Chicago, Milwaukee & St. Paul Railway, in the Kinnickinnic Valley, near the Wisconsin Glass Works, May —. No one was hurt. The locomotive was No. 104, an old passenger engine, which had been used in the yards for some time past. It had been used to push a freight train out, and was returning to the city when the explosion occurred. The entire top of the engine was blown off, leaving nothing but the flues. The greater portion of the boiler was landed twenty rods away. The cab and the wheels of the engine were left intact, and ran a distance of 800 or 900 feet after the explosion, being finally brought to a stop by the forward truck jumping the track. Burt Webb, the conductor, Phil Currier, the engineer, and the fireman, who were aboard the engine, escaped unhurt. A wrecking train arrived at the scene of the accident shortly after the explosion, and the ruins of the blown-out engine were taken to the west shops. The loss by the explosion was not in excess of $8,000.

The Locomotive.

HARTFORD, JULY, 1884.

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

Sunday Inspections.

We have on several occasions called the attention of our patrons and readers to the importance of dispensing with work on the Sabbath, and especially would we urge upon steam users and manufacturers in general that the observance of the Sabbath is a duty which is morally binding upon all. The custom of making repairs and improvements on the Sabbath is, in our opinion, a loss in the end. It cannot be a serious interruption to any business to give a few days every year to the necessary overhauling and repairing of the machinery or motive power of a mill. If men are required to work on the Sabbath, the influence will be demoralizing. They will not have the same respect for any law as they otherwise would, nor will they, in our opinion, have the same respect for their employers' interests. The whole practice is wrong, and contrary to the instincts of those even who have no religious convictions. Obedience to law is the strong bulwark to the happiness and peace of any community, and the moral law is the foundation of all civil law.

We are led to write upon this subject from the fact that many steam users ask us to send inspectors to inspect their boilers on Sunday, and in many cases these requests come from persons who would be quite unwilling to have it generally known that they asked for men to work on their boilers on the Sabbath. The fact that it is not generally known does not change the character of the disposition to make arrangements for it. One or two days in the year will be all that is necessary for inspecting the boilers of most establishments, and we earnestly urge upon all steam users to arrange for some week day for this work. We believe they will lose nothing in the end. In many, a great many, instances the proprietors of manufacturing establishments will have no work done on their premises on the Sabbath. We wish it might be so with all.

In the matter of inspections, we arrange for holidays, Saturday nights, and Monday mornings, and are willing to do anything in our power to avoid Sunday work. It is unjust to inspectors to ask or require Sunday work of them. It is unjust to their families, and particularly to their children, and it is not good for any community nor for any leading man or men in a community to arrange for having work done on the Sabbath, when it can be just as well done on any other day. Work of necessity is different, and there would be no difference of opinion on that point. But be careful not to magnify a mercenary feeling into a necessity.

It is amusing, if not instructive, to follow the discussions which sometimes occur between men on mechanical subjects, such, for example, as steam boilers. The remarkable difference of opinion which is manifested on the simplest points is simply amazing. These discussions are generally carried on by men who claim to speak from the standpoint of practical experience, but it will often be found their experience has been limited to some particular line of business, or some special type of boiler, so that they are wholly incompetent to express an intelligent opinion on a broad subject, however honest they may be in their convictions.

The steam boiler has probably been the subject of more thought, discussion, patents, and abuse in its construction and management than any other one thing under the sun, with the single exception, possibly, of a presidential candidate. Some insist on laying a boiler horizontally, others are equally certain a boiler should always stand on end, while another great and brilliant portion of the engineering fraternity, who are evidently on the fence, insist on setting boilers in an inclined position, while the degrees of inclination given by different parties embrace all the angles of the quadrant, and several more besides. Some with a view evidently of having the correct thing anyhow, combine all the different features and forms in the same boiler regardless of expense of first cost, economy of maintenance and operation, or the ridicule of intelligent mechanics.

As to fuel-saving devices their name is legion. It is no uncommon thing for one and the same party to have the agency of a patent setting guaranteed to save 25 per cent. of fuel, a grate bar to save 30 per cent. more, a damper regulator to save 10 or 15 more, a heater 40 or 50 more, pumps or injectors to save the remainder, and when they are all attached the man who owns the boiler, in nine cases out of ten, burns more coal than he did before they were applied. Many victims can testify to the truth of this statement. If we thoroughly examine the question from an independent standpoint, we shall find that generally the efficiency and economy of a steam plant is in a direct ratio to its simplicity.

Testing Machines, Their History, Construction and Use, is the title of a little book, by Arthur V. Abbott. It is a reprint from *Van Nostrand's Magazine*, and forms one of Van Nostrand's Science Series. In it will be found a description of the principal testing machines in use, with illustrations, tables, and results of some interesting tests. We commend it heartily to all who are interested in the subject.

We are favored with the Prospectus and Catalogue of St. Viatreus' College, Bourbonnai's Grove, Kankakee County, Ill. The curriculum for both preparatory and classical courses is full and comprehensive.

The Detached Steam Boiler Furnace Fallacy.

It is believed by many engineers that it is impossible to obtain complete combustion of coal in a furnace surrounded by the heating surfaces of a steam boiler, as in an ordinary internally fired boiler, or even in the furnace of the common externally fired horizontal tubular boiler where but one side of the furnace is exposed to the boiler surface, the reason advanced therefor being that the temperature of any portion of a boiler-shell covered with water is so far below that due to the perfect combustion of the fuel that it exerts a chilling influence upon the fire, and prevents complete combustion. This we believe to be a grave error, and we think the experience of parties who have tried detached furnaces, or those separated from the boiler and enclosed entirely in fire brick, and in which the combustion was completed before the gases were allowed to come in contact with the boiler-shell, will fully bear out the truth of our statement.

First, let us inquire if the combustion of coal in a well-planned boiler furnace is so incomplete as is generally alleged by those engaged in the manufacture and sale of detached furnaces. We think not. The maximum evaporative power of a pound of good coal is in round numbers fifteen pounds of water from and at 212 degrees Fahr. It is no uncommon thing for an evaporation of twelve pounds of water under the above conditions to be obtained per pound of combustible from a well-planned marine boiler.

This shows that 80 per cent. of the theoretical evaporative power of the fuel has been utilized. If we make allowance for the heat lost by radiation and that passing off in the escaping gases of combustion, we cannot avoid the conclusion that the combustion must have been practically perfect. Now no such result as the above has ever been approximated by any detached furnace arrangement. In no case that we are aware of has the arrangement given satisfaction. In two cases which have recently come under our personal notice boilers were set in this manner, and the draught was produced by blowers. In the first case two boilers were provided, and it was always necessary to run them both to do the work. The tube-head of one of them was soon ruined, fractured between the tubes, necessitating a new one. At the time the new one was put in, the owners were persuaded to reset their boilers in the ordinary way. After this was done, one boiler did the work very easily, and the consumption of fuel was very largely reduced.

In the other case referred to, a large compound tubular boiler was set in a similar manner. It was found to be utterly impossible to keep the tubes from leaking around their ends. (In both cases the heat passed through the tubes before returning under the shell.) After some persuasion the owners were induced to change the setting to the ordinary type, when all trouble soon disappeared, and the consumption of fuel was reduced from 5,000 pounds per day to from 2,400 to 2,800 pounds per day. These facts speak for themselves, and we may legitimately inquire, what is the reason for this very great waste of heat in such furnaces? We have not far to look for the explanation. In our opinion it is simply this: The benefit of the *radiant heat* from the fuel is almost wholly lost.

According to the experiments of Peclet, the proportion of radiant heat from a bed of incandescent coal is *one-half* of the total heat of combustion. The practical conclusion to be drawn from this fact is that we should always so construct our boiler and arrange the furnace, whether the boiler be an internally or externally fired one, that the radiant heat shall be intercepted so far as possible by the heating surfaces of the boiler. This can be most perfectly accomplished by placing the furnace inside the boiler, as in the marine type. The next best, and one which is without doubt superior to all others for ordinary purposes, is the arrangement found in the ordinary horizontal tubular boiler. By keeping the furnace sides well away from the boiler nearly up to the water line, keeping the bridge wall well down and battering its face, making the grate rather longer and narrower than is the usual practice, where a given amount of grate surface is wanted, we may fulfil the conditions requisite for economy in a most perfect manner, and a boiler so set will have an evaporative efficiency fully equal to the best internally fired one, so long as the setting is kept in good repair.

It may be argued that in the detached furnace the radiant heat is taken up by the hot gases, and by them brought into contact with the heating surfaces of the boiler, and equally good results obtained, but this is a fallacy. The radiant heat passes through the gases of combustion without warming them, exactly as the sun's rays pass through our atmosphere without warming it. The only way in which the radiant heat can be communicated to these gases is by being previously absorbed by the brick walls of the furnace; this is communicated to the hot gases as they flow over the furnace sides, but its intensity is very much reduced, and consequently the resulting temperature of the gases is much lower when they reach the heating surfaces of the boiler, and the evaporative efficiency is reduced in proportion. The more the principles of the action of heat are studied, the more clearly we shall see the necessity of burning our fuel in such a manner as to produce the highest possible temperature, and of so arranging our furnaces that the source of heat may be as close to the most effective steam generating surfaces of the boiler as it is possible to be and allow the gases chance to properly burn.

A Remarkable Boiler Explosion.

FROM W. K., NEW YORK.

A remarkable boiler explosion occurred on March 6th at the blast furnace of the Waller Iron & Coal Company, Rising Fawn, Dade County, Ga. The boiler was of the common type used at blast furnaces, known as a double-cylinder boiler, the upper cylinder being sixty feet long and forty-two inches in diameter, and the lower one forty-five feet long and thirty inches in diameter. The two were connected by seven legs, about one foot long and one foot diameter each. Two of such boilers were set side by side, as shown in the sketch, Fig. 4. A portion of the second and third rings from the front end, forming a section about three feet long, as shown in the sketch, Fig. 2, was detached from the boiler, and thrown in a direct line with the boiler a distance of about thirty feet, where it struck a coal car on a trestle-work, and then fell to the bottom of the trestle. A man who was working in the car unloading coal was blown by the force of the explosion—being probably struck by flying pieces of the brick-work—a distance of about twenty feet further, and was killed. The piece of the shell which struck the car was the only part of the boiler which left its position. It opened out into a double-curved shape, as shown in the sketch. The boiler was supported by four hangers, and the front end was found in its proper position, still supported by its hanger, except that the I-beam to which the hanger was attached had fallen, owing to the blowing over of the brick-work, allowing that portion of the boiler to drop a short distance. The boiler was about ten years old. The section which was thrown out had been patched, as shown in the sketch, and the longitudinal rupture extended directly through this patch, while the circumferential break was entirely outside of it. The sheet of the upper boiler to which the first connecting leg was attached had also been patched on both sides of the leg in the direction of the circumference. The first sheet of the lower boiler had been patched at least twice, the first patch, shown in C, Figs. 1 and 3, being a square sheet; the second, A, an oval sheet inside of the first. A third patch, B, circular in shape, was also inside of the first and adjoining the second. After the explosion the oval patch had a crack in it which, if original patches C and A had been allowed to remain, would have required another patch inside

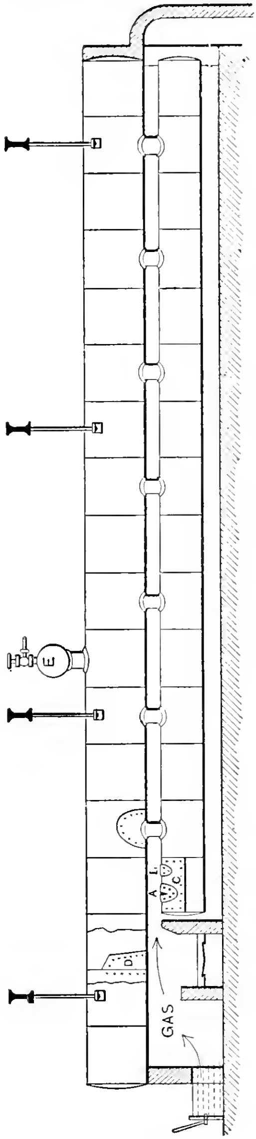

Fig. 1.

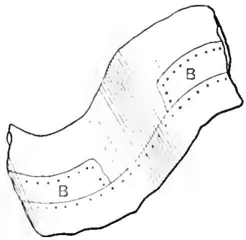

Fig. 2.

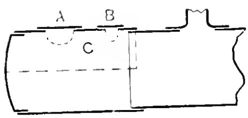

Fig. 3.

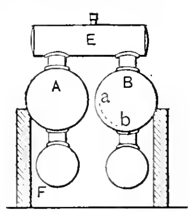

Fig. 4.

of patch A. In Fig. 4, A is the boiler which exploded as shown in Fig. 2. Boiler B also ruptured, a crack, *a b*, extending from the bottom of the third ring up one side only. A similar battery of two boilers was alongside of these two, and were unharmed. All four of the boilers, however, had been patched in the first ring of the lower drum.

—*Mechanics, June 7th*, 1884.

Internal Corrosion and Scale in Steam-Boilers.

In presuming to offer any remarks on corrosion and scale in steam boilers, I have no thought of instructing eminent engineers and chemists in a matter concerning which it would better become me to listen to instruction from them. But, profiting from that which they have already taught me, my desire is to call renewed attention to an important subject, ... and to lay before the owners of steam power, and their superintendent engineers, the results of my researches; pointing out what I believe to be the surest methods of overcoming evils which are known to cause a considerable loss of life and an enormous annual waste of property.

Further discussion and inquiry may result in the discovery of better methods, but, in the meantime, those that have proved effectual cannot be too widely made known. . . . .

Internal corrosion is a trouble from which few boilers entirely escape; but marine boilers are the greater sufferers. Land boilers are subject also to very serious and often rapid decay from external corrosion, but I do not propose to make more than a passing remark on external decay. The principal causes arise from undue exposure to the weather, unscientific mounting on possibly damp brick-work, leakage consequent upon faults of construction, or negligent management on the part of the engineer in charge. These sources of corrosion are commonly known, and the measures necessary to prevent them are now well understood; although it must be admitted they have been often culpably neglected.

Internal corrosion may be divided into ordinary corroding (or rusting) and pitting.

Ordinary corrosion is sometimes uniform through a large part of the boiler, but it is often found in isolated patches, which have been difficult to account for.

Pitting, which is still more capricious in the location of its attack, may be described as a series of small holes often running into each other, in lines and patches, eaten into the surface of the iron to a depth sometimes reaching one-fourth of an inch. Pitting is the more dangerous form of corrosion, and the peril is increased when its ravages are hidden beneath a coating of scale or fur which may have gathered over it. For without great watchfulness this insidious canker may go on unsuspected until a catastrophe reveals it.

Ordinary corrosion has been commonly accounted for by the presence of acids in the water, but the mysterious ways of pitting have been an enigma to engineers; and although a variety of theories have been advanced to explain its capricious and peculiar methods, none were conclusive until recent scientific investigations discovered the true agency.

It was long suspected that galvanic action, or electricity in some form, had to do with both corrosion and pitting. One theory was that voltaic action was set up between the iron shell and brass tubes, and another that differences in the quality of the iron plates produced the same result. Experiments were made, from time to time, to test these hypotheses, but they seem to have ended, for the most part, in the conclusion that electricity was inoperative either as a cause or a cure. Considered as a cure, it was set aside by some eminent engineers as mere empiricism; but most thoughtful men admitted that the action of electricity, if it really existed, was not understood. New light has since been thrown upon the subject, and altered views now prevail; but I will not anticipate.

There is another form of decay in boilers, known as grooving. This also comes under the head of wear and tear. It may be popularly described as a kind of surface cracking of the iron, caused by its expansion and contraction under the influence of differing temperatures. It is attributable generally to the too great rigidity of the part of the boiler affected, and it may be looked upon as resulting from faults of construction. It is, therefore, outside the scope of this paper, except in so far as it may be, and frequently is, aggravated by internal corrosion, which fastens upon the cracks and eats them more deeply into the iron.

The hard calcareous scale which is deposited by the water on the internal surfaces of the boiler may be taken roughly as identical with the fur which forms on the inside of a tea-kettle. It is composed chiefly of salts of lime, and is known by many names in different districts. . . . . On the whole, it is perhaps a greater enemy than internal corrosion, especially in land boilers, as it brings in its train so many destructive agencies, and involves so many expenses. As of fire it may be said that it is a good servant but a bad master—for a thin covering of about the substance of a coat of paint is found to protect the iron from rust, and is therefore favored by all engineers.

Beyond this point, however, it is an unmitigated evil. In the first place, it necessitates a great waste of fuel, varying according to the thickness and character of the incrustation; but the waste of coal may be fairly put down at an average proportion of not less than 100 per cent. The reason is this, that scale is a very efficient non-conductor of heat, and when it is interposed between the furnace and the water the latter is unable to take up the heat, which, by consequence, goes away unused up the flues. Then again the iron, or other metal, of the furnace and tubes, being no longer protected by contact with the water, becomes red hot, and is burnt and twisted, to the imminent danger of the boiler, while a heavy expense is incurred for renewing the plates and tubes so affected.

When the scale is thick and hard, the proper examination of the parts beneath it is impossible until it has been entirely removed. Indeed, if it were not removed, the boiler would become unworkable. Scale, therefore, being so great a foe, has to be periodically chipped with hammer and chisel; and the process of chipping is so severe that it tends very greatly to wear out the boiler. The cost of chipping is in itself a heavy item; and it should be borne in mind that a factory boiler must, during the process, perhaps every six or eight weeks, be put out of work for several days at a time.

Scale will stop the feed pipe, which supplies water to the boiler; or hardening over the fusible plug in the furnace crown, which is intended to melt and give warning when the water is dangerously low, will nullify this precaution; and it has thus caused both collapse and explosion.

To dwell on the nature and detail of all the various deposits that afflict steam boilers would occupy too much time, and it is not necessary for my purpose; but, concerning carbonate of lime, which is often a source of danger, I must offer here a few remarks.

This is deposited as a pulverent body; and under certain conditions, chiefly of neglect on the part of the engineer in charge, will form a hard scale similar to that we have been considering, but by proper attention a great deal of it may be got rid of by blowing down, or emptying the boiler to the extent of a few inches day by day, by the scum cock, while it floats near the surface, or by the blow-off cock when it has settled at the bottom.' If, however, this floury deposit is allowed to accumulate, and thicken the water, it will produce priming, which may be described as "boiling over," the same process which is apt to take place in boiling a saucepan of milk, or of water thickened with flour. The water is driven with the steam into the machinery, and may knock off the cover of a cylinder, or blow out the bottom of it. The second great danger which it involves is, that lying in a mass upon the furnace plates, it may prevent the steam from rising, and thus the water being lifted on the top of the deposit by the steam held beneath it, the furnace is left without protection, and is liable to be over-heated, and to collapse by the pressure of the steam. . . . .

The difficult problems that corrosion and scale have presented to engineers and chemists are evinced in the number of patents that have been taken out for chemical compounds to solve them. Hundreds of these compositions have been put into the market, and the number is still increasing; a proof, perhaps, that no panacea has been discovered; although many preparations are still in use by different engineers. These compounds have in truth become so numerous, that every new one is looked upon as another nostrum, and perhaps by the majority of interested persons it is not credited even with the virtues it may really possess.

The chemical laboratory has been ransacked in vain for an absorbent of oxygen that will stop corrosion, or an alkali that can be applied without risk of causing priming. . . . .

Among the many inquiries directed upon the general subject, some of the most exhaustive and minute have been those instituted by the Admiralty, extending from 1874 to 1880. They were carried out by committees appointed to inquire into the causes of the decay in the boilers of H. M. ships. The committees were invested with very abundant powers, and were directed to propose measures tending to increase the durability of boilers.

The results of their labors are contained in very able reports, full of valuable information and practical suggestions; but for the purpose of the present inquiry, they may be briefly summarized as follows:

1. With regard to a prevailing belief that the presence of particles of copper in a boiler was a source of injury, they state, first, that the quantity carried into the boiler is extremely small; and, second, that no injurious effect of importance can be produced by it.

2. That fatty acids resulting from the use of vegetable and animal oils for lubrication were a source of injury, and they recommend the use of mineral oils.

3. Moist air, or water containing air, are powerful corrosive agents. They recommend increased density in the water, especially in boilers fed from surface condensers, and that the boiler should be emptied as seldom as possible.

The main conclusion, however, at which the committee arrived—the great principle that they asserted and demonstrated—was that galvanic action, induced by the contact of zinc with the iron of the boiler, was the best and only trustworthy remedy for corrosion; and that, so long as the metallic contact was maintained, little or no corrosion would go on.

They adopted a plan of hanging slabs or plates of zinc by iron straps from the stays or rods within the boiler, the zinc being held in a clip in which it was tightly bolted. The theory was perfect, but the weak point in practice was found to be in keeping up electric contact between the two metals. The zinc and the iron not being metallically connected, but only mechanically pressed together, were liable to be so far separated—by the corroding of the surface of the zinc—that the galvanic current was soon weakened and destroyed.

The committee endeavored to circumvent this difficulty, first, by fixing in each boiler an excessive number of plates, so that (apparently) if electric contact should cease even in many plates, it might chance to be maintained in some; and, secondly, they directed a frequent examination with a view of renewing the contact, and putting in fresh plates in lieu of those destroyed by corrosion.

This system was the best they were able to arrive at, but it could be maintained only at such a cost that, to use the words of the report: "The expense of the zinc necessary for efficient protection is undoubtedly an important element in determining how far it should be adopted." For besides the expense of fitting, examining, and renewing the excessive number of plates already referred to, the committee go on to say that "the actual waste of zinc is much greater than that due to the protection of the boiler; and it becomes important to ascertain whether that waste cannot be avoided."

With great care, however, this system was found to prevail against the inroads of corrosion; and herein was a distinct advance, although it still left the question of incrustation by lime-scale comparatively untouched. Indeed, it is stated that the scale which formed in some of the boilers in which slabs or plates were used became "harder and more adherent," and it was therefore suggested that the zinc should be periodically removed altogether, for a limited time, in order that a slight corrosion forming under the scale might enable it to be separated more readily from the iron.

Under the Admiralty system, then, it must be presumed that the bad effects arising from scale, such as the burning of the iron, the waste of coal, and the injury caused by severe chipping, are still a source of trouble and expense; and such I believe is the case. I have before me a specimen of the scale which formed in two months in one of H. M. steam vessels. It was recently taken from a boiler treated on the Admiralty method, and considered to be in very good order. . . . .

The mercantile marine has in a great measure followed in the wake of the navy; and zinc is now very largely employed in the fleets of all the large companies. Every possible method of fixing it in the boilers has been adopted, with more or less success. Engineers who understood the principle of its action in forming with the iron a galvanic battery, have sought to secure metallic connection by many mechanical devices, while others, convinced of its efficacy, but not understanding its methods, have even thrown it loose into the boilers, to waste and crumble away to no purpose.

Zinc, indeed, had long been used with the object of depositing any minute particles of copper that might find their way into the boiler. It was useless for this purpose, as the Admiralty inquiry fully proved; but wherever it happened to be connected with the iron, it became protective, by setting up electric action, which would continue for a short time, until oxidization of the zinc had broken the electric contact.

A superintendent engineer who was using zinc in his boilers, fixed to the iron, told me he did not believe in the galvanic theory, while in practice he was profiting by it; and when I pointed out this fact, and asked him to explain on what other principle the zinc could be protective, he was unable to answer me.

Another engineer to an important company told me he had a theory of his own, that what was called corrosion and pitting was nothing of the kind, but was solely the result of friction from the circulation of water in the boiler. On the other hand, the majority of superintendent engineers who have some knowledge of electricity and chemistry, are quick to appreciate the truth of the now ascertained cause, and the scientific remedy. . . . .

Now, the theory of zinc in contact with iron preventing corrosion may be illustrated thus:

Take two pieces of metal, one of zinc, and one of iron, and immerse them in a solution of water diluted with acid, both will suffer from corrosion; but connect them with a wire, and you make them at once into a galvanic couple. A current of electricity is set up between them—the corrosion is directed entirely upon the zinc, which crumbles away, while the iron is no longer injured. The zinc is the positive, and the iron the negative pole. Now you have only to continue the plate of iron till it extends all round the zinc and encloses it, and you have a perfect illustration of the manner in which an iron boiler, enclosing a block or mass of zinc, is made as a whole into the negative pole of a galvanic couple, and is thenceforward absolutely protected from corrosion. It will also become evident that if the connecting wire be broken, or the contact between the zinc and the iron made imperfect by the intervention of any foreign matter, the galvanic current will cease, and the iron of the boiler will corrode as well as the zinc—just as the two pieces of metal were seen to corrode before they were joined by a wire. . . . .

To meet the various defects in the use of zinc plates, Mr. Hannay designed a ball of zinc, with a copper conductor cast through the center of it, the copper being so combined and amalgamated with the zinc at the junction of the two metals as to form brass, and thus no corrosion could form between them to stop the galvanic current. The zinc is well hammered at a certain temperature, insuring long existence in an efficient condition.

This ball of zinc is called an "electrogen"; it is fitted in any convenient part of the boiler by a simple device, and a wire from each end of the copper conductor is soldered firmly to the iron. From this moment the electrogen keeps up an uninterrupted galvanic current, and the whole of the interior of the boiler is absolutely protected from corrosion so long as any of the zinc remains.

It was ascertained, by further experiments, that a very small surface of zinc was sufficient to afford protection for a radius of twenty-five feet from the point of contact, and the spherical form of the zinc was adopted because it would maintain perfect protection with a minimum of waste, the large surface exposed by plates, in proportion to their bulk, being quite unnecessary. Herein, therefore, was the means of avoiding that waste which the Admiralty Committee stated was "much greater than that due to the protection of the boiler," and for which they sought a remedy.

Two electrogens are found in practice sufficient to protect an ordinary "single-ended" marine boiler, in which, by some engineers, forty or fifty plates would have been considered necessary. The electrogens will last for about six months, while the plates would probably corrode away in as many weeks.

The advantages that Mr. Hannay claims for his system, as compared with any employment of zinc plates, are that it is less expensive and more effectual, and that the protection it affords does not depend upon a chance contact that may be destroyed at any moment. But a further gain, perhaps even greater than these, is that it does not allow scale to form in a boiler at any time to a much greater thickness than that of an egg shell, or a coat of paint.

The zinc ball, with its perfect contact, generates a current of greater intensity than zinc plates mechanically fitted, and the consequence is that a portion of the water is slowly decomposed, and the hydrogen that is evolved at the negative pole, all over the surface of the iron and underneath the scale, forces off the scale in thin flakes by mechanical action, as soon as it becomes thick enough to be impervious to the hydrogen. In this way the scale is kept forming and reforming, hanging in loose flakes, or falling off as it becomes detached from the iron.

Thus, all the evils attending incrustation, which have been before enumerated, are avoided. Fuel is saved, burning of the iron is prevented, and chipping becomes no longer necessary.

The reason why scale becomes more hard and coherent under the zinc-plate method as used in the navy, is that while the galvanic current sets up acts in retarding corrosion, it has not sufficient intensity to decompose the water and deposit a layer of hydrogen on the iron; so the scale grows on a firm surface, and is not pushed off by gas evolved beneath it.

When zinc is merely pressed against iron, the two metals really touch each other at minute points only, and thus great resistance is introduced. Resistance in this case means that the current is destroyed to a certain extent as electricity, and converted into heat; just as the resistance of the break destroys the motion of a train and converts it into heat. Then the water creeping in between the two metals, and forming a non-conducting oxide between the two surfaces, increases the resistance, and ultimately prevents the passage of the current altogether.

When resistance is prevented, and the full intensity of the current is allowed to pass from the zinc to the iron, and back through the water, hydrogen is slowly accumulated at the iron surface, yielding protection from corrosion, and, at the same time, loosening and throwing off the scale.

The value of any discovery that will prevent the formation of hard scale in land boilers can scarcely be over-rated. These boilers in which fresh water is used do not suffer so much from internal corrosion; but the calcareous scale which forms in them has been always a great source of trouble. Compositions have failed, and zinc plates are ineffectual to remove it.

The electrogen, however, seems to have solved the problem; and, to make it sufficiently active in fresh water, the homeopathic principle is applied of *similia similibus curantur*. A small quantity of salt, which is the active corrosive agent in sea water, is made, not only to cure the disease of corrosion which it actuates, but to stimulate an electric current which entirely disposes of incrustation.

Sea water contains on an average thirty-two to thirty-eight parts of salt in 1,000. Mr. Hannay's homeopathic dose is a half an ounce to a gallon, or four parts to 1,000; and, as no proportion less than eight times this amount has any effect on iron, no harm can be done to the boiler, even if it were not protected by the zinc. Into brewers' "tanks" and other boilers, the water from which is used for manufacturing purposes, salt, of course, cannot be admitted; but this difficulty is overcome by a simple device, by which the salt is kept separate from the body of the water.

Land boilers, in many districts, would become quite unworkable through the accumulation of scale, if it were not chipped off every five, six, or eight weeks—of course at considerable expense—the boiler lying idle during the process. With electrogens it has been proved that boilers will work more than twice the usual time without any necessity for opening them, and that then the loose flakes of scale may be cleared out in a short time with a hose and a broom. Meantime, no thick scale being allowed to form, it becomes perfectly harmless; the coal consumed does its full work, and steam is made more freely.

Engineers who have witnessed the results in several recent trials, have stated their opinion that the discovery will revolutionize the treatment of land boilers.

In conclusion, a further and valuable addition has been made to the marvelous application of electricity, which have pre-eminently distinguished the last decade of scientific discovery.

But there is no finality in human invention. More light will draw, and with it new marvels will arise. It may be that, before another decade has run its course, electricity or atmospheric power will have superseded steam, and the huge iron boiler of to-day will be looked upon as the clumsy expedient of an ignorant generation.

Till then, while the evils we have been considering exist, and are potent for the destruction of life and property, inquiry into their nature and origin is both desirable and necessary, and time will not have been wasted in seeking to discover the most effectual remedies.—G. S. King, *in* "*Journal of the Society of Arts.*"

The Locomotive.

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Chimney Construction.

The important part fulfilled by a chimney renders it especially desirable that it should be of ample size, well proportioned, and properly built.

The function of a chimney is primarily to furnish a sufficient supply of oxygen to the fuel to effect its combustion. The matter of properly proportioning a chimney to give the best result in this respect will not be treated in this article, in which we merely wish to call attention to certain details of construction which should be observed.

The first point to be considered is stability. This is sometimes a matter of some difficulty, but if proper care is exercised, the condition may always be attained. A good foundation is the first requisite. Most failures of chimneys have occurred through insecure foundations, which have settled unequally.

Where practicable the load on a chimney foundation should not exceed two tons per square foot in compact sand, gravel, or loam. Where a solid rock-bottom is available for foundation, the load may be greatly increased. If the rock is sloping, all unsound portions should be removed, and the face dressed to a series of horizontal steps, so that there shall be no tendency to slide after the structure is finished.

One very strong reason for making a chimney foundation as broad as possible, is the fact that in high winds, the pressure on the foundation may be largely concentrated on the leeward side of the shaft, so that in some localities where the prevailing winds are quite strong, their effect alone may be sufficient to cause unequal settling, unless precautions are taken that the foundation is amply large. But in ordinary cases, with short stacks, no trouble need be experienced, for if the base of the foundation be only slightly larger than the shaft, it will be sufficiently firm. In the case of large chimneys, however, too great caution cannot be observed. Careful calculations should be made, and the design of the stack so modified, if necessary, that all doubt regarding stability may be removed.

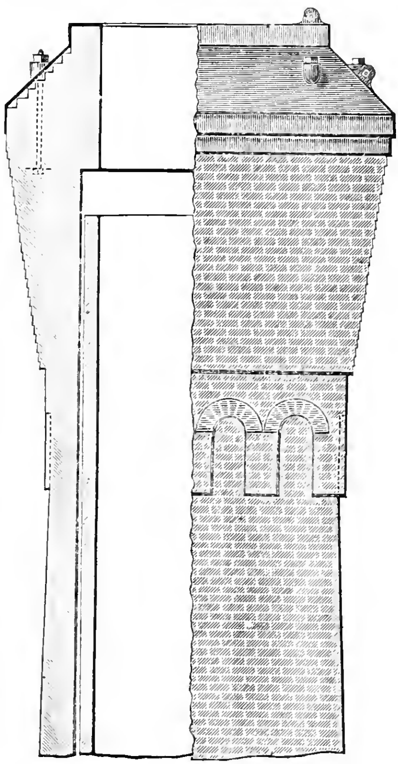

FIG. 1.

All boiler chimneys of any considerable size, should consist of an outer stack of sufficient strength to give stability to the structure, and an inner stack or core independent of the outer one. This core is by many engineers extended up to a height of but 50 or 60 feet from the base of the chimney, but the better practice is to run it up the whole height of the chimney; it may be stopped off say a couple feet below the top, as shown

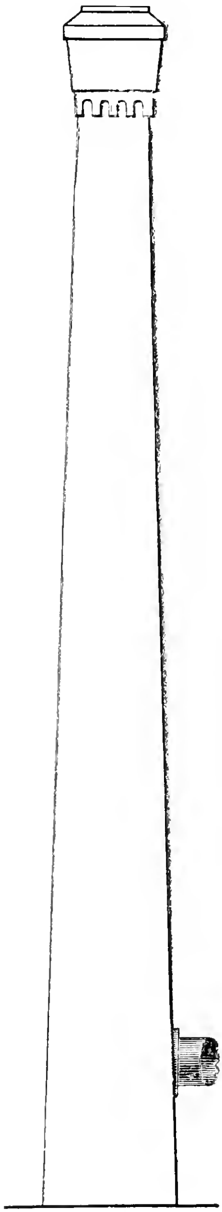

FIG. 2.

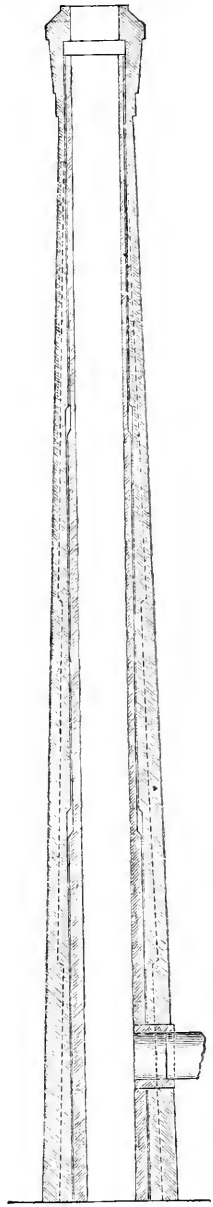

FIG. 3.

in Fig. 1, and the outer shell contracted to the area of the core, as shown in the engravings, but the better way is to run it up to about 8 or 12 inches of the top and *not* contract the outer shell. But under no circumstances should the core at its upper end be built into or connected with the outer stack. This has been done in several instances by bricklayers, and the result has been the expansion of the inner core which lifted the top of the outer stack squarely up and cracked the brick-work.

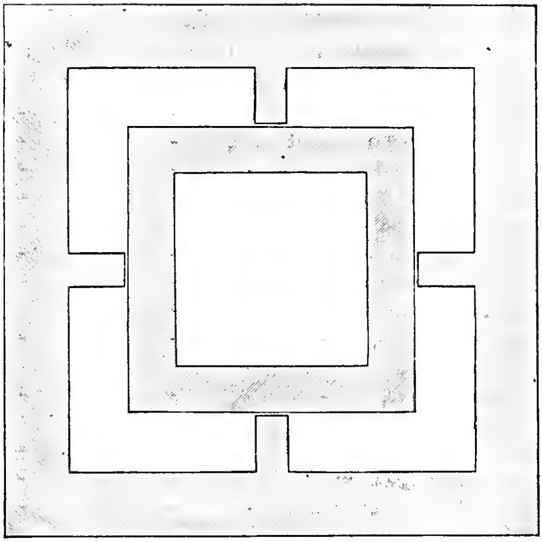

Fig. 4.

In the accompanying engravings Fig. 2 shows an external, and Fig. 3 a sectional elevation of a chimney, such as we would recommend for small batteries of boilers, where the height of the chimney does not exceed 100 feet. For a height of 100 feet we would make the outer shell in three steps, the first 20 feet high, 16 inches thick, the second 30 feet high, 12 inches thick, the third 50 feet high and 8 inches thick. These are the minimum thicknesses admissible for chimneys of this height, and the batter should be not less than 1 in 36 to give stability. The core should also be built in three steps, each of which may be about one-third the height of the chimney, the lowest 12 inches, the middle 8 inches, and the upper step 4 inches thick. This will insure a good sound core.

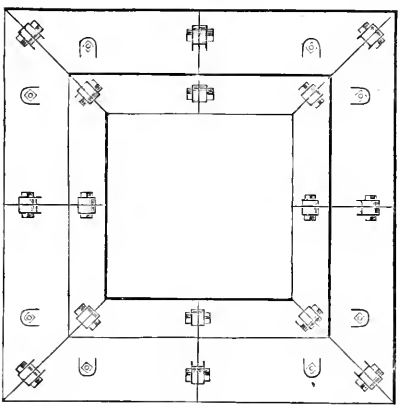

Fig. 5.

Fig. 1 shows a plain, simple finish for a chimney-top, but one which looks neat if it is well proportioned. Care should be taken, however, that it is not made too short in proportion to the length of the shaft, or it will look "squat." The finish of a chimney should be such that it harmonizes with the style of the surrounding buildings. It costs no more thus, and looks vastly better.

The top of a chimney may be protected by a cast-iron cap, Fig. 5, or perhaps a cheaper and equally good plan is to lay the ornamental part in some good cement, and plaster the top with the same material.

Inspectors' Reports.

June, 1884.

The work done by the Company's inspectors, during the month of June last, is as follows:

Visits of inspection made, - - - - - - - -	2,813
Boilers examined, - - - - - - - - - -	4,988
" " internally, - - - - - - - -	1,906

Boilers tested by hydrostatic pressure,	357
" condemned,	41
Defects reported, total,	3,149
" " dangerous,	480

The tabular statement of defects is as follows:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	369	29
Cases of incrustation and scale,	547	58
Cases of internal grooving,	16	2
Cases of internal corrosion,	124	13
Cases of external corrosion,	185	23
Broken and loose braces and stays,	40	18
Settings defective,	164	13
Furnaces out of shape,	107	5
Fractured plates,	105	52
Burned plates,	78	21
Blistered plates,	184	18
Cases of defective riveting,	266	51
Defective heads,	23	10
Serious leakage around tube ends,	331	42
Serious leakage at seams,	205	53
Defective water-gauges,	72	6
Defective blow-offs,	40	16
Cases of deficiency of water,	6	5
Safety-valves overloaded,	29	4
Safety-valves defective in construction,	38	17
Pressure-gauges defective,	218	24
Boilers without pressure gauges,	2	0
Total,	3,149	480

Where boilers are found to be badly corroded and pitted internally along the water-line, and covered with a heavy deposit of sediment, baked on hard, either through bad practice in blowing off boilers while the settings are still red-hot, or through the action of overhead flues, the best method of preventing further mischief is to send a man inside the boiler and thoroughly scrape the shell, getting down to the sound iron. This may very likely take two or three days. Then, with a stiff wire brush, thoroughly oil or paint the corroded portion with red-lead and boiled linseed oil. Two or three applications may sometimes be found necessary.

BOILER EXPLOSIONS.

JUNE, 1884.

STEAM DREDGER (69).—A steam dredger, owned by Patrick Pidgeon, a contractor, of No. 106 Wall street, exploded its boiler June 1st, in the Harlem River, where the Second Avenue Elevated Railroad bridge is being built. James Feeley, the fireman, was scalded so badly that he died in a few minutes. William Hudson, the cook, was near Feeley, but he jumped overboard. He was scalded seriously on the back. Feeley had a family living in South Brooklyn, and was thirty-eight years old. No damage was done to the scow or to the machinery of the dredger.

Saw-Mill (70).—Two negroes were killed, and two others badly injured by a boiler explosion at Cheek's mill, Canton, Miss., June 2d.

Steamboat (71).—The Rosa Belle, a small steamer plying in the White River, exploded her boiler five miles below Petersburg, Ind., June 2d, instantly killing Capt. Charles Applegate and his son, and John P. Hayne, the engineer, and making a total wreck of the boat.

Saw-Mill (72).—The steam mill which has been employed during the winter and spring in preparing lumber for the new hotel in progress of construction at Mt. Kineo, Me., was burned June 4th. During the fire the boiler exploded with terrific force, killing an Indian named Francis Tomah, and injuring one of the masons employed on the hotel. All the machinery, tools, and a large quantity of lumber were burned.

Saw-Mill (73).—An explosion at Loomis' mill, three miles north of Little Rock, Ark., June 13th, destroyed most of the structure, killed Anderson Carpenter, the engineer, and Elias Lee, and badly wounded two others.

Oil Well (74).—The boiler used in pumping Bald Ridge oil well No. 13, Butler, Penn., exploded June 15th with a terrific report, hurling fragments of the boiler in every direction, demolishing the boiler and engine-house, and mangling Richard Walker, who died in a few hours. His son, who was near him, was thrown fifteen feet, receiving fatal injuries. A small frame house near by, which was occupied by Walker, was partially demolished, and his daughter was slightly hurt.

Saw-Mill (75).—The boiler at John Holmes' saw-mill, New Burnside, Ill., exploded June 17th, instantly killing James Gragg and fatally injuring William Mounce, and slightly hurting several others. Large pieces of the boiler were blown five hundred yards.

Saw-Mill (76).—The boiler of Jackson & Sears' saw-mill, at Laurel Run, W. Va., exploded June 18th, almost entirely wrecking the building and scattering scalding water, steam, and flying fragments of timber in all directions. Killed—J. H. Seers, William Gatz. Seriously wounded—P. C. Amos, Aaron Forsyth, Jack Wagner. Several others received slight bruises.

Machine Shop (77).—A twenty-horse-power boiler exploded at the machine shops of the S. Pennock & Sons Company, Kennett Square, Penn., June 19th. Four men were seriously hurt, among whom was B. P. Kirk, treasurer of the Pennock Manufacturing Company. The shops were considerably damaged.

Brickyard (78).—A boiler in Fields & Co.'s brickyard at Albany, Ga., exploded June 20th, killing four negroes.

Lard Tank (79).—A lard tank in the packing-house of Wm. Ryan & Sons, Dubuque, Iowa, exploded June 20th, entirely wrecking that portion of the building and inflicting a loss of $15,000. The men had all quit work, and it is believed there is no loss of life. Only one tank of ten was running with a moderate pressure of steam.

Saw-Mill (80).—Wilson & Hunting's mill, at Fairfield, near Jacksonville, Fla., caught fire June 21st, and a few minutes after one of its four boilers exploded, completely wrecking the brick engine-house, and mortally wounding the fireman, Morgan Chambers. Loss, $4,000 to $5,000.

Saw-Mill (81).—The boiler in J. C. Smith's planing mill, Wausau, Wis., exploded, June 25th, scattering the boiler-house and portions of the mill and machinery in every direction. Eleven workmen, and a man looking for work, were in the mill at the time. Geo. Brown, the engineer and foreman, was horribly mangled about the face and head, and died in a few minutes. August Streich, fireman, was terribly injured, and thrown fifty feet; he died in great agony. John Rux, the stranger who was looking for work in the mill, cannot live. Mary Crocker, living in a house near the mill, was standing on the porch in the rear of her house, and was killed by a flying missile, and her mother was badly hurt about the head, back, and hands. A portion of the boiler weighing a ton or more was thrown against a house 300 feet away and demolished the house. Let Wyatt, the book-keeper, escaped with bad bruises; Buchanan, an assistant, was badly injured. Mrs. John Magusseon, an invalid in a house near the mill, was hurt by flying missiles, and will die. Carl Halache was injured about the shoulder, and others were dangerously bruised.

Saw-Mill (82).—The boiler in J. J. Flagg's shingle mill, in Lawrence county, Ark., on the line of the Kansas City, Springfield & Memphis railway, exploded June 26th. A portion of the railway track was torn up, delaying trains for several hours.

Flour-Mill (83).—The boiler in Von Behren & Shaffer's flour-mill, Stryker, Ohio, exploded June 27th, severely injuring eleven men. The explosion was a terrific one, some forty men being employed in the mill at the time. The mill, one of the largest of its kind, was blown almost to atoms, and among its debris some thirty men were buried, eleven of whom were recovered in a dying condition. The explosion was of such force that pieces of the boiler, machinery, and building were thrown a distance of half a mile. One piece of the boiler, some three feet square, was thrown against a dwelling-house a quarter of a mile distant, taking almost the entire roof away and seriously injuring two occupants of the dwelling. The cause of the explosion is unknown.

Saw-Mill (84).—A boiler in a stave factory at Portia, Ark., six miles west of Walnut Ridge, exploded June 27th, killing J. D. Flock, the proprietor, and the engineer, whose name is unknown.

Trees and Plants as Purifiers.—The beneficial effects which plants and trees may produce on dwelling-sites and on the air of habitations have been made the subject of a paper by Dr. James Evans before the South Carolina Medical Association. The network of fine fibrous roots of trees and plants, traversing the soil in every direction, feeds on the organic matter which would otherwise undergo decomposition, polluting the soil, air, and surface water. The vegetation also absorbs excess of moisture and drains the soil. This moisture is afterward exhaled from the leaves, and there is no doubt that plants also exhale, with the moisture, some of their active and peculiar principles. The scent of mint and thyme is due to menthol and thymol, antiseptics of the highest value, and it is not improbable that their exhalations have the same property. The eucalyptus is remarkable as a prophylactic against malaria. Its leaves immersed in hot water are also said to be an efficient disinfectant in the sick-room. By virtue of their power to generate ozone and to split up carbonic acid, absorbing the carbon and setting free the oxygen, plants remedy to some extent the evils of bad ventilation. In Pasteur's virus-culture experiments he found that, when they were conducted under a diminished supply of oxygen, the germs retained their primitive virulence, but, on the contrary, when they had access to oxygen the virus became weaker. It has been known for a long time, that marsh miasm is intercepted by a forest, and that persons living in localities so screened are exempt from attacks of malarial fever. The explanation of this is probably to be found in this discovery of Pasteur. When a cloud of malarial germs are wafted from a marsh to the neighboring forest, they encounter a continuous stream of oxygen pouring forth from every leaf, attenuating the virus and rendering it innocuous.—*Sanitary Engineer.*

The Locomotive.

HARTFORD, AUGUST, 1884.

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

Dew and Frost.

WITH SOME SUGGESTIONS HOW TO PROTECT PLANTS FROM FROST.

Dew is moisture deposited on bodies exposed to the air during the evening and night. Before the cause was well understood, it was thought that it fell like rain; hence such expressions as "a fall of dew," and "the falling of the dew." The true theory of dew was first explained by Dr. William Charles Wells of London, in 1814, and the facts in regard to this interesting phenomenon are these: The air, by the process of evaporation, becomes saturated with moisture to a greater or less degree, depending upon its temperature,—that is, heated air has a greater capacity for moisture than air of comparatively low temperature. The maximum saturation of air varies with the temperature. Hence, if air of a comparatively high temperature is brought in contact with a cold body, it parts with a portion of its moisture in the form of water, as is often seen on the outer surface of an ice-pitcher in a warm day. Air is now supposed to be composed of minute invisible particles, so minute that the most powerful microscopes are utterly unable to show them. Heat separates these particles, and expands the volume. The interspaces are thus enlarged by heat. Cold brings the particles nearer together, contracting the interspaces, and reducing the volume. These interspaces are the receptacles of the moisture taken up by evaporation. Hence, if the air is of high temperature, the interspaces are larger, and the capacity for moisture correspondingly great. A reduction of temperature decreases the interspaces, and consequently deposits the moisture in the form of water. Cold, by reducing the interspaces, to use a common expression, squeezes the water out, as one would discharge water from a saturated sponge by pressure. Air is said to be saturated with moisture when the density of the moisture in it is due to its temperature. During the day, the loss of heat from the surface of the earth by radiation is more than compensated for by the amount received, directly or indirectly, by the sun. After sunset, the surface of the earth and all bodies thereon begin to cool, because of the radiation of heat. Some bodies and portions of the surface will cool more rapidly than others, because of their different relations to heat. In speaking of the surface of the earth, the vegetation thereon is to be understood. The atmosphere cools slowly. Badly conducting solids cool rapidly; but bodies which are good conductors of heat, if in contact with the earth, will receive from the earth by conduction sufficient heat to compensate for the loss by radiation. When the atmosphere is clear and quiet, radiation goes on rapidly, the heat escaping into space, and the surface of the earth becomes reduced in temperature. The air in contact with the surface becomes correspondingly reduced in temperature, the interspaces are contracted as described above, and water is deposited. *This is dew.*

If the wind is blowing, even though the atmosphere is clear, there will be no dew, because by it the strata of air are continually changing in their contact with the colder surface and solids. They do not rest long enough to be reduced to the same temperature. Again, if the sky is overcast with clouds there will be no dew because the clouds form a screen which prevents the escape of the radiating heat and reflects it back to the earth, preventing a reduction of temperature. Under sheds and tents, there is no deposit of dew even in clear nights because the cover of the shed, or cloth of the tent, reflects the radiating heat back, thus preventing a reduction of temperature of the surface.

FROST.

Frost is frozen dew. The conditions for the formation of white frost are precisely the same as those for the formation of dew, except that those conditions act more powerfully on account of the lower temperature of the earth and air. A distinction must be made between hoar or white frost, and black frost. The former is frozen dew, while the latter is because the temperature of the atmosphere is below the freezing point, and the juices of the plants are frozen. To protect tender plants from the destructive effects of hoar frost, it is not uncommon to put papers and blankets, or cloths over them. These act as screens which prevent the radiating heat from escaping. It is reflected back upon the plants and the temperature is not reduced to the freezing point. Anything that will form a screen or reflecting surface, will protect plants from hoar frost. In the vineyards of France and other countries, the destructive effects of frost to the ripening crop are prevented by building fires of green wood, or damp hay, so as to make as dense a smoke as possible, which, in the absence of wind (it being borne in mind that frost only occurs in a quiet condition of the atmosphere) settles down over the vineyard, forming a screen which reflects the radiating heat back again and keeps the temperature above the freezing point. It is not the heat resulting from the fires that accomplishes the end sought, but the cloud of smoke. It occurs in this connection that this practice might well be utilized by the raisers of tobacco. It is a very tender plant, and large fields are often nearly or quite destroyed by early and untimely frosts. If slow fires were made of damp hay and green wood in different parts of the field so as to make a dense smoke that would lay over the field, and if this "smudge" was kept up all night, there is no doubt but that much of this destruction could be prevented. Quick fires would be of little account. There must be a dense smoke kept up until morning, or until the sun is well up. It will be worth the while of the agriculturist to give this matter careful consideration.

Hints for Cleaning Boilers.

Following the application of any boiler-purger or other substance for loosening scale or deposit upon the shell, heads, or flues of a steam-boiler, special care and attention should be given to cleaning out the boiler with a prompt removal of such loose fragments as may have become detached and fallen down.

These particles, if not removed, are often swept about by the various currents within the boiler, and collecting in a conglomerate mass upon some part of the fire surface, prevent access of water to that particular part, and thereby it is overheated and is bulged, or bagged as it is sometimes called—often inflicting a dangerous injury to the boiler and requiring a considerable outlay for new sheets, a patch, or perhaps other expensive repairs.

In the use of soda and other preparations used for removal of boiler incrustations, that are soluble in water, a separate vessel may be provided suitably connected to the feed-pipe, so that the preparation, in its proper proportions as recommended, may be first dissolved, and when properly prepared fed into the boiler. When there is a heater the solvent may be prepared and emptied into that.

Logwood or oak chips, leather clippings and many other waste products of a manufacturing establishment that contain some useful ingredient as tannin, soda, or starch, may often be used advantageously when they are recommended and their use directed by an inspector, otherwise serious difficulties may result, perhaps endanger the safety of the boiler.

We have known silk fabrics and other delicately-fine articles to be ruined in the dyeing process by the too free use of boiler compounds, of which the users were ignorant in two essential particulars, viz.: as to their composition and the safe quantity to be used. The importance of knowing these particulars will be evident when we remember the great tendency of the boiler to foaming when purgers are used, and the increased danger at such times of carrying over some of this water mingled with steam to the dye kettles or wherever it may be used.

We should not have a great deal of sympathy for the man who, declining to avail himself of the services and advice of a physician, ruined himself by dosing with all sorts of nostrums of which he was ignorant, but such a man at the worst can but ruin himself; while another, who persists in dosing his boiler may not only lose his own life, but he may sacrifice many other lives in the same foolish way.

We know of an instance in which a party who had some condemned bacon in his store-house which he thought to use advantageously in cleaning and lubricating his boiler, he having somewhere read that grease was an excellent thing for the purpose. As he described it afterwards, the boiler nearly turned inside out, and he fondly hopes that he may live long enough to get even with the man who recommended it to him. Another case was that of a fireman, whose duty it was, under the direction of the engineer, to fire and keep clean a battery of boilers, who, happening to hear among some of his mates say that oil was an excellent thing for softening scale, thought to make a trial of it on his own account. So one Sunday when cleaning out his boiler he went through the shops connected with the establishment and gathered up the refuse oil and grease from various drip-pans, securing in this way two or three gallons, which he poured into one of the boilers and afterwards filled it with water. Soon after steam was got up the fire-sheets became bagged and beautifully corrugated and leaked like a sieve.

In boilers under our supervision we have used crude petroleum a great many times for the purpose of loosening lime-scale and with the most satisfactory results. We don't approve of the use of grease, and we deem the application of animal oils or fat to the interior of a boiler for that purpose as very hazardous.

As a rule, when a boiler is in service, a systematic daily charge of a proper solvent graduated to the capacity of the boiler will be found more effacacious than a larger charge at longer intervals, and it is less likely to cause foaming and kindred difficulties. An important matter sometimes overlooked is the need of regular times for cleaning and the preparation which should be made for it.

When about to put a boiler out of service for a thorough cleaning it will be found an excellent plan to let the boiler cool off gradually and the pressure fall slowly until it has reached about five pounds, when the safety valve may be raised and the remainder blown off.

Run off the water and remove the hand-hole plates when the scale will be found much softened and easily detached, while the deposit can readily be washed off with a hose. We have found this an excellent plan to pursue even in marine boilers using sea water, and depositing a very refractory scale, as the waters of the North Atlantic or Gulf of Mexico.

Blowing down a boiler between the limits of high and low water, or in other words between the upper and lower gauge-cocks is often very beneficial, and assists materially in freeing it from the ill-effects of scum and other impurities. If, however, this blowing down is not intelligently done there is a probability of great waste and serious loss. For, in blowing out good water at the temperature of the steam pressure, and replacing it by other water perhaps of no better quality at the much lower temperature of the feed there is a great loss of heat and consequent waste of fuel.

Blowing down a boiler can, however, under no circumstances be depended upon to thoroughly clean it and remove loose fragments of scale and much of the deposit commonly found. This can only be done by systematic, periodical washing out at intervals to be determined by the circumstances of the case.

Correcting Thermometers.

The extent to which thermometers are used or should be used by engineers, renders it desirable some notice should be taken of the errors to which they are liable, and the methods usually adopted for their correction. If these errors were very small, say a fraction of one degree Fahr., they would be of little consequence in ordinary steam engineering work, but it is no uncommon thing to buy two ordinary thermometers made by the same man and apparently just alike, and find that their readings at ordinary temperatures differ by some degrees. This is too great an error to be disregarded, and may be easily rectified by almost any person who is possessed of a little patience. Aside from the fact that it is always best to have working thermometers measurably correct, we find the operation of correcting them very interesting work.

In buying thermometers to use for any important work we should always get the oldest ones we can find, that is, those that have been made the longest; the reason for this being the fact that the glass-tubes always undergo a change after they are newly made and filled with mercury, which change is quite rapid at first, but after the lapse of some months becomes much slower. This change consists of a contraction of the bulb, and is indicated by a *rise* of the freezing point as fixed by the maker. For ordinary purposes, the change may be considered complete at the end of a year, though in most cases, a very slow change probably goes on for several years. Thus, Mr. Joule of Manchester, England, so well known for his experimental determination of the mechanical equivalent of heat, found that the freezing point of one of his delicate thermometers continued to rise for many years. In 1870, at the end of twenty-six years, the change was still going on, though very slowly. A temporary change is also produced in the freezing point every time the thermometer is heated to a high temperature. The effect of this change nearly all passes off in a few days.

The first operation is to determine the freezing point. To do this, immerse the thermometer in melting snow, or ice, if it be the summer season. If it is desired to work with great accuracy, the thermometer should be kept at this temperature for several days, more especially if it has been recently heated to the boiling point of water. The reading of the mercury may then be marked on the tube, and the freezing point is determined. The freezing point thus found is called the *permanent* freezing point, and will be found usually to differ about three-fourths of a degree Fahr. from that obtained by the same means just after the thermometer has been heated to a high temperature, which is called the *temporary* freezing point, and is the one to be used when a thermometer is to be used for taking observations of high and low temperature alternately at short intervals of time.

The next operation is to determine the boiling point. This is attended with more difficulty than the determination of the freezing point, and for scientific accuracy requires the use of a standard barometer and thermometer, and an accurate knowledge of the latitude of the place of observation, and its height above the sea level. Scientific accuracy, however, is only obtainable by trained observers, and is not necessary in ordinary work, such as we are now considering, and we will dispense with every thing but the barometer. This, however, is absolutely necessary for even ordinary accuracy, and the corrections are very easily made.

For the determination of the boiling point, we need a tin vessel in which water may be boiled, which may be closed with a cork or wooden stopper provided with a hole, through which the thermometer-tube may be slid up and down until the boiling-point shall come just above the top outside, while the bulb is just above the surface of the water, *not* immersed in it. An opening should also be provided for the steam generated to pass off freely, so that *no pressure* is produced in the vessel. A little ingenuity will enable any one to improvise an excellent apparatus for the determination of the boiling point out of an old tin teapot, or other similar vessel.

Everything being in readiness, we bring the water in our apparatus to boiling, and when the mercury has risen and become stationary, we make a mark at the top of the column. If the barometer at the time happens to stand at 29.922 inches, we mark the point thus found 212° F., or 100° centigrade, no correction being necessary. If however, as will probably be the case, the barometer stands somewhat above or below 29.922 inches we make our mark for 212° F., either below or above the point just found. The correction amounts to 1 degree F., for every $\frac{581}{1000}$ of an inch, or 1 degree C. for every $1\frac{47}{1000}$ inch variation in height of the barometrical column from 28.922 inches. Thus, if the barometer indicated 30.503 inches, the temperature indicated by the vapor of the boiling water would be 213° F., and we would make our mark on the tube for the true boiling point 212°, just $\frac{1}{181}$ part of the distance from that point down to the freezing point below. Thus, suppose the distance from the actual boiling point, which we found as above to be just $4\frac{1}{2}$ inches above the freezing point previously found, then because our freezing point is marked 32° on the Farenheit scale, we shall have 213 — 32 = 181 degrees between the two points, to find our true boiling point for mean pressure 212°, we divide $4\frac{1}{2}$ by 181, which gives $\frac{25}{1000}$ or $\frac{1}{40}$ of an inch as the length of one degree. A second mark $\frac{1}{40}$ of an inch below the actual boiling point evidently indicates the temperature 212°.

Having found and marked on our tube two definite points, the freezing and boiling, the next step is to divide the interval between them into 212 — 32 = 180 parts. If the tube had a bore of uniform diameter from end to end, this would be a very simple matter, but no thermometer-tube will be found to possess this very desirable feature. We must, therefore, divide our scale so that each degree shall represent an equal volume of mercury, as the expansion of mercury for equal increments of heat between 32° and 212° is practically constant. To make this division of the scale requires some patience and tolerably accurate measuring.

The first step is to separate from the column of mercury in the tube, a portion which shall occupy about 10° of the scale. This may at first sight appear to be a difficult matter, but it is very easily done. Invert the tube and tap the end on the table, it will separate at some point, and a portion will run down the tube. The point of separation will nearly always be determined by a minute air bubble adhering to the side of the tube. If the mercury runs out of the bulb and fills the tube without breaking, turn the tube up and let the mercury run back into the bulb, an air bubble will always be found here, which with a little patient manipulation may be made to ascend to the neck of the tube, when by again inverting the tube the column will separate at this point. Sometimes a vigorous shaking up of the tube so as to agitate the mercury will produce the same effect. The portion which now separates will generally be longer than is wanted, but it can be "cut off" to any desired length as follows: Suppose the piece which has separated is two inches long, and we want a piece three-fourths of an inch long. Heat the bulb, still keeping the tube inverted, and the column separated, until that portion connected with the bulb has risen (or descended, as the tube is in an inverted position) $1\frac{1}{4}$ inches. The end of the column of mercury will push the air-bubble before it. When it has descended $1\frac{1}{4}$ inches, quickly bring the tube to the upright position, and bring the separated portions of the column together. A slight tap on the table may be necessary to bring them into contact. The mercury in the bulb now contracts, while the air-bubble sticks to the side of the tube. and the mercury flows past it. When it has regained its former temperature, again invert the tube, when the column will separate at the air-bubble, and we shall have a thread of the required length, if the operation has been dexterously performed. If it has not, one or two repetitions will usually suffice to separate a portion of the desired length.

Having a thread of the required length we now proceed to bring it to different portions of the tube by inclining the tube, and measuring its length in the various positions.

It is evident that the length of the divisions of the scale, instead of being of uniform length, must be *inversely* proportional to the area of the bore of the tube, or what is the same thing, directly proportional to length of the thread of mercury in the various corresponding portions of the tube. The method usually followed is to use the scale which accompanies each instrument and determine the error for each degree. A table of these errors is kept to refer to. Our method of procedure with common thermometers is to discard entirely the original scale, and make a new one. This is most conveniently done by marking it on the back of the original scale. The first method requires less labor, and is the more accurate one. The second makes the after use of the thermometer much more convenient, and is sufficiently accurate for all practical purposes, where scientific exactness is not necessary. It has the great advantage of not requiring any special or refined apparatus or calculations, and may therefore be easily performed by any one. It gives very good results, and where greater accuracy is essential, it is always better to send the thermometer to some physical laboratory and have it compared with some standard thermometer by trained observers.

If we are graduating to the Fahrenheit scale, separate as above described, a portion of the mercury which shall occupy *about* 10 degrees of the scale. Divide the interval between the freezing and boiling points into eighteen equal parts, mark these divisions with a pencil, each division is then equal to approximately 10 degrees. Bring the separated column of mercury into each one of the divisions and measure its length. Then make the permanent spaces for each 10 degrees proportional to the length of the column measured when it occupied that particular division. Divide each 10° space into ten equal spaces for the degrees, and the operation is complete.

Suppose, for example, the distance from freezing to boiling points is $6\frac{3}{4}$ inches. $6\frac{3}{4}''$ divided by 18 equals $\frac{3}{8}''$, the space occupied by 10° on the scale. Mark on the scale with a pencil these 18 divisions, making each $\frac{3}{8}$ of an inch long. Separate a portion of the mercury column *about* $\frac{3}{8}$ of an inch long, *exactness* is unnecessary. Then bring it to coincide with each division successively, and measure its length in each. Suppose we find these lengths as follows:—

1st	division,	from	32°	to	40°	the	mercury	measures	.39″
2d	"	"	42	"	52	"	"	"	.395
3d	"	"	52	"	62	"	"	"	.40
4th	"	"	62	"	72	"	"	"	.40
5th	"	"	72	"	82	"	"	"	.40
6th	"	"	82	"	92	"	"	"	.39
7th	"	"	92	"	102	"	"	"	.40
8th	"	"	102	"	112	"	"	"	.405
9th	"	"	112	"	122	"	"	"	.41
10th	"	"	122	"	132	"	"	"	.41
11th	"	"	132	"	142	"	"	"	.41
12th	"	"	142	"	152	"	"	"	.415
13th	"	"	152	"	162	"	"	"	.415
14th	"	"	162	"	172	"	"	"	.41
15th	"	"	172	"	182	"	"	"	.41
16th	"	"	182	"	192	"	"	"	.415
17th	"	"	192	"	202	"	"	"	.42
18th	"	"	202	"	212	"	"	"	.42
									7.315″

Take the sum of the lengths of the mercury column as found by measurement which, in this case is 7.315 inches and find the correct length of each 10 degree division by proportion as follows:—

7.315 : 6.75 :: .39″ : .359 = the 10° from 32 to 42.
7.315 : 6.75 :: .395 : .365 = " 10° " 42 to 52.
7.315 : 6.75 :: .4 : .369 = " 10° " 52 to 62.

And similarly we find the length of the remaining divisions.

From	62°	to	72°	=	.369″
"	72	to	82	=	.369
"	82	to	92	=	.3`9
"	92	to	102	=	.369
"	102	to	112	=	.374
"	112	to	122	=	.378
"	122	to	132	=	.378
"	132	to	142	=	.378
"	142	to	152	=	.383
"	152	to	162	=	.383
"	162	to	172	=	.378
"	172	to	182	=	.378
"	182	to	192	=	.383
"	192	to	202	=	.388
"	202	to	212	=	.388

Total, = 6.748″ within $\frac{1}{500}$″ of $6\frac{3}{4}$

The sum would come out exactly $6\frac{3}{4}$″ if the operation is carried far enough, but $\frac{1}{500}$″ is within the limit of error in reading the thermometer, or marking the scale by ordinary means.

These divisions are now marked permanently on the scale, divided in degree marks, and the thermometer is corrected accurately enough for all practical purposes.

H. F. S.

Not Jacob's Pillow.—In the House of Commons Mr. Kenny recently complained that the public notice attached to the coronation chair in Westminster Abbey has been altered by the omission of all reference to the legend that the coronation stone (in Irish, Lia Fail), was first used for the coronation of the Irish kings, and was only carried to Scotland by Fergus, the Irish king who invaded that country. Mr. Shaw Lefevre, in reply, offered to show the honorable member a letter of explanation he had received from the Dean. The legend to which the honorable member referred was not admitted to be accurate by many of the best Irish authorities. The explanation furnished by Dean Bradley was to the following effect: Among the interesting features of Westminster Abbey the coronation stone has always been popular. Many years ago an inscription in Latin was attached to it stating that the stone was the pillow on which Jacob rested his head at Bethel; and the legend went on to say that it was carried from Palestine to Egypt, and from thence to Spain. From Spain it was said to have been conveyed to the Hill of Tara, in Ireland. In the year 1851, in order to meet the convenience of the visitors to the Great Exhibition, the head guide wrote on a label a notice to the effect that the stone had been used at the coronation of the ancient kings of Scotland and Ireland, but he omitted all reference to the legend relating to Jacob's pillow, while retaining the closing part referring to Ireland. The label having become dusty and dirty, the guide, who has considerable antiquarian knowledge, turned it over recently, and on the back wrote simply the historical fact with regard to Scotland, and ignored the legend entirely. Dean Bradley adds that geologists have conclusively shown that the chair is of Scotch limestone, and that no stone of the kind is to be found in Palestine or Egypt. He has, however, in contemplation the addition of a separate inscription, setting forth the curious legend of its travels in the Holy Land, as distinct from the authenticated history of the stone.

Ancient Egyptian Mechanical Methods.

Petrie, who is the author of a treatise on ancient metrology, has lately turned his attention to ancient Egyptian processes. Though much labor has been bestowed on the literary remains of Egypt and the description of monuments, little attention has been given to finding out the tools and methods by which their results were reached. The first conclusion to which Mr. Petrie comes is that stone-cutting was performed by means of graving points far harder than the material to be cut. These points were bedded in a basis of bronze; and in boring, the cutting action was not by grinding with a powder, as in a lapidary's wheel, but by graving with a fixed point, as in a planing machine. From discovering spiral grooves in diorite and granite, at least 1-100 of an inch in depth, the author supposes that an instrument was used of sufficient hardness to penetrate the material that far at a single turn. In this, however, he was corrected by Mr. Evans. The simplest tool used was a straight bronze saw set with jewels; but there is proof of one circular saw which must have been six and one-half inches in diameter. For hollowing the insides of stone objects, the inventive genius of the fourth dynasty exactly anticipated modern devices by adopting tubular drills varying from 24-100 of an inch in diameter and 2-100 of an inch in thickness to eighteen inches in diameter. Other drills, not tubular, were used for small holes, one measuring 1 2-10 inches long and 8-100 of an inch in diameter. But this is surpassed by the Uaupes of South America, who drill holes in rock crystal by the rotation of a pointed leaf shoot of plantain, worked with sand and water. The writer of this note has seen, in Porto Rico, stone beads of the hardest material, two inches long, bored longitudinally with an orifice 1-16 of an inch in diameter. The Egyptians understood rotating both the tool and the work. For the finishing of vases, a hook tool must have been used; but the early Egyptians were familiar not only with lathes and jewel turning tools, but with mechanical tool rests, and sweeping regular arcs in cutting. In addition to the tools mentioned, are to be noticed those for dressing out drilled cores, stone hammering and smoothing, saws with curved blades, mallets, chisels, adzes, and bow drills. For marking and indicating the plane of the stone, red ochre paint was used in a variety of ways, well-studied out by Mr. Petrie. Rock excavation, both for saving the stone and for the creation of vaults and chambers, was altogether an affair of drilling. Granite bowlders were utilized in the pyramids, but the best stones were taken from quarries. The method of handling these immense masses is not known. Mr. Petrie concludes with a sensible remark upon the oft alleged inhumanity of the pyramid and temple builders. To require a man every six years to serve upon the public works, during the season when he could do nothing else, would certainly not be a great hardship.—*Journal Anthropological Institute.*

HOW BOYS' MARBLES ARE MADE.—Almost all the "marbles" with which boys everywhere amuse themselves, in season and out of season, on pavement and in shady spots, are made at Oberstein, Germany. There are large agate quarries and mills in that neighborhood, and the refuse is turned to good account in providing the small stone balls for experts to "knuckle" with. The stone is broken into small cubes by blows of a light hammer. These small blocks of stone are thrown by the shovelful into the hopper of a small mill, formed of a bedstone, having its surface grooved with concentric furrows; above this is the "runner," which is of some hard wood having a level face on its lower surface. The upper block is made to revolve rapidly, water being delivered upon the grooves of the bedstone where the marbles are being rounded. It takes about fifteen minutes to finish a bushel of good marbles, ready for the boys' knuckles. One mill will turn out 160,000 marbles per week. The very hardest "crackers," as the boys call them, are made by a slower process, somewhat analogous, however, to the other.

Iron Manufacture of Ohio.

Prof. N. W. Lord says:—"All the iron ores of any value in Ohio are found among the rocks of the coal measures, and, although they are quite abundant in this formation, it is only in a few regions that they are in sufficient quantities to sustain important iron industries, so that the chief supply of ores is now, and will be obtained from other States. The rich and pure specular ores of Lake Superior, the magnetites of Canada, etc., readily transportable by the waters of the Great Lakes to her northern shores, meet first in the coals of Ohio the supply of fuel in which those regions are so deficient. Hence it is that the coals of Ohio are the most important element in her mineral industry, and the one upon which the existence and progress of Ohio as an iron manufacturing State must, of necessity, be mainly dependent.

"The districts and places where the manufacture of iron is principally carried on are situated in the eastern part of the State, as all the mineral fuel employed is derived from the coal measures which underlie the eastern third of the State. Facilities of transportation, the existence of other industries, or large communities, however, are creating important iron manufacturing establishments at considerable distances from the supply of fuel, as at various points along the lake shore, etc. The principal points, nevertheless, of the iron industry of the State will be within the limit of the coal area, or closely connected to it by railroad communication. Of those towns which stand foremost in the iron industry of the State may be mentioned: 1. Cleveland, on the shore of Lake Erie, is the great seaport or distributing place of the ores of Lake Superior, Canada, etc., for northern Ohio and western Pennsylvania, as well as being the commercial center for the iron manufacture of northern Ohio. It also possesses large iron works, which are destined to be multiplied greatly, and make the Cleveland district of Ohio a great manufacturing center, a rival to its namesake, the celebrated Cleveland district of England, besides being the principal source for supplying the markets, accessible by the chain of the Great Lakes. 2. Closely connected by railroad and every interest, Youngstown, in Mahoning County, is the chief town and manufacturing center of the celebrated region of the Mahoning Valley, and for real enterprise and quantity of product this region leads the manufacture in the State. 3. Stubenville, on the Ohio river, is the seat of an important iron industry, which is more closely connected in conditions of manufacture and interest with Pittsburgh than with Cleveland. 4. The Ohio towns, Martin's Ferry, Bridgeport, and Bellaire, opposite to Wheeling. These towns and Wheeling, though now occupying a minor position in the iron manufacture of the Ohio river, by the unusual facilities which they have for water and railroad communication, and the enormous supplies of fuel in the great coal seam, which is everywhere visible in the vicinity, must soon occupy a pre-eminent one in this manufacture in the valley of the Ohio. 5. Ironton, in the extreme southern part of the State, on the Ohio, in Lawrence County, is now the center of the celebrated Hanging Rock region, and an important point of manufacture.

"The circumstances of the supply of ores and fuels, transportation, etc., offer such conditions that we may anticipate for its progress and high position among the manufacturing towns of the State. Besides these chief points mentioned there are others whose importance is not so great, as Leetonia, in Columbiana County, Massillon on the Tuscawaras Valley, Zanesville, Jackson, Columbus, and the Hocking Valley. On the lake shore, besides Cleveland, there are several places yet almost unknown as manufacturing points, where the facilities of communication with the supply of fuel from the coal area, and the ores from the lakes, seem to present very favorable conditions for successful industries, as Painesville, Ashtabula, Black River, Sandusky, and Toledo. At the latter place, however, there are already successful enterprises in operation."

The Locomotive.

PUBLISHED BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

NEW SERIES—VOL. V. HARTFORD, CONN., SEPTEMBER, 1884. No. 9.

Methods of Bracing Boiler Heads.

The accompanying illustrations show the methods of bracing the heads of horizontal tubular boilers most commonly practiced in this section of the country. Let us briefly examine and compare them.

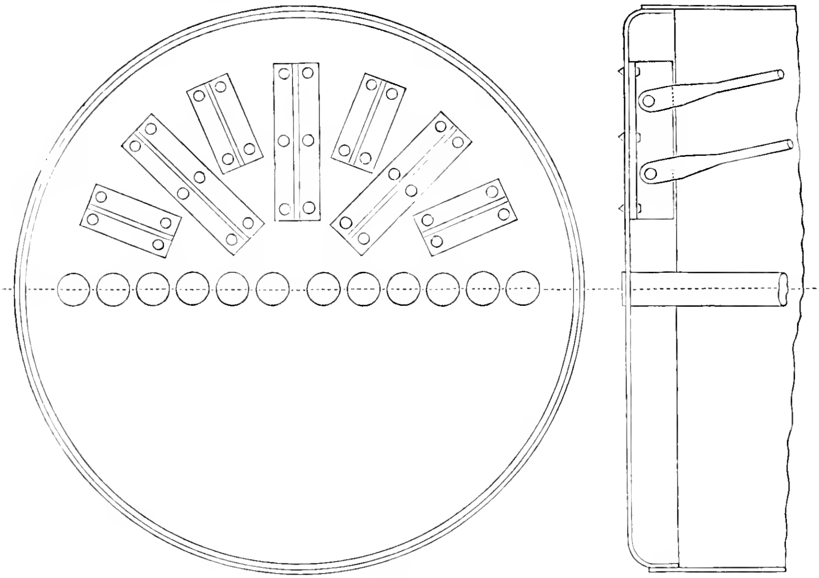

FIG. 1.

Fig. 1 shows the style of bracing recommended by this company in their specifications where ⊥ or L iron is used to attach the brace to. We recommend the ⊥ iron, as shown, in preference to L iron. The pieces should be riveted to the head above the tubes (of which only the upper row is shown in the cut) in a radial position. By making this disposition of them we are enabled to use a straight brace, and the resulting pull on the brace is more direct than it would be with the brace in any other position. The ⊥ irons should be of the best quality obtainable, $4 \times 4 \times \frac{1}{2}$ inches. The rivet-holes in their flanges, both for the attachment of the ⊥ iron to the head and for the attachment of the brace to the ⊥ iron, as well, also, as those in the boiler-head, should all be drilled, not punched. This makes a much better job.

Fig. 3 is a view of the form of brace recommended for use with the foregoing arrangement of ⊥ irons, to a larger scale than Fig. 1. These braces should be made of the very best round iron, one inch in diameter and of single lengths. The ends should be upset until sufficient stock is obtained to form the jaw and foot for attachment to the shell. This involves somewhat more labor than making them with welds, but a sound brace is insured, which is not the case with a welded brace. It is no unusual thing to find braces just welded up, and by good workmen too, which may be snapped in two like pipe-stems by striking them a sharp blow across the corner of an anvil. This is the common way of testing such work in some shops.

Fig. 2 shows a very common method of bracing the heads of tubular boilers. Two pieces of L iron are riveted horizontally across the head of the boiler above the tubes. The braces are attached by pins passing through, the braces being held between the L irons as shown. Fig. 4 is an enlarged view of this brace. It differs from Fig. 3 only in

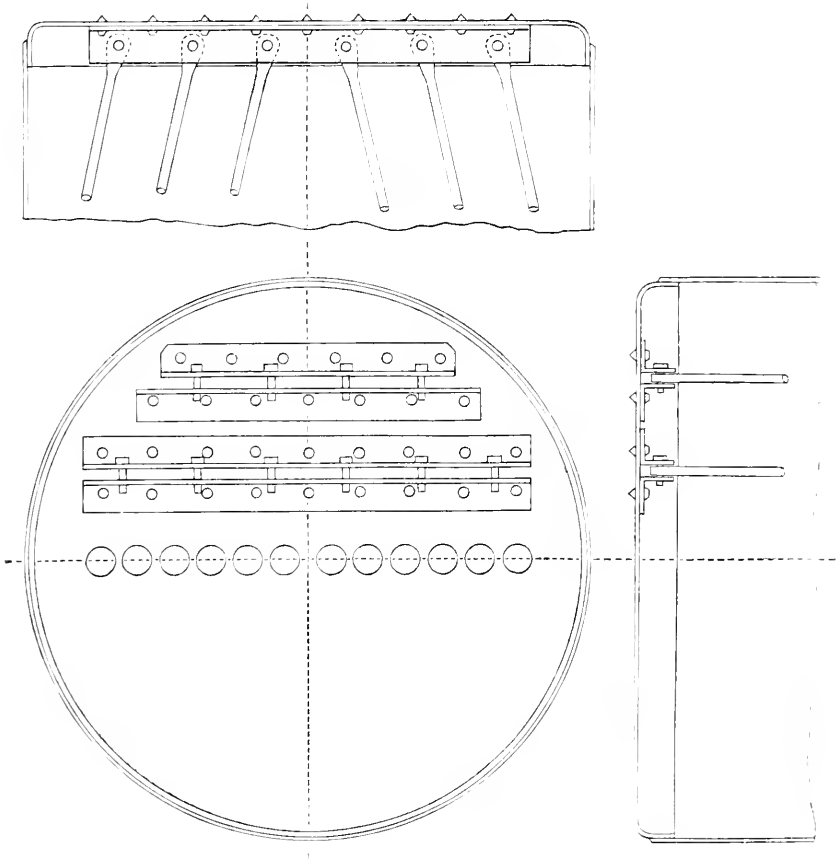

FIG. 2.

the form of the head, which is single instead of double. This makes a fairly good form of brace if it is properly constructed, but as a general rule it is not. If the braces were swung horizontally to the shell of the boiler, they would need only a comparatively slight twist, which could be put into the round portion of the body, to bring the foot fairly on to the shell, and they would then remain taut, but many boiler-makers bend them directly upwards to meet the shell; this necessitates a short bend near where they are attached to the boiler-head, in consequence of which they do not remain taut for any length of time. When we wish to resist a direct pull we should always use a straight piece of material to do it with. It is always wrong in principle to put a crooked brace into a boiler. It is, moreover, entirely inexcusable.

Fig. 5 is the best brace of the three styles shown, if made without a weld, as it always should be. It is much better adapted for use on flat surfaces which are exposed to the action of furnace heat, such as furnace crowns, etc. It is no more nor less than the old-fashioned "crow-foot," and is really a hard brace to improve upon when well made. Care, however, should always be exercised in its construction and attachment to the

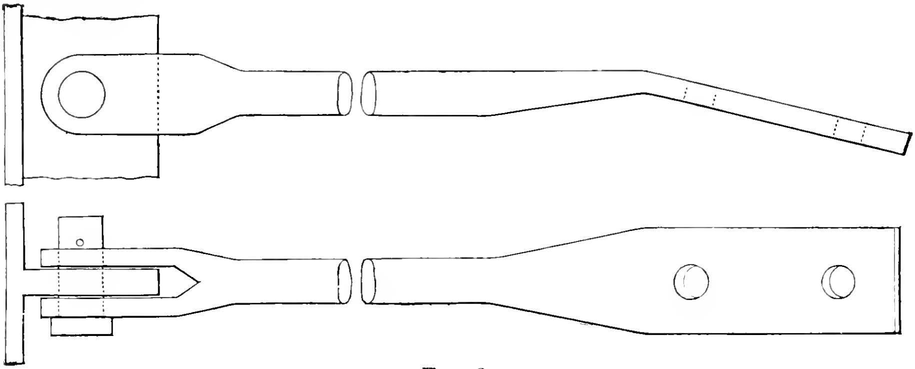

Fig. 3.

boiler. We have found many braces of this style broken short off, with nothing to indicate how it was done, leaving it to be reasonably inferred that the breakage was due to original faulty construction.

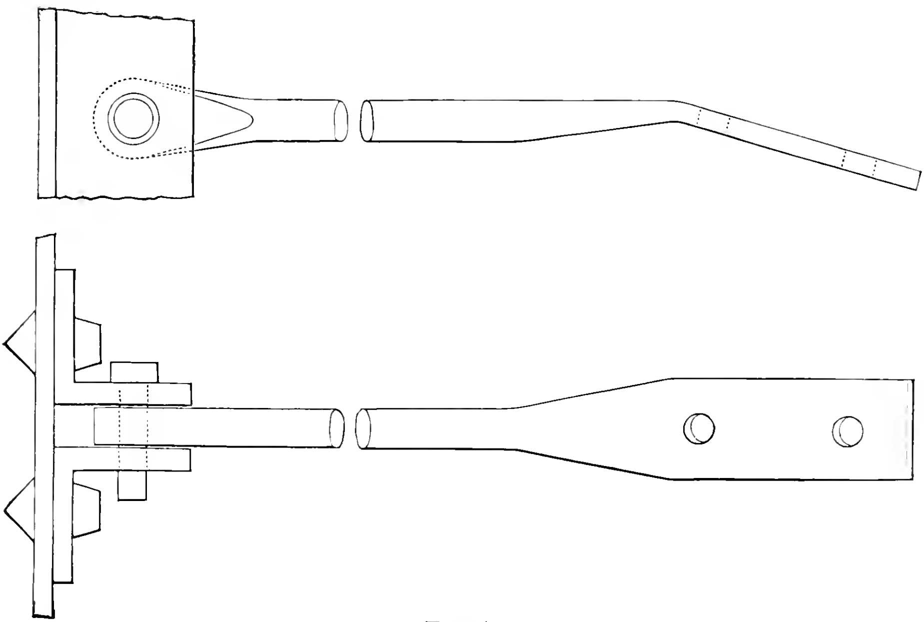

Fig. 4.

Regarding the amount of bracing necessary to properly strengthen the flat surfaces of boilers and other vessels exposed to pressure, much has been said and written, and few experiments have ever been made, but those few are sufficient, to our mind, to settle the question near enough for all practical purposes, that is, so that we always can, with due care, know when a flat surface is well braced. The question frequently arises, How much pressure will a certain plate safely sustain? It is generally brought up by the disastrous explosion of some boiler with an unbraced or poorly braced head. The question of the actual bursting strength of a boiler-head say $\frac{3}{8}$ of an inch thick and 36 inches in diameter, may, under such circumstances, seem for a time an important one, and is so to a certain extent, but when we stop to think that such a head should *never* be run unstayed, we see that the maximum strength of the head itself is but a secondary consideration after all. The real question is, to know when the bracing is sufficient.

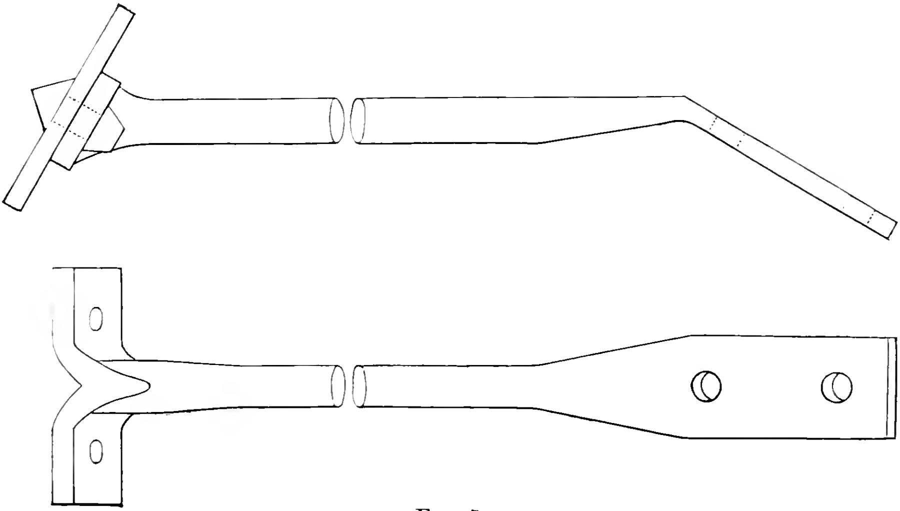

FIG. 5.

If we take such a boiler-head as that described above and subject it to hydrostatic pressure we shall find that a very low pressure, say 10 to 20 pounds per square inch, is sufficient to spring or bulge it much more than is allowable in practice. The only inference to be drawn from this fact is: We should always design the bracing of a boiler-head of any considerable size to take the *entire pressure on that surface.* This is necessary to prevent undue springing of the head.

The problem thus becomes a very simple one. We know the size of the exposed flat surface, we know the pressure at which we wish to run the boiler, and we simply put in enough material in the form of braces, which are exposed simply to tensile strain, to carry the load, allowing a due factor of safety.

THE highest building in New York is fifteen stories high, and measures 200 feet from the tower to the ground. It stands on the northwest corner of Fifty-seventh street and Seventh avenue, and will accommodate thirty-eight families. The building of such enormous structures exhibits the most monstrous disregard of common sense — not to say of human life.

A SINGULAR method of preserving historical ruins has been discovered in Ireland. On the Cave Hill, near Belfast, there was a short time ago an ancient castle. In order to protect its ruins from the ravages of time and passing vandals, some local antiquarians determined to surround it with a wall, and employed a contractor to execute the work. The wall was finished in due course, but when the antiquarians came to admire the castle it was gone. The contractor had used the ruins for building material, and not a stone of the castle remained!

Inspectors' Reports.

July, 1884.

The usual summary of the work of the Inspectors of the Company during the month of July last, is given below, and is instructive and suggestive as usual.

Visits of inspection made,	2,880
Total number of Boilers examined,	6,202
" " internally,	2,904
Boilers tested by hydrostatic pressure,	365
" condemned,	46
Whole number of defects reported,	4,189
" " of dangerous defects reported,	562

The detailed statement of defects is as follows:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	556	37
Cases of incrustation and scale,	728	48
Cases of internal grooving,	15	8
Cases of internal corrosion,	197	26
Cases of external corrosion,	332	42
Broken and loose braces and stays,	41	8
Settings defective,	219	10
Furnaces out of shape,	151	8
Fractured plates,	154	62
Burned plates,	109	13
Blistered plates,	386	34
Cases of defective riveting,	146	60
Defective heads,	25	5
Serious leakage around tube ends,	411	61
Serious leakage at seams,	243	62
Defective water-gauges,	116	11
Defective blow-offs,	54	10
Cases of deficiency of water,	7	3
Safety-valves overloaded,	15	7
Safety-valves defective in construction,	39	14
Pressure-gauges defective,	242	30
Boilers without pressure gauges,	3	3
Total,	4,189	562

We were recently shown a sample of sand which one of our patrons received on an order for very best sand for making fire-brick mortar or paste for lining up furnace-walls, which is a decided curiosity. It might be good sand for the purpose, but if we were going to use it ourselves, we would begin operations by putting it through an ore crusher. The grain varied anywhere from one to three-eighths of an inch in diameter. Considering the fact that fire-brick should be laid in a mixture of equal parts of kaolin fire clay, and finest sand, made into a thin paste with water, and that only just enough of this fine paste should be used to give the bricks a uniform bearing, we cannot avoid the inference that the same dealer carried a stock of tremendously uneven and irregularly shaped bricks.

Boiler Explosions.

JULY, 1884.

SAW-MILL (85).—The boiler in Rogers' saw-mill, Tara, Ont., exploded July 4th, completely demolishing the building. William Walker, the engineer, was killed, and D. Bennett and another workman, name unknown, were probably fatally injured.

STEAM-TUG (86).—The steam-tug H. C. Coleman exploded her boilers at Elliot's Landing on the Missouri river, seven miles from Booneville, Mo., Monday night, July 7th, and two white men and four negroes were killed. The boat was torn to pieces, and the pilot-house was blown about 200 yards away.

THRESHING MACHINE (87).—The boiler of a threshing machine on the farm of William Cavender, eight miles from Middleton, Delaware, exploded July 10th, scalding five men, three of whom, William Cavender, William Baker, and a negro named Hoggins will probably die.

SAW-MILL (88).—A terrific boiler explosion occurred at Wolf's portable saw-mill, six miles from Millfield, Ohio, July 11th, by which one man was instantly killed, and several others seriously and perhaps fatally injured. The explosion occurred while all the men were near the mill, and the building was demolished. Barrack Wolf was hurled quite a distance, and his body horribly mangled. He died almost instantly. Eugene Wolf was struck by flying timbers and perhaps fatally hurt, while Roy Blackburn was badly cut up, and Hawley Howard scalded almost to death by steam.

SAW-MILL (89).—The boiler at Carter's saw-mill near Bloomington, Ind., exploded July 14th, and blew the mill to atoms. Over a dozen men were in the structure at the time. John Carter, Wesley Carter, William Graves, and G. Crener were instantly killed. All others were severely injured.

SAW-MILL (90).—The boiler in Wilson's saw-mill, near Ellenboro, W. Va., exploded on the morning of July 18th, killing a boy and fatally injuring a young man and woman. The engine was thrown 40 feet, and the building was burned, with some lumber adjoining. Loss $3,500.

SAW-MILL (91).—Wiggins, Cooper & Co.'s mill, of South Saginaw, Mich., burned July 19th. The fire originated from a spark which was blown from the furnace into a room adjoining the engine and boiler-room, the floor and walls of which had become thoroughly impregnated with oil. The boilers exploded, but fortunately no one was injured. The mill was nearly new, and cost $15,000; insurance $10,000.

PORTABLE BOILER (92).—At 5 o'clock on the morning of July 20th, a boiler used in sinking a gas-well at Mt. Vernon, Ohio, exploded, killing two tramps sleeping near.

LOCOMOTIVE (93).—The boiler of a locomotive on the Western North Carolina railroad exploded near Cowee, Tenn., July 21st. The cars were loaded with convicts. Engineer Harry Warney, fireman Ed. Barringer, and one convict were killed. Several other convicts were horribly and perhaps fatally scalded.

THRESHING MACHINE (94).—The boiler of a portable threshing engine in operation on a farm near Barnett, six miles northwest of Litchfield, Ill., exploded July 22d, killing John West, and Frank Gaskell, and seriously injuring five others. The engine was an old one, and the boiler had been condemned as unsafe.

THRESHING MACHINE (95).—An explosion of a steam thresher occurred July 24th, on the farm of Joseph Hall, six miles south of Rushville, Ind. The engineer, Eugene Swain, was instantly killed, as was David Henderson. Ney Innis was struck by a flying missile and injured so badly that he lived but two hours. Hayden Crayen, Jr., was badly injured about the head and shoulders, and his back badly gashed. William Stevenson had his leg broken. Thomas Innis was severely, and Butch Innis terribly, scalded. Robert Tompkins and Kiss King were also seriously hurt. The head of the boiler was thrown twenty rods into an adjoining field. The remainder of the boiler was thrown into the air, coming down perpendicularly and falling on Henderson, crushing every bone in his body. The engine had been in use twelve years, but had been thoroughly tested before starting out this season.

Locomotive (96).—While a shifting engine on the Lehigh Valley railroad, with five of a crew on board, was running from Whitehaven to the Nescopeck siding, July 25th, the boiler exploded with great force, and the entire crew were killed. Three of the bodies were blown to pieces, and cannot be found. No flagman being there to warn an approaching freight train, it ran into the wreck, and several cars were demolished. The victims are J. H. Hassell, the engineer, brakeman Hassell, son of the engineer, fireman Armbruster and R. E. Smith, a telegraph operator.

Threshing Machine (97).—The boiler of a threshing-machine exploded at Lexington, Ind., July 26th, instantly killing John Owens, the engineer, and dangerously injuring three others. The accident resulted from Owens' ignorance of his duties.

Steamer (98).—The boiler of a new iron steamboat used for plying in the harbor of St. Pierre, N. F., exploded July 27th, while lying at the wharf of her owners, Louis Cabissol & Co. Fortunately all hands had gone on shore except one of the firemen. He was blown fifty feet in the air and instantly killed. The steamer sunk. Portions of her shattered frame were deposited in shore some six hundred yards distant. Numbers of passers-by marvelously escaped death.

Locomotive (99).—A yard engine on the Cleveland, Columbus, Cincinnati & Indianapolis road exploded at Cleveland, Ohio, July 28th, just as the engineer was about to start up. Thomas Ward, the engineer, was knocked down and seriously scalded, and Joseph Moss, the fireman, was blown forty feet into the air, but was unhurt, as he landed in a bed of mud. A little girl, who was picking up coal near the track, was thrown a hundred feet away, but not injured. A piece of iron weighing half a ton was thrown two hundred feet, and wrecked a switch-shanty en route. Another piece weighing about twenty-five pounds was hurled a half mile, and struck just in front of a moving street-car. The boiler was full of water, and the explosion is unexplainable.

Colliery (100).—A terrible disaster occurred at the Philadelphia and Reading Coal & Iron Company's Rausch Creek colliery, near Tremont, Penn., July 30th. Two of a large nest of boilers at the head of the shaft exploded, displacing all the boilers, and blowing the boiler-house, which was a large stone building, to atoms. The boilers were in charge of two firemen, who were the only persons about the building. One of them had only five minutes before left the boiler-house to go to the engine-room where the other fireman was sitting. They jumped out of a rear window to the ground below, a distance of 30 feet, sustaining serious but not fatal injuries. They say that the large stones went whistling through the trees like bullets, while huge pieces of the boiler were blown half a mile from the spot. Trees of immense size were cut in two by flying fragments. The cause of the explosion is unknown. The loss will probably reach $6,000 to $8,000.

Saw-Mill (101).—The saw-mill of H. N. Crumporse, Moss Point, Miss., was damaged by a recent boiler explosion.

Saw-Mill (102).—The boiler in W. H. Bobo's planing mill, at Fish, Ga., recently exploded, doing much damage to the machinery.

Colliery (103).—Two cylinder boilers exploded recently at the works of the Leisenring Coke works, Fayette Co., Penn., demolishing the boiler-house. No one injured.

The Locomotive.

HARTFORD, SEPTEMBER, 1884.

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

Boiler Inspection at less than Cost.

The following article from *Mechanics* is so full of good sense that we reproduce it for the benefit of our readers. The evils arising from encouraging Boiler Inspection and Insurance at rates below the cost of efficient inspection will be apparent to every thoughtful user of steam. Boilers should not be trifled with, nor should their inspection be passed over hurriedly and carelessly because the compensation is inadequate for a careful and thorough examination. *Mechanics* says:

"The comments on the report of Mr. Henry Hiller, chief engineer of the National Boiler Insurance Company of Manchester, England, supplied by the London *Engineer* and published elsewhere in this issue, are well worth reading, and form a most interesting addition to an article on "British Methods of Boiler Insurance," which appeared in our columns some months ago. That there is a good deal of room for improvement over prevailing practices seems to have long been recognized, and it is simply surprising that some manufacturers should so persistently refuse to look to their own interests and expend money for inspection which, they ought to know, is worse than useless, because of the insufficient price paid for it and the consequent inability to secure conscientious work from inspectors. With growing competition among inspection companies, and failure on the part of steam users to fully appreciate the value of thorough examinations of their boilers, decrease in price and corresponding decrease in reliability of the service rendered are natural and unavoidable results, and prompt measures to suppress any further tendencies in this direction cannot be too strongly urged. There is a price below which guarantee of faithful inspection cannot possibly be extended without seriously affecting the financial equilibrium of any company. What this price is, and how nearly it corresponds with what a given manufacturer is paying, is, of course, a matter of speculation, but we think that a fair estimate could be made without much difficulty, and any offer of insurance and inspection at a much lower rate should be looked upon with suspicion."

MANNING, MAXWELL & MOORE of New York, have just issued a very large and expensive catalogue of machinery, covering nearly the whole field of machines and mechanical appliances. It is a very valuable book for reference, and displays commendable enterprise.

WE ARE indebted to the publisher, Edward Meeks of Philadelphia, for a copy of ROPER'S YOUNG ENGINEERS OWN BOOK. This is the last of a series of books on practical steam engineering, prepared by Mr. Roper. It is replete with information on the subject treated, and such information as every young engineer wants at hand. It contains useful and valuable tables and formulæ which have been gathered out of works not easily accessible to engineers generally, together with much practical information from the author's long experience. It is well printed, in convenient form, and altogether makes an attractive volume. We heartily commend it.

The largest room in the world, under one roof, and unbroken by pillars, is at St. Petersburg. It is 620 feet long by 150 in breadth. By daylight it is used for military displays, and a battalion can completely manoeuvre in it. 20,000 wax tapers are required to light it. The roof of this structure is a single arch of iron, and it exhibits a remarkable engineering skill in the architect.

Wm. Wallace & Sons at Ansonia have a larger room (500 feet square, or thereabouts, if we are not mistaken) under one roof, but *with* pillars.

Some curious facts may be learned with regard to the influence of high temperatures upon cast iron, by noting the effects of the furnace heat upon the cast iron mouthpieces, and other parts of boiler fittings. By a proper application of facts so obtained we are enabled to overcome certain difficulties that arise, and make, sometimes a considerable saving in the usual bill for repairs.

The plan followed by most boiler makers of making the cast iron fronts for boiler settings in one piece, can easily be improved upon. By far the better way is to make it in three pieces and fasten these together with bolts in oblong holes. Then the expansion which *always* occurs will not crack the casting, as it has a chance to expand. When fronts are made in one piece they always crack from unequal expansion. It is unavoidable.

The *Iron Age* in its issue of September 18th, contains an article from the pen of Mr. Wm. Kent of New York, on "Irregularities in Railroad Building and recent Business Depressions," which is worthy the careful attention of Capitalists and Iron Manufacturers.

In consideration of the fact that this country is favored with abundant crops this season, and also that the condition of the money market generally is healthy, we think it safe to predict a return of prosperity in the near future.

Many of the tiny screws used in this country in watch-making are turned out on three little automatic machines in Danbury, Conn. One of them, while turning out a perfect screw at a fair rate of speed, is considerably improved on by its companions. The machine takes up but little room. A man could carry it under his arm without much difficulty. A wire is fed through a tube into the machine. It is carried forward by revolving teeth. As it appears, a knife cuts away the surplus metal to make the stem for the thread, just as the chisel operates at the lathe of the wood-turner. As this is finished a small tube, in which the thread is formed, advances and clasps the stem, forms the thread at lightning speed and falls back. As this is done, two knives cut that portion of the wire off, and the completed screw falls down. The wire again advances and the process is repeated. The marvel of the machine is best grasped when the size of the screw formed is understood. They are an eighth of an inch in length, and it would require 200 of them to weigh an ounce. The thread on the stem is so small that it is scarcely discernible to the naked eye. Each machine will make 5,000 screws a day.—*Manufacturers' Gazette.*

Hydraulic Cement.

Editor Locomotive.—

To the majority of people using cement very little is known of its sources of supply, manufacture, or quality. The knowledge is confined usually to the fact that there are two kinds, viz.: American, so-called, and Portland. It should be divided into Roman and Portland, the first being natural rock calcined and ground, while the latter is a mixture of several materials combined mechanically and similarly treated; but not all "Portland" cement, so-called, is imported, nor is all Roman, American. Each kind and every different maker and each locality produce a different article, with quality adapted to different uses. It is always made from lime, silica, and alumina. The color depends upon the quantity of iron, incidentally and always present in the material as found and used: the more iron the darker the cement, and the less lime, silica, and alumina will it have, and everything else being equal, the poorer is the quality. Some are quick in setting and some are slow, some swell in bulk in setting and some shrink. In some, apparent superiority will be obtained upon testing shortly after use, while, in fact, this superiority is but transient, and upon trial a few months later is so demonstrated. Altogether more knowledge is desirable. The sources of supply in this country are importations from England, Germany, France, and Sweden, and manufacturers in this country at Rondout, Howe's Cave, Buffalo, and Akron, N. Y., Allentown, Penn., Cumberland, Md., and on the James River, Va., Louisville, Ky., Utica, Ill., Mankato, Minn., and St. Louis, Mo. The material is plenty at each of these localities and each have peculiarities. Outside of these localities there is very little of available material. Its uses are rapidly extending.

HARTFORD, August 14, 1884. P.

Heating Surface of Steam Boilers.

We are frequently asked to give a rule for computing the heating surface of tubular steam boilers. The matter is very simple, but the following explanation and example will probably be of service to many engineers.

The heating surface of a steam boiler of any kind is the surface exposed to the action of the fire which has water on the other side. The extent of this surface is measured exactly the same as any surface would be.

For instance, we have a boiler 60 inches in diameter, with 66 tubes 3 inches in diameter and 15 feet long; what is the amount of heating surface?

The operation of finding the effective heating surface in this case is best divided into three parts.

First.—The surface of the shell. As the brick-work is, or should be, closed in at the center of the shell, we have as the effective heating surface one-half the circumference of the boiler multiplied by the length of the tubes, that being the length of shell exposed to the fire.

$\frac{1}{2}$ circumference of shell, 5 feet diam., = 7.85 feet.
Length of shell - - - = 15 feet.
$7.85 \times 15 = 117.75$ square feet in shell.

Second.—That portion of the two heads between the two tubes. As the water-line comes but slightly above the center of the boiler, we usually assume it as half way. Then we have a surface equal to one entire head of the boiler covered with water and exposed to heat.

A tube-sheet 5 feet in diameter - = 19.63 square feet.
66 tubes 3 feet in diam. = $3.23 \times 2 =$ 6.46 square feet.
Total heating surface on heads = 13.17 square feet.

Third.—The tubes. It is usual to reckon the inner surface of the tubes as heating surface. Then we have 66 tubes each 15 feet long. 66 × 15 = 990 feet of 3-inch boiler tubes. By the manufacturers' standard table the length of 3 inch tube required for one square foot of inside surface = 1.373 feet. Then 990 divided by 1.373 = 721 square feet in the tubes.

Adding the above together we have—

For the shell, - - - -	117.75 square feet.
For the heads, - - - -	13.17 square feet.
For the tubes, - - - -	721.05 square feet.
Total, - - - - -	851.97 square feet.

We must proceed in a similar manner to obtain the heating surface of any boiler whatever. Usually about 15 square feet of heating surface in a tubular boiler is reckoned equal to one nominal horse power.

Useful Notes from Various Sources.

Average annual depth of rain-fall at various points in the United States:

Augusta, Ga., - - - - - -	23 inches.
Albany, N. Y., - - - - - -	31 to 51 "
Baltimore, Md., - - - - - -	40 "
Boston, Mass., - - - - - -	25 to 46 "
Detroit, Mich., - - - - - -	30 "
Fort Pike, Louisiana, - - - - -	72 "
Fort Adams, R. I., - - - - -	52½ "
Fort Hamilton, N. Y., - - - - -	43⅔ "
Key West, Florida, - - - - -	30 to 39 "
Marietta, Ohio, - - - - - -	35 to 54 "
New Orleans, La., - - - - -	51 "
Philadelphia, Pa., - - - - -	$45\frac{8}{40}$ "
Washington, D. C., - - - - -	41 "

It requires a quite heavy rain for a length of 24 hours to yield a depth of 1 inch.

An inch in depth of rain is equal to

3,630 cubic feet, or
27,155 United States gallons, or
101.3 tons per acre.

In breathing a grown person requires from .25 to .35 of a cubic foot of air per minute, when walking, or hard at work, two or three times as much. About 5 cubic feet of air per person per minute is required for perfect ventilation of rooms in winter, and about 8 in summer.

Where the barometer is at 30 ins., and the temperature at 70 degs. Fahr., air weighs about $\frac{1}{813}$ part as much as water.—*Trautwine.*

In testing oils, attention should be directed to the following points:

1.—Their identification and the detection of adulteration.

2.—The measurement of density.

3.—The determination of their viscosity.

4.—The detection of tendency to gum.

5.—The determination of temperature of decomposition, vaporization, and ignition.

6.—The detection of acidity.

7.—The measurement of the coëfficient of friction.

8.—The determination of their endurance, and the power of keeping the surfaces cool.

Paraffine oils should not be kept in leaden or zinc vessels, as they dissolve so much of these metals as to sometimes render them nearly useless for illuminating purposes. Tin, copper, or iron vessels should be used.

The temperature of decomposition of the mineral oils is a good gauge of their values. An oil should not generally be used which takes fire at so low a temperature as 250° F. Some of the best oils do not burn, or even give off much vapor at a temperature of 300° or more.

Animal and vegetable oils do not vaporize, but decompose at high temperatures.

Oil is best tested for viscosity, and tendency to gum by dropping some of it on a smooth plate of glass set in a slightly inclined position and noting its behavior as it runs down.

The real value of a lubricant to the user is a somewhat difficult quality to determine, since it really depends, not upon the relative friction-reducing power and endurance, as is usually assumed, but upon the value of the power saved by its use; this value varies in every case, and is affected by every variation of working conditions.—*Thurston* —"*Friction and Lubrication.*"

Taking Down a Chimney.

From a paper entitled *Chimney Construction*, by Messrs. R. M. and F. S. Bancroft, we take the following interesting account of an ingenious arrangement employed for taking down a chimney shaft in Middlesboro', England, the method followed being necessary, as the chimney stood in a crowded position, and therefore could not be thrown down. The bricks had to be lowered with as little damage as possible, so that they might be used again for building purposes. Owing to the position of the chimney, the bricks could not be thrown down outside, and if thrown down inside they would have been smashed, or if lowered by mechanical means the process would have been very tedious, and was impracticable. Under these circumstances it was considered whether the bricks could not be allowed to fall by their own gravity, and at the same time be cushioned sufficiently to break their fall and prevent damage. In order to do this an air-tight iron box was placed at the bottom of the chimney; this box was fitted with an air-tight door mounted on hinges and closing on an India-rubber face, against which it was tightened by a wedge. A wooden spout was then fixed to the top of the box and carried up the chimney; it was 3½ inches by 5 inches inside, and was made of planks 1⅛ inches thick, well nailed together, with a little white lead on the edges, thus making it air-tight. The spout was made in about twelve foot lengths, and these were joined together by cast-iron sockets or shoes, and corked round with tarred yarn, the whole apparatus costing about $30. A few stays were put inside the chimney to keep the spout steady, and steps were nailed upon it, by which the men ascended. It will be seen that, the whole of the spouting being air-tight, if a brick filled the spout it would not descend; but as the section of a brick is 3 x 4½ inches, and the spout was 3½ x 5 inches, there was a quarter inch space each way through which the air could pass the brick freely, the space further allowing for any irregularity in the sizes of the bricks. The result was that the bricks, being cushioned in their fall, arrived at the bottom without any damage. As soon as the box was full the man at the bottom rapped on the spout as a signal to stop, and then opened the air-tight door and removed the bricks from the inside. This being done, he shut the door and signaled same to the man at the top. The man on the top lowered his own scaffold, and as the spout became too high he cut a piece off with a saw. If there was much mortar adhering to the bricks it was knocked off before putting the latter into the spout, and such mortar, etc., was allowed to fall inside the chimney, and was afterward wheeled out.—*The Iron Age.*

Turned to Marble.

A well-dressed, small, bald-headed man, wearing two restless black eyes, flashing on the inside of a pair of gold specs, a white necktie, low shoes, and a philosophical appearance generally, was met last evening in the corridors of the Burnet. This gentleman, who answers to the title of Signor Baccioco, hails from Genoa, and is visiting the city for the purpose of introducing a new system of embalming.

"You may hardly credit it," remarked the professor, on being quizzed, "but the idea of the final decomposition of the body is a thing of the past. A complete revolution has already begun, which bids fair not only to abolish the cemeteries of the country, but give to art much that the grave robs."

"How?"

"In this way: The veins of the bodies submitted to our treatment are charged with a mineral which not only — by its chemical action — changes the veins into hard stone, but before coming entirely solid, has the same effect upon all the surrounding tissues. In other words, it is simply a rapid process of petrification or marbleizing of the flesh and veins and tissues. The idea was first discovered in Genoa, by a friend of mine, a chemist, who has already utilized the idea by marbleizing a number of animals and placing them on his lawn. It takes from two to three weeks for the chemicals to have their proper action after the blood has been drained from the system."

"What of the appearance of the body?"

"Singular to say, the human body retains a most peculiar, healthlike color, except around the eyes, which, of course, always present that sunken, weird appearance. The chemicals are not so very costly either, the body of a girl of eighteen costing from $25 to $10 according to the size and weight."

"And as to its preservation?"

"Last longer than the old Egyptian method. The anti-cremationists of the country are taking hold of it with a good deal of zeal, and I think, rightfully. The idea of being able to actually metamorphose the human body into stone, and placing it into one's garden or utilizing it for art purposes, may sound somewhat startling to even the American mind, but it is based upon a sound philosophical principle and will be the idea of the future. Here, for instance," continued the professor, taking from his inside coat-pocket what the *Sun* at first mistook for a piece of stalactite, "is actually the finger of a gentleman who was formerly a professor in the Jena University. It took just two weeks to obtain that result by our process. The rest of the body is in a Berlin museum. Should the system become finally adopted, the acres now used for cemetery purposes will be used up in a better way." —*Cincinnati Sun.*

Simple Home Remedies.

The following remedies for many simple ailments we find recommended in *Hall's Journal of Health.* And while the remedies may not be new to many of our readers, they will be found useful to all. We now publish them that they may be at hand for ready reference.

Half a tea-spoonful of common table salt dissolved in a little cold water and drank will instantly relieve "heart burn" or dyspepsia. If taken every morning before breakfast, increasing the quantity gradually to a tea-spoonful of salt and a tumbler of water, it will in a few days cure any ordinary case of dyspepsia, if at the same time due attention is paid to the diet. There is no better remedy than the above for constipation. As a gargle for sore throat it is equal to chlorate of potash and is entirely safe. It may be used as often as desired, and if a little is swallowed each time, it will have a beneficial effect on the throat by cleansing it and allaying the irritation. In doses of one to four tea-spoonfuls in half a pint to a pint of tepid water it acts promptly as an emetic, and, in cases of poisoning, is always on hand. It is an excellent remedy for bites and stings of insects. It is a valuable astringent in hemorrhages, particularly for bleeding after the extracting of teeth. It has both cleansing and healing properties, and is, therefore, a most excellent application for superficial ulcerations. Mustard is another valuable remedy. No family should be without it. Two or three tea-spoonfuls of ground mustard stirred into a half a pint of water acts as an emetic very promptly, and is milder and easier to take than salt and water. Equal parts of ground mustard and flour or meal made into a paste with warm water and spread on a thin piece of muslin, with another piece of muslin laid over it, forms the indispensable "mustard plaster." It is almost a specific for colic when applied for a few minutes over the "pit of the stomach." For all internal pains and congestions there is no remedy of such general utility. It acts as a counter-irritant by drawing the blood to the surface; hence in severe cases of croup a small mustard plaster should be applied to the back of the child's neck. The same treatment will relieve almost any case of headache. A mustard plaster should be moved about over the spot to be acted upon, for if left in one place it is liable to blister. A mustard plaster acts as well when at a distance from the affected part. An excellent substitute for mustard plasters is what is known as "mustard leaves." They come a dozen in a box, and are about four by five inches. They are perfectly dry, and will keep for a long time. For use it is only necessary to dip one in a dish of water for a minute and then apply it. Common baking soda is the best of all remedies in cases of scalds and burns. It may be used on the surface of the burned place either dry or wet. When applied promptly, the sense of relief is magical. It seems to withdraw the heat and with it the pain, and the healing process soon commences. It is the best application for eruptions caused by poisonous ivy and other poisonous plants, as also for bites and stings of insects. Owing to colds, over-fatigue, anxiety, and various other causes, the urine is often scanty, highly colored, and more or less loaded with phosphates which settle to the bottom of the vessel on cooling. As much soda as can be dipped up with a ten cent piece, dissolved in half a glass of cold water and drank every three hours, will soon remedy the trouble.

Progress of Soap-Fat Butter.

A committee of the Senate of the State of New York has been engaged, lately, in the investigation of the bogus butter business, with a view to ascertain its nature, extent, and best probable mode of regulation.

Out of thirty specimens of butter sold by as many respectable grocers, analysis showed that only ten were composed of real butter; all the rest were chiefly composed of lard. The price charged for the soap-fat butter was about twenty-five cents per pound—the real butter selling for about the same.

Dr. Love, the chemist, testified that he could not distinguish the spurious butter from the genuine so as to swear to it, by its outward appearance, but he had no doubt of the accuracy of his chemical analysis. He said that in the manufacture of butterine and oleomargarine no chemical change takes place, but simply a mechanical mixture, and that all the substances used in the mixture have the same properties after the mixture as before, so that the lard, fat, and oils used in the bogus butter are no more injurious to health in the bogus butter than out of it. He had found no traces of nitric acid in his analysis, and would have noticed it if it had been present. He was of opinion that impure substances could be deodorized, so that they could not be distinguished. Even dead animals could be so deodorized, but if diseased germs were not destroyed they would prove deleterious to health. He knew of nothing in the process of manufacture of bogus butter that would be likely to kill disease germs.—*Scientific American.*

Underground Reservoirs in Constantinople.—The magnificent and vast receptacles for water built under ground, and within the city of Constantinople, have been so entirely neglected, that nearly all have fallen into decay and oblivion. One only of these remains to be seen with the water in it, which is much lower than it was in ancient days. Yèrè Batan Seraï, or "the subterranean palace," is its name, as the Turks call it, and it is said to be, without any exception, the noblest relic of Roman taste and industry. It resembles an immense subterranean lake, and occasionally is visited by the curious traveler. Many years ago it was supposed that a young Englishman lost his life here, by making the attempt to explore its dim recesses alone. He, and the little boat which disappeared from the sight of a few companions, and others equally interested in watching for him, never came back to the entrance. After that, for some time at least, no one was permitted to descend into Yèrè Batan Seraï. Then, again, tourists were allowed to visit the waters in company with a guide, as they are at present.

Those who are grateful for the privilege of seeing such a remarkable monument of old Constantinople, should also think gratefully of one Gallius, who discovered this reservoir above three hundred years ago. It had remained unknown to the Turks since the capture of Constantinople, and was then in total darkness. Now some rays of light penetrate it through a break in the wall. A light boat or raft is used to take strangers about on the waters, and torches are necessary to enable one to view the place satisfactorily.—*Manhattan Magazine.*

Purification of Water by Motion.—A discovery has been made by Dr. Pehl, of St. Petersburg, which promises to have a very important bearing on many industrial processes. The water of the river Neva is very free from bacteria, having only about 300 germs in a cubic centimeter. The canals of St. Petersburg, on the contrary, are infected with bacteria, their number reaching 110,000 in a cubic centimeter. even during good weather. The same is true with regard to the conduits of water for the supply of the city. While the chemical composition of the water passing through these city conduits hardly differs from that of the Neva (by which they are supplied), the number of bacteria reaches 70,000, against 300 in the water freely taken from the river; and the worst water was found in the chief conduit, although all details of its construction are the same as in the secondary conduits. Dr. Pehl explains this anomaly by the rapidity of the motion of the water, and he has made direct experiments in order to ascertain that. In fact, when water was brought into rapid motion for an hour, by means of the centrifugal machine, the number of developing germs was reduced by 90 per cent. Further experiments will show if this destruction of germs is due to the motion of the mass of water, or to molecular motion. If this discovery of Dr. Pehl's be confirmed, it will become possible to destroy bacteria, and render a water comparatively pure, simply by passing it through a centrifugal machine. The subject is of special interest to brewers, who suffer, perhaps, more than any other manufacturers, from the attacks of bacteria.

Homage to the Oyster.—Sweet bird of aqueous habitation, come, expand thy hardened wings and pour forth an epicurean song of saline sweetness. Sport thyself in the milky stew, warm thy esculent form in the ascending clouds of steam—invade the indigestible fry. Take on the robes of scalloped beauty. Mingle thy succulence with the best of the land wherever thou flyest and wreathe the inner man with smiles of joyous exultation. Delicious bivalve, we greet thee.—*Baltimore American.*

The Locomotive.

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Safety-Valves.

The ignorance oftentimes displayed in the management of safety-valves renders it desirable to give some necessary data with regard to them, such as hints on their management, how to calculate the position of the weight to give any required pressure, and also something about the proper pressures to which boilers may be subjected under different circumstances.

The carelessness sometimes displayed by engineers (?) who have charge of boilers is simply criminal, and deserves the severest penalties. A recent occurrence will illustrate this. Visiting an establishment where we had boilers insured, our attention was attracted by the suspicious actions of the engineer. Watching for what he supposed was a favorable opportunity, he climbed up on top of the boilers and headed toward the safety-valve, always keeping as nearly between it and us as he could, but not, however,

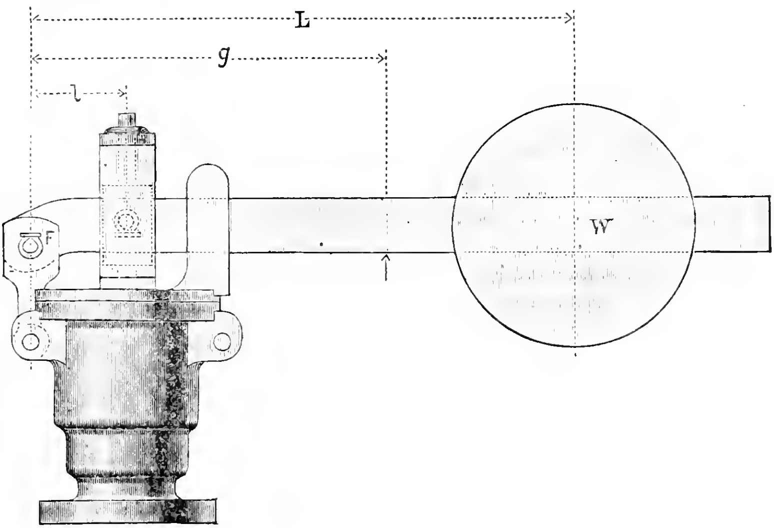

FIG. 1.

succeeding in always keeping it from view. Reaching the valve he busied himself a few moments about it, and then returned with a nonchalant air to where we were. The following conversation then occurred:

Inspector. "Tired of living, are you?"

Engineer. "No; what do you mean?"

Inspector. "I thought perhaps you were."

Engineer. "What makes you think so?"

Inspector. "Why, from the use you make of that wedge you now have in your overalls pocket. I see that you had the safty-valve fastened down with it. Now if you want to die, why don't you go out and jump into the river, and drown yourself; then nobody's life but your own would be endangered?"

Engineer. "Those boilers are all right. I don't believe a boiler can blow up so long as there is plenty of water in it. I have been running boilers twenty years." And so on to the end of the chapter.

This fellow had actually made an iron wedge, and driven it into the forked guide above the lever, so that it was impossible for the valve to lift, in order to "bottle up the steam," as he expressed it. And this in spite of the fact that the pressure was all that could be safely allowed, and he had also moved the weight out on the lever fifteen pounds beyond the limit allowed. This is an actual occurrence.

Now it stands to reason that if we have a boiler of a given diameter and thickness of plate, if we wish to run it for a reasonable number of years, we must limit it to a safe pressure. And by *safe* pressure we mean a pressure under which it will do its daily duty for a term of fifteen to twenty years without showing signs of distress. Now what is this limit? Experience, that master by which all things practiced are ultimately settled, teaches us that from one-fourth to one-fifth of the bursting pressure is the greatest under which a boiler should be habitually worked.

In the above case the boiler was 48″ in diameter, plates $\frac{1}{4}$ inch thick, single-riveted seams, and had been at work for about sixteen years.

The greatest pressure at which such a boiler should ever be worked is seventy-five pounds per square inch. If, with fair usage, we wished to get fifteen years' services from it with safety, it would be better to limit it to sixty pounds per square inch from the beginning. There would then probably be no necessity for cutting down the pressure after the lapse of a few years.

For the benefit of young engineers, and those interested in the safe use of steam, we will repeat here the rules used for calculating the bursting, and safe working pressures of boilers, and also those for fixing the weights on safety-valves.

TO COMPUTE THE BURSTING PRESSURE OF A BOILER.

Data required: Diameter of shell.
Thickness of shell plates.
Tensile strength of shell plates per square inch of section. If no brand is to be found on the plates, it should be taken at 40,000 pounds per square inch.
Pitch of rivets.
Diameter of rivet holes—usually about $\frac{13}{16}$ of an inch.

First ascertain the percentage of the plate left after the rivet holes are punched, as follows:

$$\frac{\text{Pitch of rivets—diameter of rivet hole.}}{\text{Pitch of rivets.}} \quad . \quad . \quad . \quad . \quad . \quad . \qquad (1)$$

That is: *From the distance apart of the rivets from center to center, subtract the diameter of the rivet hole and divide the remainder by the first number; the quotient is the percentage of plate remaining to the solid plate.* This percentage is what we must use in calculating the strength of the shell.

Second: *Multiply the tensile strength of the material of which the plates are composed, by their thickness in parts of an inch, and this product by the percentage of plate as found above; divide this last product by one-half the diameter of the boiler; the quotient will be the bursting pressure per square inch.*

The bursting pressure thus found, divided by the factor of safety, will give the safe working pressure.

As an illustration suppose we have a boiler 54 inches in diameter, plates $\frac{5}{16}$ in. thick, made of iron branded T. S. 50,000 lbs., pitch of rivets = $3\frac{1}{8}$ inches, rivet holes $\frac{3}{4}$ inch diameter; what would be the bursting pressure?

The percentage of plate in such a joint would be, $\frac{3\frac{1}{8} - \frac{3}{4}}{3\frac{1}{8}} = .76$ of the whole plate.

Then we shall have $\frac{50,000 \times \frac{5}{16} \times .76}{27} = 440$ pounds nearly as the pressure required to rupture the shell.

If we assume a factor of safety of 5 which is about right we shall have $\frac{440}{5} = 88$ pounds for the safe working pressure.

It is immaterial in most cases whether a boiler is single or double riveted so long as the *pitch of the rivets* is the same.

For making the necessary calculations about safety-valve weights, etc., the following will suffice to cover the most important points. Referring to cut:

W denotes the weight at end of lever in pounds.

L " " distance between center of weight and fulcrum in inches.

w denotes the weight of the lever itself in pounds.

g " " distance between center of gravity of lever and fulcrum in inches.

l denotes the distance between center of valve and fulcrum in inches.

V denotes the weight of the valve and its spindle in pounds.

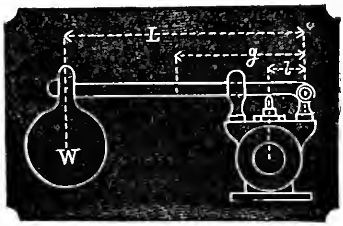

Fig. 2.

A denotes the area of valve in square inches.

P " " pressure in pounds per square inch at which the valve commences to blow.

To find the weight required to load the valve for any given pressure, L, l, g, A, V, and w, must be known. Then

$$W = \left\{ (P \times A) - \left(V + \frac{[w \times g]}{l} \right) \right\} \times \frac{l}{L} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Or, multiply P by A and call the product a; then multiply w by g and divide the product by l and add V to the quotient; call the sum b.

Divide l by L and call the quotient c.

Subtract b from a and multiply the difference by c. The product will be the required weight in pounds.

Example. Diameter of valve = 4″. Distance from fulcrum to center of weight = 36″. Distance from fulcrum to center of valve = 4″. Weight of lever = 7 pounds. Distance from fulcrum to center of gravity of lever = $15\frac{1}{2}$″. Weight of valve = 3 pounds.

What must be the weight at the end of the lever to make the blowing off pressure 80 pounds?

Area 4″ valve = 12.566 square inches.

$a = 80 \times 12.566 = 1005.28.$ $\qquad b = \frac{7 \times 15.5}{4} + 3 = 30.125.$ $\qquad c = 4 \div 36 = .111.$

Then $(1005.28 - 30.125) \times .111 = 108.3$ pounds.

To find the length of lever, or *distance from fulcrum* at which the weight must be placed for any required blowing of pressure, W, w, g, l, V, and A must be known. Then

$$L = \left\{ (P \times A) - \left(V + \frac{[w \times g]}{l} \right) \right\} \times \frac{l}{W} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Or, proceed as in the first case for the quantities a and b. For the third quantity, c, divide the distance from fulcrum to center of valve by the weight. Subtract b from a as in the first case and multiply the difference by c. The product will be the required length.

Example. Take the same data as given in the above case. How far must the weight be placed from the fulcrum to make the blowing off pressure 75 pounds?

Area 4″, valve = 12.566 square inches.

$a = 75 \times 12.566 = 942.45. \qquad b = \frac{7 \times 15.5}{4} + 3 = 30.125. \qquad c = 4 \div 108.3 = .037.$

Then $(942.45 - 30.125) \times .037 = 33.7$ inches.

To find at what pressure the valve commences to blow when the weight and its position on the lever are known.

$$P = \left\{ \frac{(w \times g) + (L \times W)}{l} + V \right\} \div A \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Example. Take the data in the first of the above cases, where $w = 7$, $g = 15\frac{1}{2}$, $L = 36$, $W = 108$, $v = 3$, $l = 4$, and $A = 12.566$.

Then we have $\left\{ \frac{(7 \times 15.5 + (36 \times 108.3)}{4} + 3 \right\} \div 12.566 = 80$ pounds.

And in the second case where the weight is 33.7″ from fulcrum we have

$$\left\{ \frac{(7 \times 15.5) + (33.7 \times 108.3)}{4} + 3 \right\} \div 12.566 = 75 \text{ pounds.}$$

The cut on first page, Fig. 1, shows a good form of safety valve for marine use; in Fig. 2 are given the outlines for a valve as commonly used on stationary boilers. The lettering on each cut refers to corresponding parts.

Inspectors' Reports.

AUGUST, 1884.

The usual summary of the work of the Inspectors of the Company during the month of August last, is given below, and is instructive and suggestive as usual.

Visits of inspection made, - - - - - - -	2,607
Total number of Boilers examined, - - - - - -	5,296
" " internally, - - - - - - -	2,037
Boilers tested by hydrostatic pressure, - - - - - -	434
" condemned, - - - - - - - -	51
Whole number of defects reported, - - - - - -	3,925
" " of dangerous defects reported, - - - - -	634

The detailed statement of defects is as follows:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment, - - - -	414	44
Cases of incrustation and scale, - - - -	629	58
Cases of internal grooving, - - - - -	16	5
Cases of internal corrosion, - - - - -	139	32
Cases of external corrosion, - - - - -	221	41
Broken and loose braces and stays, - - - - -	81	16
Settings defective, - - - - - - -	205	10
Furnaces out of shape, - - - - - -	107	12
Fractured plates, - - - - - - -	92	28
Burned plates, - - - - - - -	176	53
Blistered plates, - - - - - - -	234	12
Cases of defective riveting, - - - - -	473	87
Defective heads, - - - - - - -	25	9
Serious leakage around tube ends, - - - - -	428	101

Nature of defects.	Whole number.	Dangerous.
Serious leakage at seams,	223	57
Defective water-gauges,	133	18
Defective blow-offs,	39	10
Cases of deficiency of water,	20	9
Safety-valves overloaded,	21	8
Safety-valves defective in construction,	29	5
Pressure-gauges defective,	214	19
Boilers without pressure gauges,	6	0
Total,	3,925	634

The evil results likely to arise from the improper location of the feed, or rather perhaps we should say the delivery of the feed water into a boiler at the wrong place, are more serious in their character and greater in extent than is generally known. It is no unusual thing, in fact we might almost say that as a rule, if plain cylinder boilers are fed with cold water through the bottom of the shell, and no provision is made to allow of its thorough incorporation with the water already in the boiler, and assuming the temperature due to the steam pressure, before coming in contact with the bottom plates of the boiler over the fire, these plates will crack through the girth seams, and the owner is fortunate if the boilers do not explode. The force of contraction under such circumstances is irresistible. It is very bad practice to put up cylinder boilers and introduce the feed through the mud drum. It should enter the boiler and be delivered just below the water line. By this means it mixes with and attains a high temperature before it comes in contact with the shell plates, and much trouble is avoided.

Boiler Explosions.

August, 1884.

Pile Driver (104).—The boiler of a pile-driver used in constructing the new pier at Meadow's End, Milford, Conn., exploded August 2d. The pile driver was stripped clean by the explosion. Had the accident occurred ten or fifteen minutes earlier, at least ten men must have necessarily been mangled, as they were working about the machine. The damage was about $500 besides the delay.

Threshing Machine (105).--J. A. Smith, living near Kenesau, Neb., was instantly killed, August 4th, by the explosion of a threshing machine boiler. His body was thrown twenty yards, and a portion of the boiler forty rods.

Agricultural Engine (106).—The boiler of a field-engine on the farm of Matthew Rhodes, in Jackson County, Ill., exploded August 8th, killing Herbert Newton, and James M. Sullivan, and seriously wounding Ed. Riley. Three horses were also killed, and all the wheat surrounding the engine which was driving the threshing-machine at the time, was burned.

Steam-Tug (107).—The propellor *Mamie Glass* exploded her boiler August 11th, at Madison, Ind. Engineer George Keller was frightfully mangled, and instantly killed. Joe Lichlyter was knocked into the river and lost, and Commodore Wolf was blown, with the pilot house, fifty feet in the air, and broke his way out of the debris into the water. Though bruised he was not seriously hurt.

Locomotive (108).—Engine 51, with Barney Welch in charge, left Fort Wayne, Ind., August 14th, with a freight-train on the Southern Division of the Grand Rapids & Indiana Railroad. When nearing St. Mary's river, twenty miles south, the boiler exploded, causing terrible destruction to itself and the first ten cars of the train, six of which were entirely destroyed by fire. Engineer Welch was hurled from his cab into the air and frightfully mangled. Charles Hendershott was scalded from head to foot, he died in two hours. The head brakeman and two tramps were seriously injured.

SAW-MILL (109).—A boiler explosion at Heaton & Coles's saw-mill in the eastern part of Cincinnati, August 15th, started a fire which destroyed the mill, the Little Miami cattle sheds, and ten small dwellings. Loss $75,000.

—— MILL (110).—An explosion occurred at Oliver Bros. & Roberts' lower mill, on South Fourth street, Pittsburgh, Pa., Aug. 15th. No one was injured.

SAW-MILL (111).—Just after the engine in Polley's mill on French Island, near La Crosse, Wis., had started, August 16th, one of the boilers exploded, demolishing the west side of the mill, and injuring four men, as follows: William Laskonska, Edward Nelson, Charles Lee. George Hobert. Several others were slightly hurt.

LOCOMOTIVE (112).—Locomotive No. 3 of the Boston, Hoosac Tunnel & Western Railway Company exploded in the roundhouse at Mechanicsville, N. Y., August 15th, and was totally wrecked, and two other engines belonging to the same company disabled. Engineer Auchenpaugh was seriously injured. The engine-house caught fire, but the flames were extinguished by the fire department.

—— WORKS (113).—A boiler exploded at the works of the Wassil Tin Clay Company, Columbus, Ohio, August 16th. A workman by the name of Johnson was slightly injured. The loss to the company will be about $1,000. It is supposed that the explosion was caused by the lack of water in the boiler.

TILE WORKS (114).—The boiler of D. Willen's tile-works, Delphos, Ohio, exploded with great force, August 18th, instantly killing the engineer, Barney Magg. The cause is attributed to low water and inexperience of the engineer.

THRESHING MACHINE (115).—The boiler of a threshing machine exploded on the Howell farm, in Cambridge, Mich., August 19th, instantly killing Frank Kinney, and a young man named Johnson. A brother of the latter is also expected to die of his injuries.

STEAM TUG (116).—The boiler of the tug *Pacific* exploded while lying at Miller & Ritchie's mill, Ashland, Wis., August 20th, tearing the Captain to pieces, and killing Frank Duchow, the engineer. The tug was owned by the Union Mill Company.

STEAM LAUNCH (117).—The government launch *Dafney*, employed at the works at Memphis, Tenn., exploded her boiler August 21st, killing paymaster N. Godden, who was blown overboard, and seriously scalding engineer R. Graham, pilot C. D. Ryan, deck hand Peter Walsh, and a newsboy who was on the launch.

NAMES OF COUNTRIES.—The Phœnicians, who were a great commercial people in the young days of the world, are thought to have given the present name of most of the countries around the Mediterranean Sea. The Phœnician language contained the words Europe, Asia, Africa, Italy, Spain, Gaul, Britain, Ætna, Sardinia, and Siberia, as well as many others now used as the names of minor places. Europe, in Phœnician, meant "white complexion," and was applied to the country north of the Mediterranean because the natives were a lighter complexion than those of Asia or Africa. Africa signified "the land of corn," and Asia meant "the middle land," being so named because it was between Europe and Africa. Italy was the "country of black pitch;" Spain was the "land of rabbits;" Gaul, or France, the "land of yellow hair;" Britain, "the country of tin;" Ætna, "the smoky furnace;" Sardinia, "a man's foot," and Siberia, "thirsty land," because it is so dry.

The Locomotive.

HARTFORD, OCTOBER, 1884.

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

Herr Franz Hulna has been investigating the effect of sewage upon the purity of of river water. He examined the water of the river Oder, above Breslau, (the second city in point of size in Prussia, having something over 200,000 people) in its course through the city, and below the town. From the point where the water supply for the city is pumped to a little above the city, the water undergoes a slight but appreciable deterioration. In passing through the city a continuous change for the worse occurs. This is manifested by the increase of oxidizable matter and of chlorine, and by a great augmentation of ammonia and albuminoid ammonia. Microscopic examination disclosed the abundant presence of organisms of putrefaction. Farther down was observed a gradual process of self-putrefication by contact with oxygen along with the co-operation of animal and vegetable life in the stream. At ten miles below the city the influence of the sewage could not be detected, either by chemical or microscopic examination.

An English physician has recently been trying to count the hairs on the human head. Taking an ordinarily hairy head the number of hairs per square inch was found to be 1,066. This would give about 128,000 for the entire head, while some would have as many as 150,000.

There were thirty-nine earthquake shocks recorded in the territory of the United States during the year 1883, distributed as follows: Three in the New England States, two in the Atlantic States, eleven in the Mississippi Valley, and twenty-three on the Pacific coast.

A mistake which is frequently made in setting boilers consists in loading them down on top with a great mass of brick-work, which often does more harm than good Of course some good non-conducting covering is necessary if we wish to attain a high degree of economy, but for boilers some of the lighter coverings are much to be preferred to brick. This is especially true in the case of long cylinder boilers, of small or comparatively small diameter. It is no unusual thing to find boilers of this type with several tons of brick and mortar piled on top, which load the boiler has to carry, in addition to its own weight, on two supports, perhaps at the extreme ends. In such cases the girth seams generally show distress near the center of the shell where the greatest strain comes. What is needed is some good light coverings, made in sections so that it can be easily removed without destroying it, for purposes of inspection and as easily replaced again.

About the most remarkable piece of engineering work that has come under our notice lately was a steam boiler *set in sandstone.* The blocks of stone were neatly dressed, and the work looked very fine outside, but the furnace, and the pier supporting the back end of the boiler seemed to be in about the same condition that the eggs were in at a certain hotel where a guest ordered them poached and the waiter strongly advised him to have them scrambled, "for," said he, "them aigs ain't very fresh, boss, and dey *look* better scrambled!"

WE would call attention to the article in this issue on "The Alteration of Mineral Coal by Exposure to the Atmosphere," etc., with the suggestions given for avoiding waste. We do not vouch for the truth of any of the assertions made therein, but believe the matter is worth careful consideration by those who handle large quantities of coal.

"ACCORDING to Dr. Tach of Buenos Ayres, there is no danger of an exhaustion of the quinine supply."—*Ex.*

This is really unfortunate.

Employers' Liability.

We have repeatedly called attention to the vast amount of litigation which has been called forth under the recently passed Employers' Liability Act. It is the best friend which the gentlemen of the long robes have had for many years past. It bristles with legal quibbles and difficulties in almost every clause, and has caused, and is still causing, more vexatious annoyance to colliery proprietors, manufacturers, and factory owners than any other act ever passed. It has done much to destroy the amicable relationship which formerly subsisted between employer and employed by opening the door of litigation on the part of dissatisfied workmen or paid Trades' Unionists. It militates seriously against all manufactures, the proprietors of works and factories being hedged round with restrictions and complications which place them at unfair disadvantage with continental and foreign competitors, and we undertake to say that there is scarcely a manufacturer of any standing in the commercial world but unhesitatingly condemns this act as not only unnecessary, but as not restrictive, and injurious in its application.

These remarks have been called forth from a perusal of a most protracted and costly trial which has been held during the past week, at Swansea, before Judge Stevens and a special jury. For four whole days were judge, jury, and counsel engaged in the investigation of a case connected with the working and management of a colliery, which in all probability half-a-dozen practical men would have settled in as many hours. The amount of money which must have been spent in feeing the array of counsel, the solicitors, and the host of witnesses on either side, must have been enormous. The plaintiff, Mrs. Elizabeth Lewis, brought her action under the Limited Liability Act to recover three years' wages—£200—against the proprietors of the Gelly Colliery, Rhondda Valley, for the death of her husband by an explosion in that colliery. For the plaintiff there appeared Mr. McIntyre, Q. C., M.P., Mr. B. Francis Williams, and Mr. T. Lewis, whilst for the defendants the Attorney-general has been specially retained, and Mr. Abel Thomas. The defendants were Mr. Edmund Thomas, and Thomas Griffiths, the owners of the Gelly Colliery, and the Mutual Boiler Insurance Company.

Now although this case occupied the attention of the court for four days with such a formidable array of legal talent, the facts lay in a nutshell, and should have been of easy solution by means of amicable adjustment or arbitration. Everybody knows that all collieries are now worked under the general rules of the Mines Regulation Act, the first of which is to the effect that the owner and manager shall provide sufficient ventilation to dilute and render harmless all noxious gases in all the working places of the mine. It is always well known that there is (happily for the employers of labor) a saving clause in the Employers' Liability Act, to the effect that employers are not liable for damages where there is contributory negligence on the part of the workmen. The two questions, therefore, for the determination of the jury in this case were—first, whether the colliery was properly and sufficiently ventilated; and, secondly, had there been contributory negligence on the part of the workmen. Of course there was a vast amount of evidence on both sides, and a conflict of opinion which necessarily puzzled both judge and jury. The simple facts are these. On August 21, 1883, the deceased was ripping the roof in the stall; another man, named David Lewis, was holding a lamp, when an explosion occurred, killing the deceased and four other men. The contention of the plaintiff was this was consequent upon defective ventilation, and a good deal of evidence was adduced to prove that the attention of the owners and managers had been previously called thereto. On behalf of the defendants, it was alleged the accident occurred through the negligence of the deceased, who was ripping the roof of his stall whilst another man was holding a lamp in an improper position—that the heading fell, drawing the frame through the gauze of the lamp, and causing the explosion. The manager swore that no one had ever called his attention to the defective state of the ventilation. His Lordship, in an exhaustive summing up of the case, referred to the difficulties which beset such actions. The defendants were not liable for damages could contributory negligence be shown on the part of the plaintiff; and the onus did not rest with the defendant to prove that there was contributory negligence on the part of the plaintiff, but with the plaintiff to prove that there was not. The plaintiff could not recover unless he could prove that the defendant had so neglected his duty as to cause the explosion. What constituted neglect, where neglect commenced, was one of those difficult points which the jury would have to consider and determine, and one upon which he could not help them. The jury, after a short deliberation, returned a verdict for the defendant. The case was an important one for both owner and workmen, and its protracted length and the vast amount of scientific and skilled evidence called to prove the condition of the mine, and what is or is not contributory negligence, suffices to show the legal difficulties which beset the practical operation of the Employers' Liability Act, and that an amendment is urgently required—one which, it is earnestly hoped, will endeavor to give some more satisfactory solution of the "Gordian knot" as to what constitutes contributory neglect. —*English Mining Journal.*

From *Chemical News*, Vol. 49, p. 190, 1884.

The Laboratory that Jack Built,

OR THE HOUSE THAT JACK BUILT ON CHEMICAL PRINCIPLES.

"A little nonsense now and then
Is relished by the wisest men."
—DANTE.

This is the laboratory that Jack built.

This is the window in the laboratory that Jack built.

This is the glass that lighted the window in the laboratory that Jack built.

This is the sand used in making the glass that lighted the window in the laboratory that Jack built.

This is the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

This is the salt, a molecule new, that furnished the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

This is the chlorine of yellowish hue, contained in the salt, a molecule new, that furnished the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

This is the sodium, light and free, that united with chlorine of yellowish hue, to form common salt, a molecule new, that furnished the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

This is the atom that weighs twenty-three, consisting of sodium so light and free, that united with chlorine of yellowish hue to form common salt, a molecule new, that furnished the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

This is the science of Chemistry that teaches of atoms weighing twenty and three, and of sodium metal so light and free, that united with chlorine of yellowish hue to form common salt, a molecule new, that furnished the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

H. C. B.

How to Expose Thermometers.

One of the first conditions to be regarded is that of securing a good height above the ground, on which considerable diversity of opinion prevails. Much depends upon the immediate conditions of the locality. When this point is decided upon, a uniform and satisfactory shelter or screen should be provided for the instrument. The height and the screen should be so adjusted that the thermometer shall be free from the influence of the ground-fog, and that access of the air to it should be perfect. The shelter should shield from all reflected heat, from all radiation from surrounding objects, as well as from moisture. Many different forms of shelter have been contrived in different countries. In experimenting upon the merits of these devices, a standard of comparison is found in the swung thermometer, or as the French call it the *thermométre fronde*, which is a common thermometer attached to a string or wire, and rapidly swung through a circle whose radius is the length of the string. The theory of this arrangement is that, as the instrument is rapidly brought in contact with a large mass of air, it must give the temperature of the same unless the results are vitiated by other causes. From a number of experiments the following conclusions as to the best disposition of shelters are advanced: When exposed to direct sun-heat they should be at least thirty-six inches long; with proper precautions the thermometer "fronde" both dry and wet, will give the most correct air temperature and relative humidity; a single louvre shelter is sufficient. The interposition of a second louvre prevents the free access of air, and if ventilation is used it must affect the air which is propelled to the thermometer. For obtaining even approximate relative humidity in calm weather, single louvred shelters are necessary, and for the best results, an induced air current is essential, especially in the winter in northern countries. Where a window shelter is used, there should be a free air-space of from six to twelve inches between the shelter on the north side of the building and the wall. The simplest form of screen would be four pieces of board ten or twelve inches square, nailed together box-fashion, leaving the botton and the side toward the window open; the thermometers, dry and wet, should be placed five inches apart near the center of this screen, with their bulbs projecting below the plane of the lower edge. Shade may be given, at such times as the sun is shining on the north side of the house, by the adjustment of the window-blinds.

On the Alteration of Mineral Coal by Exposure to the Atmosphere, Together with a New Method to Preserve it.

BY FRANZ POECH, ANT MINING ENGINEER, VIENNA.

It is well known that mineral coal, especially the less compact lignites, holding much water, crumbles gradually by exposure to the air for some time, and the finest and most valuable pieces are gradually converted into rubbish and dust. Bituminous coal is less liable to crumble, but loses by exposure in calorific power, and those varieties applicable for the production of coke lose the power of coking. Most mineral coals have a tendency to ignite spontaneously, and many a coal depot has already been destroyed by this action.

An effectual method for the prevention of alteration and the spontaneous combustion of coal would therefore be of great value to coal producers, who are often compelled to store coal in enormous masses.

How sensibly the value of coal is diminished by long storage is shown by the following example :

From a heap of stored Bohemian brown coal, medium coal 1, which lay exposed five weeks, only 60 per cent. of this grade could be obtained in the resorting before shipping: the other 40 per cent. was converted into nut coal and dust.

The 40 per cent. removed by alteration lost in value $1\frac{5}{6}$ kreutzer* ($1\frac{1}{20}$ cts.) per hundred-weight, from which the calculated loss for the entire quantity of stored coal amounts to 4.3 kr. ($1\frac{8}{10}$ cts.) per hundred-weight, the cost of resorting included.

The loss to coal works, caused in this way, is therefore considerable; a work in northwest Bohemia hardly makes 4.3 kr. per hundred-weight of coal. Moreover, the loss increases in direct proportion to the time of storage, and cases may be cited in which 80 to 90 per cent. of the coal deposited was altered by exposure.

Mining-Engineer Wenzel Poech, in Karbitz, has discovered a simple, cheap, and practicable means of preserving piles of coal. It consists principally in leading steam into the coal pile, thus excluding the air and moistening the coal uniformly.

Before proceeding to the description of the process I will discuss briefly the chemical and physical phenomena attending the alteration and spontaneous combustion of coal.

Porous bodies, it is well known, have the property of absorbing gases. This is seen in platinum sponge, which condenses so much air in its pores that the heat produced will cause hydrogen, directed against its surface, to combine with the oxygen, and form water. It is also seen in charcoal, one of the most porous substances, representing, as it were, the skeleton of the wood mass. According to the experiments of Saussure, charcoal absorbs nine times its volume of oxygen, and 35 times its volume of carbon dioxide.

Mineral coal also possesses a porous structure, and Saussure has shown that it absorbs three times its volume of oxygen.

According to Fayol, the absorption power of all coal, from anthracite to lignite, is 5 to 10 per cent. by weight.

The property possessed by porous bodies of absorbing gases is a surface action. The walls of the pores attract the gases, just as water is drawn into narrow tubes. This has not been proven conclusively, but there is a good ground for making the assumption; moreover, the hygroscopic power of substance is taken as the measure of its absorbing power.

While all other gases absorbed by coal remain unaltered, oxygen is condensed and combines with the carbon and hydrogen, producing heat.

Varentrapp has shown that brown coal oxidizes in a current of air of less than 50° C. temperature, and that the amount of oxygen absorbed, although small, is nevertheless increased by an elevation of temperature, and may result in the complete consumption of the carbon without producing ignition.

E. Ritchers determined the fact that fresh, dry bituminous coal will absorb a considerable amount of oxygen in a few days, without giving off any carbon dioxide and water, and that these oxidation products remain condensed in the pores of the fuel. The latter circumstance offers no impediment to the absorption of oxygen, this only ceasing when the disposable hydrogen and the easily oxidized part of the carbon are combined with oxygen.

* Florin (Gulden) =100 kr., is now worth about 42 cents.

At normal temperature the absorption of oxygen proceeds until the complete oxidation of the easily-oxidized constituents; hereby carbon dioxide may be given off, but at higher temperatures both carbon dioxide and water are driven off.

In case the absorption takes place slowly, so that the heat produced may be disseminated, and no appreciable rise in temperature results, hydrogen and oxygen remain condensed in the pores; only in the contrary case are they expelled, and new oxygen absorbed, new quantities of heat produced. Through the increase of temperature, however, an energetic chemical action takes place between the oxygen and the combustible material of the coal, the result of which is finally spontaneous combustion.

Coal dust does not absorb more oxygen than coarse granular coal, but the absorption, in consequence of the larger surface presented by the dust, proceeds much more rapidly, and herein, together with the difficulty of furnishing the coal dust with sufficient fresh air to carry away the heat, lies the cause of the more easy spontaneous combustion of coal dust.

According to Fayol the temperature of ignition of lignite, in the form of powder, is 150° C., of anthracite 300° C.

The causes of the crumbling of coal by exposure are manifold. In all probability it is due to the absorption of oxygen and the resulting carbon dioxide, which, being compressed, must exert a pressure on the walls of the pores. Possibly, also, by the chemical reactions, a body is disturbed which hitherto acted as cement.

Of great importance, directly or indirectly, in this connection, is the circumstance that the hygroscopic moisture evaporates after a certain time, leaving the fine cracks and pores free for the penetration of the oxygen of the air, for which there is thus furnished a larger surface for its action.

Now, the escape of hygroscopic water cannot take place without the production of mechanical alterations, as may be seen in the similar action of the warping of drying wood, or in the cracks of a dried swamp; hence the cracking and crumbling of stored coal through chemical action will be facilitated if the pores are first deprived of their protecting water.

A means which prevents the escape of the original mine moisture must be of the greatest benefit in preserving it. As will be shown more in detail further on, this can be accomplished in a simple manner by immersing the coal in water, or in an atmosphere of steam, since the mechanically held water will not escape in this case, and the passage of oxygen into the pores be prevented. By keeping the coal constantly moist or by steaming it, aside from the fact that the air is also externally excluded from the pieces of coal, the oxidation and alteration may be effectually opposed.

Brown coal loses little in calorific power by crumbling, but considerable in commercial value. In bituminous coal, as a rule, the yield of coke in coking, and of gas in dry distillation, suffers considerable loss. Gas works prefer the newly-mined coal, as is quite natural, since the disposable hydrogen, so valuable in gas-making, is the first to be oxidized by the absorbed oxygen.*

In regard to the part played by iron pyrite in the spontaneous combustion of coal, the following remarks may be made:

The view that only coals containing pyrite or marcastite are subject to spontaneous combustion, must be abandoned, since the observation has been continually made that often the coals free from pyrite have the greatest tendency to spontaneous combustion.

Fayol, who studied this question thoroughly and conducted careful experiments, remarks in this connection:

* The "Journal für Gasbelenchung und Wasserversorgung," 1884, page 232, cites a case in the Nettlesworth coal, which, after six months' storage, had crumbled to dust. The yield of gas fell from 29 ms. to 27.

1. The first and greatest cause of spontaneous combustion is the absorption of oxygen by the coal.

2. The most favorable conditions for the self-heating of coal are a mixture of pieces and dust, an elevated temperature, a large mass of coal and a certain volume of air.

3. Large pieces, low temperature, small volume, and the complete absence of air or good ventilation, act in opposition to self-heating.

4. In general, pyrite plays only an unimportant, mostly insignificant part in spontaneous combustion.

5. Mechanical forces, or the heat produced thereby, cannot be assigned as the usual causes of the burning of coal mines.

Durand assumes that when the sinking roof of a gallery concentrates the entire pressure in a few places, considerable elevation of temperature may be thereby produced.

In order to investigate the effect of pyrite in elevating the temperature, Fayol carried out many experiments by placing pulverized coal, coal and pyrite in an air bath at 100° to 200° C., allowing them to remain some time, and observing the increase in weight and temperature.

He succeeded in showing that pyrite oxidizes less easily than coal (in the air bath at 100° C. the samples of coal took up 7 per cent. oxygen in three months, pyrite only 4 per cent.), and that the addition of pyrite to the coal even retards the increase in temperature. The results of the experiments of Fayol confirm the older work of Richters, but are less complete, in that they have reference only to the air-dried condition of the coal.

That the relation of pyritiferous coal to oxygen is different in presence and in absence of moisture, the experiments of Richters have conclusively proven.

This investigator found by direct experiment that pyritiferous coal, kept constantly moist absorbs twice as much oxygen as in the dry state. The moisture accelerates the decomposition of the pyrite, and induces further chemical processes, such as the formation of salts, the absorption of water, etc., by which again heat is produced. In order that the moisture may cause this action a sufficient amount of oxygen is necessary.

Moisture, as a rule, rather retards than accelerates the production of heat, and only under peculiarly favorable conditions, and in presence of much pyrite and a sufficient volume of air is it capable of promoting the alterations.

Hence, neither pyrite nor moisture nor mechanical power appears capable, in general, of causing the burning of mines, and, in by far the greatest number of cases, the cause of spontaneous combustion can only be found in the absorption of oxygen.

If the coal is placed in an atmosphere of water vapor, which excludes the atmospheric oxygen from the coal, the hygroscopic water will have no tendency to leave the pores of the coal, nor can a chemical action set in, even in presence of pyrite, the oxidation of which is, under other circumstances, essentially promoted by the presence of moisture.

It is, therefore, not to be doubted that, by displacing the oxygen and keeping the coal moist, alteration and spontaneous combustion may be checked. A complete immersion would meet the requirements, but would only be practicable in rare cases; irrigation alone would not be perfectly successful.

Wenzel Poech excludes the air and produces a uniform wetting of the stored piles of coal, as already mentioned, by admitting spent steam into the depot pile.

For this purpose a series of trenches are cut in the depot ground: they are so covered with beams and boards that narrow spaces remain, not large enough to permit the coal to fall through.

The boards are simply laid on cross pieces, are not fastened, and can be easily removed for the purpose of cleaning out the trenches.

On the ground thus prepared the coal to be stored is deposited in the usual way, the trenches are then connected with the exhaust-pipe of a steam-engine, and the steam admitted; it passes through the interstices in the covering into the coal pile, disseminates itself through the latter, displaces the air, and in consequence of the condensation of the vapor moistens the coal uniformly.

In order to effect a uniform distribution of the vapor it is necessary to cover the coal depot with fine coal and cinders, as in the case of charcoal heaps; thereby strong draughts of air will also be prevented from passing through the pile and interfering with the equal distribution of the steam. In case of coal containing little pyrite, careful covering of the pile is not so necessary, but is of importance in case of coal rich in pyrite.*

The width of mesh of the network of canals which exist in large depot grounds depends upon the size of the pieces of coal to be stored and the height of the pile; for medium-sized coal the distance between the canals, with a height of pile equal to 3 m. is 3 m.

The exhaust steam of a steam-engine of 4*e*, which was worked for but six hours during the day, was entirely sufficient for the preservation of a depot of 20 car-loads of coal.

In carrying out the process it was repeatedly shown that the losses sustained in the purely mechanical movements, in the pouring out at the unloading of the coal, are far smaller than they are usually assumed to be, and that in this assumption a large portion of the waste produced by alteration was attributed to the destruction by the pouring out.

In the loading of the coal preserved by steam it was found invariably that only in the locality where the first unloading took place, and where the coal fell from greater heights, attrition took place, the rest of the coal was good, was well preserved, and could be loaded without resorting.

The cost of construction of the trenches and their coverings — for which latter old and otherwise useless boards, beams and road-beams of the mine are utilized — for a depot for 100 car-loads of coal amounts, at most, to 30 florins.

The cost of working is nothing, and the outlay consists only of the cost of preserving the trenches and the interest and amortization on the applied capital.

Results relative to the use of this process have been obtained at the following works:

"Exc. gräflich Nostiz'scher Maria Antonia" shaft, near Karbitz.

"Ferdinand," shaft, near Teplitz.

"Bruno" mine, in Weisskerchiltz, near Teplitz.

At the Maria Antonia shaft, in consequence of the thankworthy permission and support of "Bergdirector" J. Neuber, the manager, Wenzel Poech was enabled to make the first experiments, and since then the process has been in full working order.

At the Ferdinand shaft, belonging to the Austrian Coal Industry Association, confirmation of the described preservation method was quite accidentally found; over a reservoir, covered with debris, and into which exhaust steam passed, coal had been deposited, which, on reloading it, it was found to be perfectly preserved.

According to communications from Mining-Engineer Hans Gutmann, further experiments were carried on with favorable results, and the working of the process on a larger scale was proposed.

The Director of the Bruno Mine, Em. Baier, uses old gratings to cover the canal; he also subjected coal, without covering with cinders, for more than two months to exhaust steam, and found it in no way altered.

To insure a uniform production, and with reference to the increasing losses at the

* This should be confirmed by determining, first, whether the covering of the pile by preventing the escape of the heat developed by the condensation may not be harmful.

works, it is much to be desired that this process may prove completely successful, especially as the methods formerly used proved worthless.

The usual insertion of wooden tubes and the production of canals in the coal pile is directly detrimental, since oxidation is thereby only favored; investigation has also shown that at the surfaces of contact between the walls of the tubes and the coal, the latter is most liable to spontaneous combustion, so that now, on the contrary, the tendency is to level the coal as compactly as possible.

I arrive, therefore, at the following conclusions:

Freshly-mined coal, deposited on the rubbish piles is capable of condensing several times its volume of oxygen in its pores. The oxygen absorbed enters into chemical combination with the easily-oxidized constituents.

According as the absorption is rapid or slow, a greater or less elevation of temperature is produced. In the former it may lead to spontaneous combustion.

The crumbling of coal is, among other causes, a consequence of the absorption and condensation of oxygen in its pores, and the chemical changes taking place. The escape of the hygroscopic moisture favors the absorption of oxygen.

The pyrites can only produce a furthersome effect on the increase of temperature when present in considerable quantities, and then only in presence of moisture and air; in the dry state they must be regarded as perfectly passive, and may even be detrimental to the warming.

Freshly-mined coal placed in an atmosphere of steam can suffer no change. Even with incomplete exclusion of the air the steam will, in general, oppose oxidation and warming, principally by uniform moistening of the pieces of coal.—*Van Nostrands.*

Scientific deduction by the most profound investigators are not always to be implicitly trusted, as a member of the Geological Section of the American Association for the Advancement of Science at its late meeting found to his chargin. It seems that Professor Williams of Cornell University, read a paper on a geological topic which was discussed by Professors Hall and Claypole. The latter, in support of Professor Williams, declared that the *Spirifer disjuncta* and the *Spirifer mesostrialis*, which are shells supposed to belong to different geological periods, exist side by side in the same rocks. Professor Hall, who is State Geologist of New York, and is one of the foremost geologists of the world, asserted that Professor Claypole's statements were erroneous, and very excitedly offered to eat his hat if such a rock were shown him, and give his coat and boots to the person making the exhibit. Professor Williams took the first train to Cornell, and from that place expressed a box to Professor Hall, which arrived before the adjournment of the association, and when opened was found to contain a rock in which the two spirifers were undeniably present. It is not known whether the discomfited professor has actually made a meal of his hat, but he has been called upon to surrender his coat and boots to the triumphant discoverer of the rare, but not impossible combination.—*The Iron Age.*

Emma Abbott has been singing "Home, sweet home," to the convicts in a Pennsylvania prison. This is almost as touching as the effort of a church-organist who played "I am a Pirate King" while the red-nosed deacon was taking up a collection.

The Locomotive.

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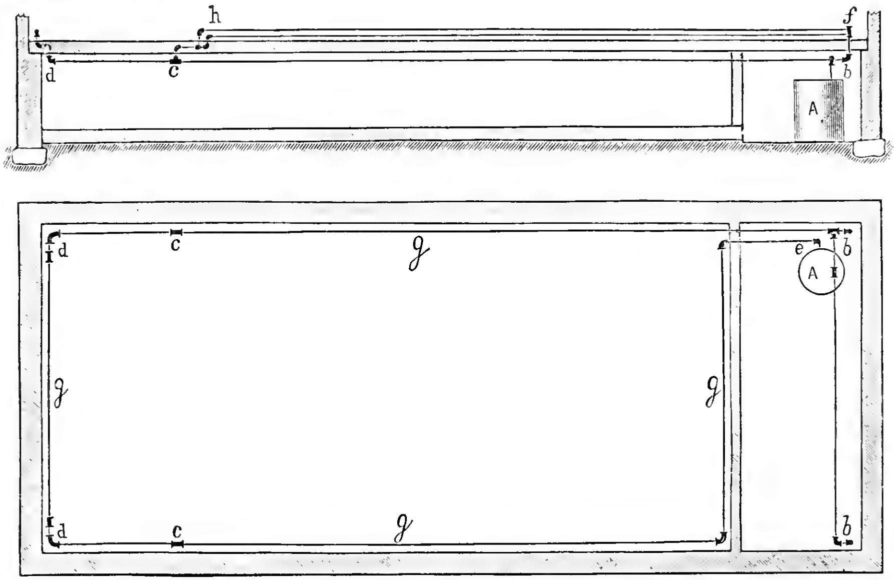
Some Hints on Steam Heating.

We are frequently called upon to examine steam-heating systems with reference to improving their working, and often find the most extraordinary arrangements which it seems possible to devise. A recent case showed such an extremely peculiar combination of pipe and fittings that we feel impelled to give our readers a sketch and short description of it.



The accompanying cut shows the main features of the system, which, in this case, was put into a church, where, of all places, a perfect-working system seems to us desirable. The lower portion of the figure is a plan of the basement, the upper portion is a longitudinal section of the building, or rather of that part of it in which the heating arrangements were contained.

"A" shows the location of the boiler, one of the vertical type. The main steam-pipe *b b* extended across the boiler-room, and from either end connection was made to the double lines of pipe *f h* in the room above. These pipes were located one line on each side of the room close down to the floor. From the end of the main steam-pipe nearest the boiler, a pipe *g g g g* led out of the boiler-room and entirely around the basement, as shown. This pipe was fastened to the walls of the room, and as close up to the ceiling as it could well be placed. Thus it will be seen that the circulation of air around it, which alone is what renders heating surface effective, was necessarily very much restricted. In addition to this, the amount of heating surface furnished by this pipe was not over two thirds of what was absolutely required to heat the room properly during the coldest days, even had it been placed in the most advantageous location. A pipe also extended across the room above, back of the altar, the connections to which will be described presently.

There were also two vestries (not shown) which should have been warmed. In one of these no attempt had been made to do so, except by means of a *very* small stove; in the other was one radiator, just one-half large enough for the purpose intended. This radiator was connected *to* the pipe running around the basement, but in view of the fact that both the steam and drip-pipes (so-called) were taken out of the same tee, and the drip-pipe was run all the way (about 30 feet) to the radiator *above* the steam-pipe, it did not surprise us to learn that the radiator had *never* been hot. But the extraordinary feature of the system was the manner in which it was attempted to drip the double lines of pipe in the auditorium. This is shown in the upper portion of the figure, from which it will be seen that the ends of these pipes were simply connected to the steam-pipe in the basement, as shown at *h*. The tees for these connections are shown in the lower portion of the figure, at *c c*. The effect of connecting these pipes in the manner shown was, not to drip the pipes up stairs, but to so effectually trap air in them and stop the circulation, that with 15 pounds of steam pressure on the boiler it usually required *four hours* to get steam through them, and they were three inches in diameter, and only about eighty feet long at that! And during that long (in cold weather) four hours the pipes kept up such a thumping that one would imagine the congregation were cannonading each other instead of being engaged in peaceful devotions.

The pipe across the room back of the altar was simply connected at each end with the pipe running around the basement, as shown at *d d d*, and behaved precisely like those at the sides of the room—which was exactly what would be expected of it.

The system should have been arranged so that each room could be warmed independently of any other portion of the building; but we were informed that, as originally put up, there was not a single valve in the whole apparatus, except those on the radiator in the vestry, and those were useless, for there was not the slightest chance for any steam to get to them as the pipes were arranged.

The changes advised were: To run a main steam-pipe through center of basement overhead, and supply steam to the pipe running around basement at its middle point at the further end of the room, at the same time moving this pipe away from the walls and suspending it about two feet down from the ceiling, so that the air in the room would have a chance to circulate around it and make it effective as heating surface, and discontinuing that portion of it running across the end of basement next to boiler-room; to put up a suitable coil overhead in the lower vestry, and a larger radiator in upper vestry; to discontinue the use of pipe back of altar up stairs, and put in a couple radiators in vestibule near the entrance, and to drip the lines of pipe at sides of room up stairs into a proper return-pipe, which was carried around two sides of the basement, and into which *all* drips, from whatever source, are led below the water-line of the boiler. Nearly enough old pipe could be utilized to make all the changes required.

There are certain principles to be kept in view, in designing a steam-heating plant, by which, if the details of the work are faithfully executed, a perfect working and noiseless apparatus will be assured.

The first thing to be considered is the location of the boiler, especially its height with reference to the building to be warmed. For a dwelling-house or church the only system which should be used is the low pressure gravity return, that is, one in which the water of condensation returns to the boiler by gravity, or *flows* back, and for this it is necessary that the water-line in the boiler should be about four feet below the level of the lowest radiator or heating coil. In large buildings, six feet would be better.

Any system requiring the use of a steam-trap or pump to return its water to the boiler should not be admitted unless it is of such a magnitude that an engineer is constantly employed to look after it.

This is a point which architects should always bear in mind, but, as a general thing, they seem to be either strangely ignorant or very careless about it.

The next point to be borne in mind is this: Steam pipes should always pitch downward from the boiler, so that steam and water of condensation (of which there is always *some* in every pipe, no matter how well protected it is) shall flow in the same direction. This applies to *all* pipes used for conveying steam, no matter for what purpose.

The third important question to be considered relates to drip and return pipes. To avoid noise and insure a good circulation throughout the system, and render the expulsion of air from pipes and radiators easy, every drip-pipe *must* be sealed with water at its lower end. This is accomplished in the easiest and most perfect manner by keeping the main return pipe below the water-level in the boiler, and bringing the drips into it separately, or, where several are connected, making the connection below the water-line. Each drip should be provided, just above the water-line, with an air valve, of which there are several most excellent automatic ones in the market.

If the above points are borne in mind, and the details are carried out in a workmanlike manner, and boiler and pipes are of proper size, a noiseless and perfect working system will be assured *every time.*

Another Marine Boiler Mystery.

The *American Machinist* says: On November 20th, the tug-boat *James McMahon*, of New York, was engaged in towing some barges from Stamford, Conn., to Jersey City, when, without any warning, the bottom of the boiler blew out, tearing a rent through the craft, and sending it to the bottom of the Sound. Three men lost their lives by the occurrence. The engineer, who escaped, on being questioned about the affair, said that when the explosion occurred the boat was working along at its usual speed. Just before the accident he looked at the steam-gauge, which indicated the maximum pressure of 50 pounds to the square inch, and he was sure there was plenty of water in the boiler. The cause of the explosion was a profound mystery to him. All and sundry connected with the boat, directly and indirectly, are now speaking of the explosion as an "inexplicable mystery." There seems to be something intensely attractive about the nourishing of mysteries connected with boiler explosions, to judge by the ready way their presence is discovered. Should this tug ever be fished from the bottom of the Sound, we confidently predict that the mystery of the explosion will be dispelled by the discovery that the boiler sheets were corroded till they had not strength left to resist the working pressure of 50 pounds to the square inch. This was the kind of mystery that sent the *Riverdale* to the bottom of the Hudson river a year ago, and it is the mystery that leads to destruction the lion's share of the boilers that explode.

A NEWSPAPER paragraph says of the peculiar epidemic now raging in some parts of West Virginia and Kentucky: "where the patients have been treated with mercury, they have generally died." Just what we might naturally expect. When you try to make a thermometer of a man during such warm weather, you must expect him to "go up."

Inspectors' Reports.

SEPTEMBER, 1884.

The usual summary of the work of the Inspectors of the Company during the month of September last, is given below.

Visits of inspection made,	2,852
Total number of Boilers examined,	5,619
" " internally,	1,866
Boilers tested by hydrostatic pressure,	384
" condemned,	38
Whole number of defects reported,	3,716
" " of dangerous defects reported,	642

The detailed statement of defects is as follows:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	437	36
Cases of incrustation and scale,	589	40
Cases of internal grooving,	20	2
Cases of internal corrosion,	117	10
Cases of external corrosion,	312	45
Broken and loose braces and stays,	119	98
Settings defective,	242	23
Furnaces out of shape,	112	14
Fractured plates,	91	43
Burned plates,	63	18
Blistered plates,	241	12
Cases of defective riveting,	272	39
Defective heads,	37	15
Serious leakage around tube ends,	385	86
Serious leakage at seams,	190	35
Defective water-gauges,	148	55
Defective blow-offs,	48	16
Cases of deficiency of water,	11	8
Safety-valves overloaded,	45	11
Safety-valves defective in construction,	30	10
Pressure-gauges defective,	203	25
Boilers without pressure-gauges,	3	1
Manhole plate defective,	1	0
Total,	3,716	642

Internal corrosion is sometimes one of the worst things the steam-user has to contend with. With certain kinds of water, it is an insidious foe, and is apt to do great damage to the shell-plates before its presence is suspected, or the extent of its action realized.

The primary causes of this action are many, and sometimes quite difficult to determine. The nature of the impurities in the feed-water, and the treatment which the boiler receives at the hands of its attendants, are, in general, the potent factors of corrosion. The character of the plates also has much to do with the nature of the action.

Pitting is one form of internal corrosion which is most easily discovered by inspection, and regarding the nature of which there has been a vast amount of controversy. Some attribute it to galvanic action, some to the action of the feed-water, while others attribute it to various other causes, among which some sort of gas theory is usually prominent. As a matter of fact, in this as other things, a variety of different causes may operate, either separately or conjointly, to produce the same result; hence the diversity of opinion as to its causes, and the failure of many of the remedies which have been suggested as specifics for the prevention of the trouble.

In many cases pitting has been traced to galvanic action, and remedies for this have cured the trouble. Galvanic action seems most liable to occur, where grease or some fatty acid finds the way into the boiler through brass tubes, as where a surface condenser is used. The fatty acid attacks the brass and carries portions of it into the boiler, and it adheres to the shell and tubes. Under the patches so formed pitting sometimes goes on quite rapidly. The remedy in this case is obvious.

But the majority of cases of pitting in land-boilers arises from an entirely different cause. Paradoxical as it may seem, the feed-water may sometimes be so pure that it causes the trouble. Where water containing so few impurities that it may be said to be acid, is used in boilers, they require a certain line of treatment, especially when they are not in use, or they will be most certainly badly pitted in a short time. Boilers used for heating purposes are especially liable to be so attacked when out of use during warm weather. Among such boilers, unless proper care is exercised in "laying them up," pitting and corrosion is the rule, and sound boilers are the exception. This class of boilers generally wear out faster, while standing idle, than they do when in use. The proper steps to be taken to preserve them uninjured can most easily and cheaply be learned from some experienced boiler-inspector. Location has much to do with the matter, and it is impossible to give any hard and fast rule for their cure which shall apply to all cases.

There is a peculiar kind of corrosion which sometimes occurs beneath patches of incrustation, which is very apt to escape anything but the most careful scrutiny, and often produces serious results before its presence is suspected. Generally, a coating of incrustation is regarded as a measurable protection against corrosion, but in the case we are speaking of, from some peculiarity in the composition of the feed-water, it seems to invite it. The remedy can only be prescribed after a careful examination of all the circumstances by an experienced inspector, and sometimes an analysis of the water is necessary to point out a remedy. We have known cases of this kind when the boiler-shell has been eaten entirely through before the trouble was suspected.

Boiler Explosions.

September, 1884.

Steamer (118).—The Ellen Hardy, a steamer plying between Oshkosh and Portage, burst her boiler on the 9th, when about three miles this side of the last-named city. No one was seriously injured, but the boat was so badly damaged that she will be laid up the remainder of the season.

Distillery (119).—The cookers at the Enterprise Distillery of Pekin, Ill., owned by Spellman & Doheny, exploded September 10th, making a total wreck of the building. The loss will reach $30,000. Seven persons were in the distillery at the time, three of whom are dead. Andy Duffin was killed instantly, the top of his head being cut off. He leaves a wife and four children. E. Duffin, killed, leaves a wife and two children. E. Welch Miller died, and J. Murphy, engineer, also, his flesh being badly scalded.

Steam Tug (120).—The steam tug Frank Somers exploded her boiler in the James River, near City Point, Va., September 14th. At the time of the accident she was towing a schooner up the river to Richmond. The crew of the tug consisted of Captain Cavenaugh and four men. As soon as the explosion occurred all the men jumped overboard. Cavenaugh and a boy of eighteen were drowned. The remaining four members of the crewof the sunken boat were saved by the men on the schooner. The Frank Somers belonged to Cavenaugh, her master.

COTTON COMPRESS (121).—The boiler of the Central Railway compress at Eufaula, Ala., exploded September 15th, killing four men, and wounding several. About 400 bales of cotton were burned. The compress was recently erected at a cost of $65,000. The total loss $100,000. Ten negroes will die.

WAGON SHOP (122).—A steam boiler in a wagon manufactory at Morton, Tazewell county, Ill., exploded September 15th, killing two men instantly, and injuring two others so seriously they are expected to die. A number of other persons were more or less injured.

LOCOMOTIVE (123).—The boiler of a small locomotive at the Excelsior Colliery, near Wilkes Barre, Pa., exploded about noon, September 16th, while standing in the yard. Fortunately no one was on board, but Owen Conway, Peter Walsh, and James Mackin, who were in the immediate vicinity, were all seriously injured by the flying debris. Walsh and Mackin were much cut and bruised, and the former had an arm broken. Conway, who was nearest to the engine, was not only badly injured but also seriously scalded by the steam.

AGRICULTURAL ENGINE (124).—A farm engine, owned and operated by Ecker Bros., exploded at River Falls, on the 16th inst., instantly killing the engineer, Chas. Ecker, and seriously and probably fatally scalding Chenney Chapin. The engine was an old one that had been used more or less for the past five years, but had been pressed into service this fall because of the great crop.

COLLIERY (125).—A terrific boiler explosion occurred September 16th at the Lykens Valley colliery, near Lykens, Pa. The explosion occurred a little after five, and was heard many miles. Had it taken place half an hour later the loss of life would undoubtedly have been great. The explosion was caused by a defective boiler. Four boilers exploded together, throwing iron and timbers in every direction, for several hundred yards. There will be a total suspension of work at the colliery for weeks. Paul Schultz, Joseph Dunlap, and George Bright were painfully injured. Elmer Kocher, a driver boy, was fatally wounded.

FLOURING MILL (126).—A boiler explosion occurred at Vincennes, Ind., September 20th, which nearly demolished the flouring mill of Empton & Callender, and fatally injured Thomas Childress, the engineer, who was standing close to the boiler at the time. The engine-room, except a few splinters and broken bricks, was swept away. A part of the boiler scraped up the end of the mill, breaking in the siding from the first floor to the roof, after which it went over the building and fell into the street, a square away. The main portion of the boiler went through a warehouse, packed with five tiers of flour, scattering it in every direction. The head and another portion flew in an opposite direction, one heavy piece falling close to a little dwelling, and the other going through a stable belonging to the milling firm, setting it on fire and burning it down. Smith Manning, an employee, jumped out of a third-story window to the roof of a shed and escaped with slight injury. John Callender, who was near the engine-room door, was knocked down by debris, and blown across the room and considerably bruised. The damage to the mill is estimated at $10,000.

SAW-MILL (127).—The Davis mill at Shaftsburg, Mich., was destroyed by an exploding boiler September 22d. No lives were lost.

BREWERY (128).—An upright boiler in Witter's brewery, Elizabeth, N. J., exploded September 23d, the fragments being thrown through the roof, and 300 feet from the building. The brewery immediately took fire, and it was totally consumed, together with its contents. F. W. Bauer's grocery adjoining was also destroyed, with the stock. The loss is $25,000. There is insurance for about $10,000.

COLLIERY (129).—The boiler in the engine-room of the Millwood coal shaft, at Blairsville, Pa., exploded September 16th, killing John Hanna, the fireman. Several others were seriously injured, and one or two will probably die. The boiler-house was completely demolished, entailing a loss upon the company of $5,000.

The Locomotive.

HARTFORD, NOVEMBER, 1884.

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

Depression in Business.

The depressed condition of business throughout the country is the general theme of discussion among business men, and various theories are given as the cause. It is a well-known fact that the business of the country is always more or less disturbed in the years of presidential elections, and this condition of things arises from the fact that there is more or less uncertainty as to the policy of the incoming administration. Merchants of all kinds are reluctant to fill their stores with goods, because they are afraid that some legislation will be enacted that will reduce prices and find them stocked up with goods that can subsequently be purchased at less cost. Hence they buy in small lots, to supply present demands. The consumer buys sparingly also. He hopes for lower prices and a better condition of business. This all reflects back upon the manufacturer, and he finds it impossible to keep his works in full operation, and dispose of his product. He feels compelled to reduce his expenses by running on short time, reducing wages, or shutting down his works entirely for a while at least. What is the result? Thousands of people have their incomes reduced, or are thrown out of employment entirely. Now these people will of necessity begin to reduce their expenses to the lowest possible limit. Garments that once would have been cast aside, will be mended and patched, and made to do service for a long period. Even the well-to-do, in the face of such "hard times," will very materially lessen their expenses. This necessity for strict economy applies to every article in the household—food, clothing, furniture, etc. If the purchasing power, or ability, of the consumer is thus reduced, the effect must be at once felt by the producer, and the result is an accumulation of manufactured goods with no market. Here, then, is one cause of over-production, and, in our opinion, it is a cause which does not receive the consideration which it should. When business is good and people are receiving fair compensation for their services, they are, according to their means, liberal purchasers. In a population of 50,000,000, an average reduction in expense of two dollars per capita means $100,000,000, and of five dollars per capita, $250,000,000. With this limit on the purchasing ability of the consumer apparent over-production must be the result. This principle ramifies out into all departments of business. With decreasing passenger and freight traffic, railroads are compelled to economize on their whole plant, and the iron interest, and other interests, consequently suffer.

These depressed conditions in business are often brought about by panics--the result of a vicious system of credits, and poor and reckless management; and while this may be in some measure the cause of the present condition, we are forced to believe, after consultation with business men of all classes, in various parts of the country, that the uncertainty as to the future policy of the government has much to do with it. There are very divergent views among our law-makers on the tariff question; but we are slow to believe that any class of men will knowingly favor legislation that will paralyze our great industries. The question is beset with serious complications, and men, no doubt, have honest differences of opinion. If confidence is once restored, the trouble will soon be over, and in the belief that the deliberations of our national counselors will be marked by candor and wisdom, we confidently expect a revival of business with the incoming year.

IN our last issue, on page 147, in discussing the strength of riveted joints, the example given as an illustration should have been described as a "double-riveted joint."

On the same page we also made use of the expression "It is immaterial in most cases whether a joint is single or double-riveted, so long as the *pitch of the rivets* is the same."

What we had in mind was the computation of the strength of boilers as found in use. The majority of boiler-makers, until within a short time at least, have been in the habit of making the single and double-riveted seams of the same pitch, and of such proportions as gave the rivet in the single-riveted seam a great excess of strength over the section of plate between the holes. We do not now recall to mind, in our own experience, an instance where an excess of strength has been shown by the plate.

Strictly speaking, and especially in designing new work, we should also take into consideration the resistance of the rivets to shearing, and in some cities the municipal law requires the application of formulæ relating to rivet-strength in computing working pressures, in all cases. This matter will be found fully discussed in the pages of THE LOCOMOTIVE, from May to July, 1882.

THE *Journal of the Franklin Institute* for the current month contains an admirable lecture on the "Wave Theory of Light," delivered before the Institute by Sir Wm. Thomson, the eminent Scottish scientist.

A CORRESPONDENT, S. S., makes the following inquiries:

1st. How near the bottom of a boiler should the bridge-wall be to give the best results, and is it necessary to have a bridge-wall at the back end of the boiler, and if so, how high should it be?

2d. In case of low water in a boiler, what is the proper course to pursue?

3d. Is it possible for enough cold air to get into the tubes to damage them if the back draft is open?

Ans. 1st. The bridge-wall should be about nine inches below the lowest point of the boiler-shell. It should run straight across, and not be curved to conform to the boiler-shell. No bridge-wall is necessary at the back end of the boiler. The space back of the bridge-wall should be partly filled in, commencing a few inches below the top of the bridge wall sloping down toward the back end to within a few inches of the ground, and paved with bricks. The back connection door should be about 16x24 inches, and set about 8 inches from the boiler-room floor. This gives a good chance to hoe out all ashes which accumulate while the boiler is running.

2d. In case of low water, close the damper and immediately cover the fires with ashes, or if no ashes are at hand use *fresh coal.* Don't turn on the feed under any circumstances, nor tamper with, or open the safety-valve. Let the steam outlets remain as they are. The furnace doors may be left open after banking the fires.

3d. Opening the back connection doors, if tubes were over-heated, would be very apt to start leaks, (if the damper were open,) through the contraction which would be caused by the stream of cold air which would pour in.

FROM recently tabulated returns by the American Iron and Steel Association, it appears that there are at present in the United States 675 blast furnaces, with sixteen in process of erection. The productive capacity in net tons, of the completed blast furnaces, is 9,300,000 tons, an increase of 1,300,000 tons in capacity during the past two years. The capacity of the bituminous furnaces in net tons is 4,850,000 tons, an increase of 725,000 tons within two years. The annual capacity of the anthracite furnaces is 3,175,000 tons, an increase of 425,000 tons in two years. The annual capacity of the charcoal furnaces is 1,275,000 tons, or 50,000 tons more than two years ago. There are 434 complete rolling-mills and steel-works, or 34 more than two years ago, and four works building. Of these mills, 71 make rails. The rolling-mill capacity for iron and steel is 7,600,000 tons. There are 5,265 puddling furnaces, 2,782 heating furnaces, and 1,555 trains of rolls. There are 81 nail factories, having 5,695 nail machines: two new nail works are building, which will operate 67 machines. There are 21 completed Bessemer steel works, and one building. There are 46 Bessemer converters, and three being built. The annual capacity in ingots is 2,490,000 tons. There are 35 completed open-hearth steel works, with a capacity of 550,000 tons, having 58 completed furnaces. There are 41 crucible steel works, with 3,594 melting-pots, having an annual capacity of 115,000 tons. There are 70 forges making 75,000 tons of blooms and billets, and 53 bloomeries making 70,000 tons of blooms.—*Engineering.*

Steel Making, by a Steel Maker.

Pig iron is melted direct from the ore in a blast furnace, and contains from three to five per cent. of carbon. When remelted it is called "cast iron" or "metal."

Spiegal iron is precisely the same, but contains in addition from five to fifteen per cent. of manganese.

Bar iron, often called wrought iron, is pig iron which has been smelted and deprived of nearly all its carbon, either in a puddling furnace or other analogous process; the spongy mass or ball of iron is usually hammered or rolled into a bar, generally three inches wide, five-eighths of an inch thick and from six feet to twelve feet long.

Puddled steel is precisely the same as "bar iron," except the process of puddling is stopped when rather more than half the carbon has been removed from the pig iron. There is consequently no hard and fast line between bar iron and puddled steel, the one intergrading to the other by imperceptible degrees. Although there are an infinite number of intermediate stages between the softest bar iron and the hardest puddled steel, and although it is impossible to state the exact percentage of carbon which marks the dividing line between one and the other, it is usual to call all puddled bars which cannot be hardened in water, bar iron, and all those which can, puddled steel. The dividing line falls somewhere near a mixture containing a half per cent. of carbon, and although it looks very vague and unscientific to use two terms which thus intergrade, no confusion of any kind, nor misunderstanding, has ever been known to arise from their use.

Blister steel is bar iron which has been converted into steel in a converting furnace, and varies in the amount of carbon which it contains from one half to $1\frac{1}{2}$ per cent. There are, of course, an infinite number of degrees of carbonization between "hard heats" and "mild heats," but for the convenience of the trade six of them have been selected, and have received names, as follows:

		Per cent. of carbon.
No. 1.	Spring heat,	$\frac{1}{2}$
" 2.	Country heat,	$\frac{5}{8}$
" 3.	Single-shear heat,	$\frac{3}{4}$
" 4.	Double-shear heat,	1
" 5.	Steel-through heat,	$1\frac{1}{4}$
" 6.	Melting heat,	$1\frac{1}{2}$

Bar steel is blister steel which has been tilted or rolled down to the size required.

Single-shear steel is produced by welding half a dozen bars of blister steel together. Only those bars are chosen in which the process of conversion has been so far carried on that the outside of the bar is steel and the centre of the bar iron. When these are welded together, and tilted or rolled down to a small dimension, the result produced is a mechanical mixture of iron and steel, a material which combines great tenacity with the capability of carrying a moderately hard cutting edge, and is much employed for certain kinds of knives.

Double-shear steel is produced by drawing down single-shear to suitable-sized bars and rewelding two of them together, so that the mixture of iron and steel may be more perfect.

Cast steel is steel that has been melted in a "pot" (called a crucible in the encyclopædias), and poured into a "mold" (called a "form" in the learned books), thus becoming an "ingot," which is afterwards hammered or rolled to the size required. It may be made of various "tempers," varying in the pencentage of carbon which they contain from three-quarters or less to 1½ or more. The different tempers may be arrived at in various ways. For the great majority of purposes there can be no doubt that the best way is to put into the melting-pot broken pieces of blister steel converted exactly to the temper required; and the more evenly the steel is converted, and the more carefully all bars which are harder or softer than the temper required, or which are "flushed" or "aired," are rejected, the better. Blister steel, when carefully "taken up" or selected, will produce a cast steel which combines the greatest amount of hardness with the maximum amount of elasticity when hardened. It may, however, happen that for certain purposes "soundness" in the bar, the result of the absence of "honeycomb" in the ingot, may be the most important quality required in the steel; for others the property of welding most perfectly may be the *sine qua non;* or the great evil to be avoided may be the tendency to water-crack in hardening; or the steel may be used for some purpose where it does not require to be hardened, and the object to be secured is the combination of the greatest amount of hardness and toughness when unhardened. In all cases the mode of manufacture must be adapted to the objects which it is most important to secure.

In addition to the operations already mentioned there are two other ways in which the same percentage of carbon may be secured. You may either put cut bar iron into the pot and "fetch it up" to the required temper with charcoal, or you may put broken pig iron into the pot and "let it down" to the required temper with cut bar iron. A fourth *modus operandi*, which for most purposes is the best of all, might be enumerated, namely, the selection of blister steel slightly harder than the temper required, so as to admit of being slightly let down to the exact temper by the addition of a small quantity of somewhat milder cast-steel scrap.

The process of converting iron into steel is carried on in a converting furnace. This consists of two stone troughs, technically called "converting pots," each of them about four feet wide, four feet deep and twelve feet long, and placed side by side, with a fire underneath them, the flues of which conduct the heat all around each pot. These troughs or pots are built up of slabs of a peculiar kind of firestone, obtained in the neighborhood of Sheffield, and possessing the property of not cracking if heated slowly to a high heat and allowed to cool slowly. The slabs are united together with a mortar made of ground fire-clay. Over the two pots is built a vault of fire-brick, and the whole is enclosed in a dome of red brick, to prevent as much as possible the heat from escaping.

At the bottom of each pot is placed a layer of charcoal, broken up into small pieces, from a quarter to half an inch square. On this a layer of bars of iron is placed, which is covered with charcoal; another row of bars of iron follows, and so on until the pot is filled with alternate layers of charcoal and iron; it is then carefully closed with a thick cover of "wheel swarf," or mud, which accumulates in the troughs of the grindstone, a substance which will resist long exposure to great heat, and renders the top of the pot practically air-tight.

In order to test the progress of conversion, and ascertain the precise moment when the fire should be allowed to go out, two or three bars of iron are allowed to protrude through a hole in one of the pots made for the purpose. These bars, technically called "tap bars," are drawn and inspected at or near the close of the process, and are tightly packed in white ashes where they pass through the end of the converting pot, so that no air may find its way to the charcoal inside.

The converting pots full of alternate layers of iron and charcoal, and for all practical purposes hermetically sealed, are gradually raised to nearly a white heat, and kept at about that temperature for a week or more, according to the amount of carbonization required. Another week is occupied in the process of cooling, which must be done slowly, in order to prevent the pots from cracking, after which the cover is broken up and removed, and the bars, which went into the furnace bars of iron, are taken out of it bars of "blister steel," so-called from the bubbles or blisters which have arisen on the surface during the process of conversion. Some of the charcoal has been consumed during the week at which it was white hot, but considerable portion of it remains, and is taken out of the furnace as black as it went in.—*Chicago Journal of Commerce.*

Compound Locomotives on German Lines.

The economical advantages obtained by compound stationary and marine engines make it a matter for surprise that the system has not already been more extensively introduced in locomotives. While the makers of road locomotives or traction engines have not failed to avail themselves of the compound principle, locomotive engineers have on the whole fought shy of it. Of course, in an engine, on the perfect working of which the regularity of the traffic and the safety of the passengers depend in a high degree, changes should not be thoughtlessly introduced. Nevertheless, we think that these can be duly safeguarded, and the advantage of compounding obtained at the same time, and that the introduction of the compound principle into general use on locomotives can only be a question of time. The first practical application of it was made by the French engineer, Mallett, in 1876, in some tank locomotives for the Bayonne & Biarritz line; which were made with two cylinders arranged as usual, of 240 and 400 mm. diameter, respectively, or in the ratio of areas of 1 : 2.78. To make starting possible, Mallett adopted an arrangement consisting of a change valve for admitting fresh steam from the boilers to both cylinders, which was afterwards shifted so as to admit steam to the small cylinder only, the large one being fed in that case from the receiver. This necessitates that the two link motions should be quite independent of each other, as the cut-off in the large cylinder, when fed direct from the boiler, has of course to be earlier than that in the small cylinder; but, when taking steam from the receiver, has to be at about the rate of the cylinder areas, and generally about the same or later than in the small cylinder. The rule usually observed in stationary engines, of making the cut-off in the large cylinder equal to the rate of the areas, which is not usually quite correct even in that case, becomes greatly modified in locomotives on account of the very early exhaust and large compression caused by the link motion. With these two independent valve gears the regulation is entirely left to the intelligence of the driver, and although rules can be given him as to the notch on the reversing sector into which he must put the large cylinder gear for each notch of the small cylinder gear, it is evident that the double reversing levers and the change valve handles give him so much more to attend to than in the ordinary engines, that this system can hardly generally commend itself to locomotive engineers; although it has the advantage that on steep inclines, for instance, the tractive power can be greatly increased by admitting fresh steam to the large cylinder direct. In England, Mr. Webb has been the first to try compounding on a larger scale, and his three cylinder engines have been fully described in this journal. It is, however, open to very great doubt whether this system has any vitality. Although doing away with the coupling rods removes a source of great trouble and wear, and the fixed valve motion adopted for the large middle cylinder simplifies the reversing gear for the outside cylinders, the starting capacity of the engine is reduced to the power of the small cylinders, and the friction of the single pair of wheels they drive, as it is evident that, being unconnected, the crank of the middle cylinder can assume every possible position with regard to the other cranks, and if on its dead center when the engine has to start, the starting is entirely left to the other cylinders. As these are only 11½ inches in diameter, the starting power of the engine is only that of a small locomotive of that size, and the adhesion on the rails available for starting is only that of the single pair of wheels on which the small cylinders work.

Although the horse power required for a locomotive drawing a train at full speed is considerably greater than that required to give it that speed in the usual distance, the piston pressure or tractive force required to put the train in motion is considerably larger than that required to keep it in motion afterwards, so that in this engine the horse power it is capable of developing with the assistance of the large cylinder is quite out of proportion to the tractive force it can exert at starting. Only light trains could be started with this engine. Four cylinder engines would have considerable advantages as regards the steadiness of running, as the forces which cause the oscillations of the engine can be balanced thereby, but of course make it more complicated and costly; and this may easily absorb any benefit to be got from compounding, the repairs of locomotives being a very heavy item, and their increase can easily be more than the saving in coal.

In Germany, Herr von Borries, superintendent of the Hanoverian lines, is the foremost advocate of compounding. The system he favors is similar to Mallett's. He also uses two cylinders only but instead of admitting fresh steam at boiler pressure to the large cylinder, he admits a little to the receiver, to bring it to the same steam pressure usually prevailing there when the engine is running. In this way he preserves the same proportion between starting and running power as exists in uncompounded locomotives, the smaller cylinder being made of the usual size for the class of uncompounded engines. Two small engines on this system were put to work in 1880, and showed a saving of eighteen per cent. of fuel against uncompounded engines of the same size. To put the system to a severe test, two three-wheeled coupled goods engines on the same plan were ordered, and have been in use since January, 1883. The principal dimensions are:

Diameter of right-hand cylinder	460mm.	=18.1	in.
Diameter of left-hand cylinder	650 "	=23.6	"
Ratio of piston areas	1–2		
Stroke	630mm.	=24.8	"
Diameter of wheels	1,330 "	=4′ 5″	"
Steam pressure	12atm.	=180	lbs.
Grate are	1.53sq.m.	=16	sq. ft.
Total heating surface	121.6 "	=1,310	"
Weight empty	35.6 tons	=35.5	tons
Weight in working order	39.7 "	=39.6	"

A connecting pipe in the smoke box forms the receiver. To enable the engine to start, steam is admitted by a self-acting reducing valve to the receiver, the pressure in the latter being one-third of the boiler pressure; this valve is afterwards closed on long runs, but not when shunting. A back-pressure valve, one inch diameter, admits steam from the receiver to the small cylinder, when the start has to be made from such a position that the steamport is closed, and where the receiver would cause a back pressure. Both link motions are worked by one reversing shaft. To obtain different cut-offs in the two cylinders, the levers carrying the swing links are placed at an angle of 53°, so that in full forward gear the lever for the right-hand cylinder and in full backward gear that for the left-hand cylinder stands parallel to the center line of the valve motion; the swing links being of different lengths. This in forward gear gives the following admission of steam:

Small cylinder	0.2	0.4	0.6	0.8
Large cylinder	0.32	0.5	0.66	0.8

In backward gear the proportions would be reversed, and only the outer notches are available, but the engines run backward only when shunting. Numerous diagrams show the average pressure on the small piston to be always nearly double that on the large piston. The weights are distributed as below:

	EMPTY.			CHARGED.		
	Left hand.	Right hand.	Total.	Left hand.	Right hand.	Total.
	Kg.	Kg.	Kg.	Kg.	Kg.	Kg.
Leading axle	6,300	6,350	12,650	6,850	6,850	13,700
Driving axle	6,400	6,200	12,600	6,450	6,450	12,900
Trailing axle	5,050	0	10,350	6,550	6,550	13,100
		Total	35,600		Total	39,700

The engines proved satisfactory, and gave no trouble in starting, the generation of steam being regular and the beat almost inaudible, no sparks being ejected. Working alternately, with uncompounded engines exactly the same except in the cylinders, they showed a consumption of fuel of 12.66 kg. per 100 axle-kilometres, and 12.66 kg. per locomotive-kilometre, against 14.14 kg. and 12.82 kg. respectively, and drew 102 axles, as against 99. The smaller saving of fuel compared with the light passenger locomotives is caused by the goods engines having to work on inclines in full gear and at slow speeds, and the intermittent blast causes the fire to burn irregularly, while the former run with greater expansion at high speeds, working at quick haulage. The saving, however, is increased to 10½ per cent., showing that the compound system is better adapted for passenger than for goods engines, as might be expected. Ten other compound single-wheel engines have since been put into use for local traffic. The principal dimensions are:

Diameter of right-hand cylinder	270mm. = 10.63
Diameter of left-hand cylinder	410 " = 16.14
Ratio of areas	1:2 3
Stroke	420mm. = 16.5
Diameter of driving wheel	1,130 " = 3′ 5″
Steam pressure	12atm. = 180 lbs.
Grate area	0.8sq.m.
Heating surface	34.5 "
Weight, fall	20 tons.
Weight on driving wheels	10.6 "

The compound arrangements are similar to those of the goods engines, except that the cut-off is the same in both cylinders, as they have to run both ways. The exact saving could not be ascertained, as there are no uncompounded engines of the same size. The first cost of the compound engines is about four per cent. more than that of the same size of uncompounded locomotives, a difference which is practically *nil*, as the price of a locomotive depends very largely on the state of the market, and varies by more than that for one and the same engine at different times. The engines were built by Herschel & Co. of Cassel, who are the patentees of the reducing valve employed, and have been in every respect satisfactory.—*Manufacturers' Gazette.*

The Screw-Driver Problem.

We observe with unfeigned sorrow and regret that there is evinced a disposition on the part of some of our contemporaries to let loose upon a suffering and defenseless community that *bête noir* of mechanics, the screw-driver problem. The problem in brief is this: A correspondent, D. F., inquires: "Can I exert more force with a long-handled screw-driver than I can with a short-handled one?"

Without discussing either the abstruse scientific principles involved in the problem, the unquestioned right which the correspondent enjoys, in his capacity of a free and enlightened citizen of this great and glorious Republic, to exert more force with his long-handled screw-driver than he does with his short-handled one, or *vice versa*, *if he wants to*, provided the head of the screw will stand it, or the significance of the initials of his name, we would like to point out one or two cases where the long-handled one should have the preference.

If we were trying to drive a joke into somebody's head, we could probably exert more force with the long-handled screw driver than we could with the short one, that is, if its hardness and specific gravity (of the screw-driver, not the head) were in direct ratio to its greater length.

If we were going to write an editorial upon some weighty problem in science, or political economy (or extravagance), we would give the preference to the long-handled one, for the reason that we could, probably, "swop" it for a better pair of shears than we could its more unpretentious rival.

If we were trying to sell lightning rods or books "designed to fill a long-felt want," with a screw-driver, we should also give the preference to the long one, for more bricks can be bought with it than with the short one, and our experience teaches us that when engaged in such occupations the more bricks we have in our coat-tail pockets the better, that is if we have any regard for our *os sacrum*.

These are but a few of the many cases where it would be safe to say the long-handled screw-driver has an advantage over the short one. For the common purpose, however, of driving gimlet-pointed screws, there is no difference in the force which can be exerted, provided you can get as good a "grip" on one as on the other.

Eating Before Sleeping.

The notion is widely prevalent that it is unhealthy to eat late at night, or just before retiring. This came from the severe denunciation of "late suppers" contained in nearly all the old popular works on diet. But it was the midnight debauch that was the object of attack, and even here it was less the gluttony than the drunkenness which alarmed the doctors and called forth their reprehensions. A man may induce apoplexy by gorging himself with food at any hour of the day.

Man is the only animal that can be taught to sleep quietly on an empty stomach. The brute creation resent all efforts to coax them to such a violation of the laws of nature. The lion roars in the forest until he has found his prey. The horse will paw all night in the stable, and the pig in the pen, refusing all rest or sleep until they are fed. The animals which chew the cud have their own provision for a late meal just before dropping off to their night slumbers.

Man can train himself to the habit of sleeping without a preceding meal, but only after long years of practice. As he comes into the world nature is too strong for him, and he must be fed before he will sleep. A child's stomach is small, and when perfectly filled, if no sickness disturbs it, sleep follows naturally and inevitably. As digestion goes on the stomach begins to empty. A single fold in it will make the little sleeper restless; two will awaken it, and if it is hushed again to repose the nap is short, and three folds put an end to the slumber. Paregoric or other narcotic may close its eyes again, but without either food or some stupefying drug it will not sleep, no matter how healthy it may be. Not even an angel, who learned the art of minstrelsy in a celestial choir, can sing a babe to sleep on an empty stomach.

It is a fact established beyond the possibility of contradiction that sleep aids digestion, and that the process of digestion is conducive to refreshing sleep. It needs no argument to convince us of this mutual relation. The drowsiness which always follows a well-ordered meal is itself a testimony of nature to this interdependence.

The waste of human life by the neglect of the lesson is very great. The daily wear and tear of the body might be restored more fully than it usually is, if this simple rule was not systematically violated.—*David M. Stone in Journal of Commerce.*

Absent-Mindedness, or Abstraction.

Who has not friends against whom they have had the laugh because of some action or speech while their thoughts were far away? In some individuals the faculty or habit of abstraction may become so thoroughly developed that the subject is to all intents and purposes an automaton, pure and simple, and may be said to dwell on the borders of the somnambulistic state itself. The latter opinion alone can be expressed regarding the well-authenticated case of the clergyman who, engaged in an abstruse mathematical calculation, was reminded by his wife that it was time to dress for dinner. The gentleman in question proceeded up-stairs to his bedroom still deeply involved in his thoughts, with the result of being found soon thereafter in the act of getting into bed—a proceeding simply suggested to the semi-unconscious mind and well-nigh absent volition by the act of entering his bedchamber and commencing to undress. Only on the supposition of habit having developed this awkward faculty of allying one's self to a species of sleep in the hours of wakefulness can the doings of a late well-known Scottish professor be accounted for. This gentleman, passing out of college on one occasion, ran against a cow. Pulling off his hat in his abstraction, he exclaimed, "I beg your pardon, madam!" Although aroused to a sense of his mistake, shortly thereafter he stumbled against a lady under somewhat similar circumstances, greeting his astonished neighbor with the remark, "Is that you again, you brute?" It was this gentleman who bowed to his own wife in the streets, but remarked that he had not the pleasure of her acquaintance; while another vagary consisted in making his appearance at college in the costume of his day, displaying on one leg a black stocking of his own, and on the other a white stocking of his better half. Another narrative credits the professor with addressing a stranger in the street, and asking this person to direct him to his own house. "But ye're the professor!" replied the interrogated and astonished person. "Never mind," was the reply, "I don't want to know who I am—I want to know where the professor lives!"—*Dry Goods Bulletin.*

German Bulls.—A German newspaper gives a few samples of German bulls, which are quite as amusing as those perpetrated by the Irish, who have been, heretofore, supposed to have had a monopoly in the business: "Among the immigrants was an old blind woman, who came to America once more before she died, to see her only son." "After the door was closed, a soft, female foot slipped into the room, and with her own hand extinguished the taper." "Both doctors were unable to restore the deceased once more to life and health." "The chariot of revolution is rolling onward, and gnashing its teeth as it rolls," is what a Berlin revolutionist told the students, in 1838, in a speech. "The Ladies' Benefit Association has distr buted twenty pairs of shoes among the poor, which will dry up many a tear." "I was sitting at the table enjoying a cup of coffee, when a gentle voice tapped me on the shoulder. I looked around and saw my old friend once more."—*Texas Siftings.*

The Locomotive.

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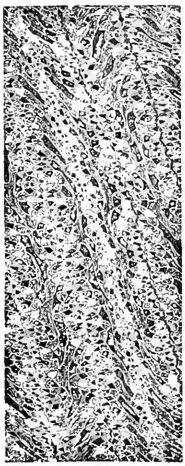
Experiments on Iron and Steel.

BY J. M. ALLEN.

In continuing the experiments on the fiber of iron and steel, attention was called to the manufacture of gun barrels, and to the beautiful interlacing of fiber as shown in their structure. Pieces of gun barrels were obtained from The Colt's Patent Firearms Manufacturing Company, which were prepared as hereinafter described, and submitted to the etching process.



We will here give a description of the method of manufacturing gun-barrels, for the benefit of those who are not familiar with it. The end to be obtained is great strength, and the material must be of such quality as to withstand the pressure tending to burst the barrel when the gun is fired. The better qualities of gun-barrels are known as *stub*, *stub twist*, *wire twist*, *and Damascus twist*.

We copy from "Knight's Mechanical Dictionary" as follows:

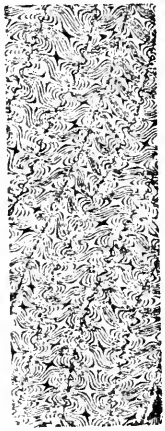
Stub iron consists of horse-shoe nails cleaned in a tumbling box, mixed with from 12 to 50 per cent. of steel pieces of the same size; puddled, hammered, heated, tilted, and rolled. From this material a *skelp* is made.

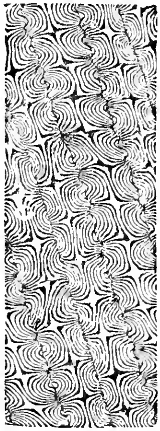
The iron plate technically termed a *skelp* is usually about a foot in length and when heated to a welding temperature is rolled around a mandrel and passed through a set of rollers which in turn elongate the *skelp*, reducing the diameter, and giving the proper size and taper to the barrels.

Twist barrels are made of a ribbon of iron wound spirally around a mandrel and welded.

Stub-twist is a stub-iron ribbon coiled around a mandrel and welded; *wire-twist* is made by welding laminæ of iron and steel together, or two qualities of iron and drawing the compound into a ribbon which is coiled and welded as described above.

Damascus iron is made of several bars of iron and steel laid parallel in a fagot and drawn out into a bar. A piece of the bar is heated to redness, one end placed in a vise, and the other end grasped by tongs, by which the bar is twisted till it assumes a cylindrical shape. Several such bars twisted in divers directions are laid together, welded and drawn into ribbons which are severally wound on mandrels and welded as before described.





The barrels are then bored, turned, tested, and finished.

By this process it will be seen that the metal is so arranged as to present the greatest resistance to the explosive force within. The pieces which were obtained for experiment were from ends of barrels. These were cut open, flatted out, and carefully finished on both sides. They were then submitted to the etching process and the fiber was beautifully developed, as shown in the illustrations.

Inspectors' Reports.

OCTOBER, 1884.

The usual summary of the work of the Inspectors of the Company during the month of October last, is given below, and it will be found to possess the usual interesting features of the reports from this department:

It will be seen from a perusal of the report that there were made 3,412 trips of inspection, 6,081 boilers were visited, 2,111 were inspected internally, 408 were tested by hydrostatic pressure, and 33 were condemned as unfit for further use. 4,409 defects were reported, of which 457 were considered dangerous.

The detailed statement of defects is as follows:

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment,	516	45
Cases of incrustation and scale,	781	54
Cases of internal grooving,	28	4
Cases of internal corrosion,	173	10
Cases of external corrosion,	323	28
Broken and loose braces and stays,	50	13
Settings defective,	248	17
Furnaces out of shape,	179	14
Fractured plates,	108	45

Nature of defects.	Whole number.	Dangerous.
Burned plates,	100	25
Blistered plates,	257	21
Cases of defective riveting,	459	49
Defective heads,	36	17
Serious leakage around tube ends,	461	26
Serious leakage at seams,	205	27
Defective water-gauges,	161	8
Defective blow-offs,	43	8
Cases of deficiency of water,	18	6
Safety-valves overloaded,	25	6
Safety-valves defective in construction,	21	6
Pressure-gauges defective,	215	26
Boilers without pressure-gauges,	2	2
Total,	4,409	457

The question frequently arises: What is the proper way to regulate the draft of a steam-boiler furnace, by opening and closing the ash-pit and furnace doors, or by means of a damper in the flue leading from boiler to chimney?

There is some difference of opinion and practice regarding this matter, which probably arises from differences or peculiarities in the constructive details of various boiler plants, which might make it desirable, or even necessary, to regulate one way in one case and the other way in another case.

Our own preference is decidedly in favor of regulating the draft by means of a damper placed in the uptake or pipe leading from the front end of the boiler, smoke-box, or front connection to the main flue. This uptake should be made of wrought iron, and riveted securely to the boiler shell, and the damper should be fitted as close to its lower end, or the tube openings as possible, and be provided with a convenient hand attachment whereby it may be set at any desired point and secured there.

There is much less liability of burning out the grates in a boiler furnace when the draft is regulated by a damper, than there is when it is regulated by the ash-pit door. For, let the ash-pit door be closed tightly, and all circulation of air in the ash-pit is stopped, there is nothing to prevent the heat from the layer of incandescent fuel being transmitted downward and overheating the grates, and overheating means warping, twisting, and cracking of the bars, and we have known them to be melted from this cause.

When, on the contrary, the ash-pit doors are fully open, there is nothing to prevent the free circulation of air throughout the pit, and the bars are kept cool. We recommend omitting altogether doors to the ash-pit, and making the opening through front nearly the full width of the grate, and making a water cavity or trough, at least 6 inches deep in the bottom of the ash-pit. This should be kept full of water, as it has a great effect upon the temperature below the grates.

For ease and certainty of regulation, a damper placed in the uptake as described above, possesses great and obvious advantages over any manipulation of ash-pit or furnace doors. Any one who has had charge of boilers fitted up in this manner can readily appreciate the truth of this statement.

There is, also, in our opinion, decidedly less loss of heat by infiltration of air through cracks in the setting walls when the draft is governed by a damper in flue than there is when the doors are used for same purpose; for, when ash-pit doors are tightly closed, the draught of the chimney will draw air in through every crack and crevice in the walls, and, this air entering the furnace at all points has a cooling tendency which it is most desirable to avoid. If the ash-pit doors are open, however, any leakage past the damper will readily be supplied by air passing through the fire, which is always the way air should go into a boiler furnace.

The damper should always be so fitted and adapted to the boiler, that, when it is tightly closed as far as it can be by the apparatus provided for operating it, it will allow sufficient draft to just keep the fires going, and carry off any coal gas which may be generated in the furnace.

The foregoing relates more particularly to boilers used for power purposes, and those plants of such size as to require the constant supervision of an engineer or fireman. With many of the small house-heating boilers, where the draft is automatically regulated, it is deemed expedient by most steam-fitters to regulate the draft by the ash-pit door. For boilers of this type, this is undoubtedly a good plan in many cases; with the attention this class of boilers receives, there is probably less danger of filling up a house with coal gas.

Boiler Explosions.

OCTOBER, 1884.

SAW-MILL (130).—A large boiler in the mill and cotton gin of Edward Maier, Fredericksburg, Texas, exploded October 1st, with terrific force. John Becker, the fireman, was instantly killed; George Gendes, a workman, was fatally scalded, and a boy named Knapp was fearfully scalded. Edward Maier, the proprietor, was seriously scalded about the head, and two other employés were slightly injured. Both the mill and gin were completely wrecked. The loss is estimated at $20,000.

THRESHING-MACHINE (131).—The boiler of a threshing-machine exploded October 3, at Lake Elmo, Minnesota, a village on the Omaha Railroad, about twelve miles from St. Paul, and about the same distance from Stillwater, killing two men, and badly injuring a number of others. The explosion occurred on the farm of Gottlieb Broze, instantly killing Broze, and severely injuring the engineer and one of the helpers.

SAW-MILL (132).—At Roger's saw-mill, Haralson county, Ga., a 40-horse power boiler exploded October 9th, killing J. C. Rogers, owner, and James Eson, instantly, and fatally wounding Bud Pardow, who died. Two sons of Mr. Rogers were badly wounded and three others injured. The mill was badly wrecked.

SAW-MILL (133).—The boiler in a saw-mill near Roland, Ill., exploded October 16th, and killed three men.

LOCOMOTIVE (134).—The explosion of a mine locomotive at Shenandoah, Va., October 20th, killed one man and wounded several others. A breaker was set on fire, but soon extinguished.

THRESHING-MACHINE (135).—The boiler of a threshing-machine on the Leech J. Nichols farm at Beltrami, Minn., exploded October 21st, instantly killing Thomas Evenden, the engineer, and John Smith, John Singwood, Chris. Swanson, Charles Swanson, and John Johnson farm hands, and William Pierce, aged eleven. An unknown man was badly scalded. The engineer was recovering from a debauch.

FLOUR MILL (136).—The boiler of the Columbus, Miss., flouring mills, exploded October 21st, killing the engineer and mortally wounding the fireman, both of whom were colored.

SAW-MILL (137).—The boilers in B. Scratches & Co.'s saw-mill at Atoka, Ind. Ter., exploded October 23d, killing three men—J. B. Oliver, Frank Choate of Atoka, and John Radcliff, the engineer, from Clayton, Ill. Oliver and Choate leave large families. The explosion was the result of carelessness. The damage amounts to $1,200; no insurance.

LOCOMOTIVE (138).—A horrible catastrophe which caused the death of two men, occurred at seven o'clock, A. M., October 29th, at Locust Point, Md. Locomotive No. 128 of the Baltimore & Ohio Railroad was standing on a side-track opposite Woodall's dry dock. In the cab were the engineer, Joshua Dixon, and fireman, Daniel A. Burke. Without a moment's warning the boiler exploded with terrific force. Dixon was instantly killed, and his body blown into the water 150 feet away. Burke was blown upon a bank some distance off, and when he was reached he gave a few gasps and died. Dixon's body was horribly mutilated, and as it flew through the air struck the telegraph wires to which overalls and suspenders adhered. Both men leave families.

THRESHING-MACHINE (139).—The boiler of a steam thresher on the farm of Daniel Wentz, in Jackson Township, Perry County, Pa., exploded October 30th, killing David Snyder. A barn was fired and consumed with 3,400 bushels of grain and farming implements.

WOOD-WORKING SHOP (140).—A little before noon, October 20th, in the cigar factory, Nos. 122 to 128 Michigan street, Chicago, Ill., there was a tremendous explosion of the boiler. The windows in the rear upon the alley where the engine and boiler were located, and part of the wall, were blown out. The building took fire and was burned. One man was killed.

SAW-MILL (141).—The boiler of Isaac Wehrenmann's saw-mill on Ten Mile Creek, Middleburne, Tyler county, W. Va., exploded October ——, totally destroying the building and machinery, instantly killing John Fox and William Worden, and wounding five other men, two of them fatally. The cause of the accident is not known, as the engineer is dead.

Rack Railways.

Some interesting particulars concerning existing lines of rack railways have recently been supplied by the *Annales Industrielles.* These railways, of which the Rigi line was the first application, made by Mr. Riggenbach, have been considerably extended in use. Those which are worked exclusively by locomotives and rack gear are six in number, as follows:

	Constructed.	Ruling Gradient.
1. Vitznau-Rigi, ...	1870	25 per 100, or 1 in 4
2. Kahlenberg-Vienna, ...	1872	10 " " 1 in 10
3. Schwabenberg-Pesth, ...	1872	10 " " 1 in 10
4. Arth-Rigi	1874	21 " " 1 in 4.8
5. Rio-de-Janeiro, ...	1882	15 " " 1 in 6.7
6. Drachenfels to the Rhine, ...	1883	22 " " 1 in 4

These are tourist lines employed exclusively in passenger traffic. The following lines, six in number, are worked on the "mixed" system, partly by rack and partly by ordinary adhesion, for which alternative the locomotives are purposely constructed:

	Constructed.	Ruling Gradient.
7. Ostermundingen-Berne, ...	1870	10 per 100, or 1 in 10
8. Rorschach-Heiden, ...	1874	9 " " 1 in 11
9. Wasseralfingen, ...	1876	8 " " 1 in 12.5
10. Rüti-Zurich, ...	1877	10 " " 1 in 10
11. Laufen-Berne, ...	1878	6 " " 1 in 16.7
12. Oberlahnstein, ...	1880	10 " " 1 in 10

There are 42 locomotives in all, weighing from 9 to 18 tons.

In addition to the foregoing 12 lines worked by locomotives, Mr. Riggenbach has constructed four funicular or rope railways, on which the function of the rack is to act as a safety-brake. The power is obtained from water stored in tanks, and serves both as a motor and as a counterweight. The lines are those of Giessbach, on the Brienz Lake; incline, 28 per 100, or 1 in 3.6; of Dom Jesus de Braga, in Portugal—incline, 45 per 100, or 1 in 2.2, opened in 1883, and the Montreux-Geyon line, Lake of Geneva—incline, 57 per 100, or 1 in 1.8, also opened in 1883.—*Mechanics.*

Wonder why Herr Riggenbach fails to mention the Mt. Washington Railway, constructed several years before any of the above (in 1866, we believe), and of which all other Rack Railway Systems are copies?—(ED. LOCO.)

The First Oil Well.

Some three months since (August 27th), there was celebrated in one of the Western towns of Pennsylvania the 25th anniversary of the first oil well ever drilled. It was sunk near Titusville, and yielded 10 barrels a day, the product being then known as rock oil. This was the humble beginning of the business which now employs a vast number of laborers, millions of capital, and exported last year over 500,000,000 gallons of petroleum. No better idea of the world's progress can be gained than by the recollection that coal oil, in itself an immense improvement over all preceding means of illumination, has in 25 years come into general use and been superseded by illuminants as far superior to it as it was to the old tallow dip. Gas and the electric light have taken its place in all the cities and towns of any size, and the only hope for the trade lies in either finding or creating further markets for the product abroad.—*Mechanics.*

IN obtaining a temperature higher than that of the boiling of water or of oil, the use of a sand bath has usually been resorted to by chemists. As this method, however, is characterized by certain drawbacks or deficiencies, sand being a very bad conductor of heat, a German chemist has recently proposed as a substitute the employment of pounded fragments of graphite; these have the property of letting the heat pass much better, do not oxidize and have no soiling effect on the inclosing vessel. *L'Electricité* admits the advantages presented by this mode to electricians who have to make researches in thermo-electricity, adding that small shot of iron would serve nearly the same purpose.—*Mechanics.*

CROCODILES are the only reptiles whose nostrils point in the throat behind the palate, instead of directly into the mouth cavity. This enables the crocodile to drown its victim without drowning itself, for by keeping its snout above water it can breathe while its mouth is wide open.—*M'f'rs Gazette.*

MARSEILLES' or thieves' vinegar, as it is called, is pronounced infallible as a preventive of cholera. It was invented during a season of pestilence, by four thieves, who spent their time plundering the dying and the dead, with no fear of infection, the vinegar with which they supplied themselves being a successful disinfectant. Their recipe, which is in use to-day, was as follows: Dried tops of large and small wormwood, rosemary, sage, mint, rue, lavender flowers, two ounces of each; calamus-root, cinnamon, cloves, nutmeg, garlic, one-fourth of an ounce each; camphor, one-half ounce; concentrated acetic acid, two ounces; strong vinegar, eight pounds. Macerate the herbs in the vinegar for two weeks, strain, press, and add the camphor dissolved in the acetic acid. Thieves' vinegar is used as a perfume about the person, or dropped in the water for bathing purposes. A little of it burned on a shovel will deodorize a room.—*Ex.*

The Locomotive.

HARTFORD, DECEMBER, 1884.

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

THIS number closes the fifth volume of the new series of the LOCOMOTIVE. It has been the aim of its managers to furnish its readers with sound information bearing upon the care and management of steam boilers.

The wide field from which this information is derived gives it especial value. It is practical, and grows out of the practical work of the company.

The demand for the LOCOMOTIVE is continually increasing. It has a large circulation in foreign countries, and it is the purpose of its managers to maintain the high reputation which it has among practical scientific men. The advice which it contains as to the care and management of boilers, their attachments and connections, makes it especially valuable to every steam user. By following these recommendations many accidents might be prevented. In addition to the articles bearing more directly on the care and management of steam boilers, are valuable articles on other scientific subjects. The rapid march which is being made in the physical sciences is introducing new features in the comforts and conveniences of our homes and places of business. It will be our aim briefly to notice such progress. We have endeavored to make the LOCOMOTIVE a paper of value and interest to stationary engineers, from whom there comes a large demand for each issue; and we shall continue to discuss practical questions intimately connected with their work. The series of articles on "Experiments upon Iron and Steel," is complete with this number. The object in preparing these articles has been, first, to show how iron and steel may be seriously impaired in strength by carelessness in the construction of boilers or machinery. By subjecting the parts to undue and excessive strains, defects which cannot be detected on the surface are often located, which develop into dangerous fractures when the boiler or machine is put into use. The study of the fibre of metals is an interesting one, and if by any process we can so develop it as to be able to see just what effect an undue strain has upon it, we add so much to our knowledge of its behavior.

The Manufacturers' Gazette, under the able editorial management of Mr. Thomas Pray, Jr., has become one of the liveliest and best of our exchanges. We can heartily commend it to manufacturers and engineers.

The Journal of The Franklin Institute for December contains a very interesting article by Prof. R. H. Thurston, of the Stevens Institute, on the energy stored in the heated water in steam boilers when under steam pressure.

IN 1865 steel rails cost $195 per ton; in 1885 $27 will buy a ton of a much better quality. This is considerable of a reduction, and represents a vast improvement in manufacturing processes. The productive capacity of the country in this respect, at least, seems to have increased in a far greater ratio than the population has.

Rule for Ascertaining Size of Safety-Valve for Any Given Grate Surface.

The required aggregate area of safety-valve to be placed upon boilers, may be expressed by the formula,

$$A = \frac{22.5 \times G}{P\ 8.62}$$

in which A is area of safety-valve in inches; G is area of grate in square-feet; P is pressure of steam in pounds per square-inch, to be carried on the boiler above the atmosphere. The following table gives the results of the formula for one square foot of grate as applied to boilers used at different pressures:

PRESSURES PER SQUARE-INCH.

10.	20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.
1.21	0.79	0.58	0.46	0.38	0.33	0.29	0.25	0.23	0.21	0.19	0.17

(area corresponding to one square foot of grate.)

Example.—Required, area of safety valve in square-inches for boiler running at 80 lbs. pressure and 30 feet grate surface.

For 1 foot square from table at 80 lbs.	— 0.25
Square feet grate surface	— .30
Area of valve in square-inches	= 7.50

If a forced or artificial draft is used the estimate is based on a consumption of 16 lbs. of fuel for each square foot of grate surface.

This rule was furnished by the scientific commission which framed the inspection law for the city of Philadelphia.

Table Showing the Proper Size of Rolled I Beams to be Used for Different Loads and Spans when Loaded in the Center.

IT being common practice with many to hang boilers from wrought iron beams, which are supported either on the walls of the setting, or columns resting on the foundation, we have prepared the following table, showing the proper sizes of beams for various loads, which will be found of use in designing such work.

The sizes given are for beams similar to those rolled by the New Jersey Steel and Iron Company, unsupported sideways, and having the load applied at the center.

A single example will show the application of the table.

Suppose we have two boilers, 54″ diam., 16ft. long., shells $\frac{5}{16}$″ thick; heads, $\frac{3}{8}$″ thick; each having 52 tubes, 3″ diam. by 15 feet long; the boilers to be set over one furnace with a clear space of 6 inches between them, and hung from beams resting on columns standing close to the outside walls of the setting. What sized beam should be used to support them?

The shell of such a boiler would weigh about - -	3,400 lbs.
The heads would weigh about - - - -	500 "
The tubes would weigh about - - - -	2,600 "
The water at ordinary level would weigh about - -	8,000 "
Add for piping, covering, etc., say, - - - -	500 "
Total, about - - -	15,000 "

The distance between supports would be about 14 feet, with ordinary thickness of setting walls; then, as we have two boilers, and support one-half of each on each pair of supports, we shall have a weight of 15,000 lbs. to be supported by a beam 14 feet long. The table gives us at once a 15″ light beam, if but one beam is used, or if, as is usually the case, two beams are used with a saddle over them and the suspending bolt or rod passing down between them, thus giving 7,500 pounds on each beam, a 10½″ light would be sufficiently strong.

NOTE.—The letter *l* after size of beam denotes a "light" pattern.
" *h* " " " "heavy" "

LOAD IN POUNDS.	DISTANCE BETWEEN SUPPORTS IN FEET.												
	8	9	10	11	12	13	14	15	16	17	18	19	20
1,000	5 *l*	5 *l*	5 *l*	5 *l*	6 *l*	6 *l*	6 *l*	7	7	7	7	7	7
1,500	5 *l*	5 *l*	6 *l*	6 *l*	6 *l*	7	7	7	7	7	8 *l*	8 *l*	8 *l*
2,000	6 *l*	6 *l*	6 *l*	7	7	7	7	7	8 *l*	8 *l*	8 *l*	8 *h*	8 *h*
2,500	6 *l*	6 *l*	7	7	7	7	8 *l*	8 *l*	8 *l*	8 *h*	8 *h*	8 *h*	10½ *l*
3,000	6 *l*	7	7	7	7	8 *l*	8 *l*	8 *h*	8 *h*	8 *h*	10½ *l*	10½ *l*	10½ *l*
3,500	7	7	7	7	8 *l*	8 *l*	8 *h*	8 *h*	8 *h*	10½ *l*	10½ *l*	10½ *l*	10½ *l*
4,000	7	7	7	8 *l*	8 *l*	8 *h*	8 *h*	10½ *l*	10½ *l*	10½ *l*	10½ *l*	10½ *l*	12¼ *l*
4,500	7	7	8 *l*	8 *l*	8 *h*	8 *h*	10½ *l*	10½ *l*	10½ *l*	10½ *l*	10½ *l*	12¼ *l*	12¼ *l*
5,000	7	8 *l*	8 *l*	8 *h*	8 *h*	10½ *l*	10½ *l*	10½ *l*	10½ *l*	10½ *l*	12¼ *l*	12¼ *l*	12¼ *l*
6,000	8 *l*	8 *l*	8 *h*	8 *h*	10½ *l*	10½ *l*	10½ *l*	10½ *l*	12¼ *l*	12¼ *l*	12¼ *l*	12¼ *l*	15 *l*
7,000	8 *l*	8 *h*	8 *h*	10½ *l*	10½ *l*	10½ *l*	10½ *l*	12¼ *l*	12¼ *l*	12¼ *l*	15 *l*	15 *l*	15 *l*
8,000	8 *h*	8 *h*	10½ *l*	10½ *l*	10½ *l*	10½ *l*	12¼ *l*	12¼ *l*	12¼ *l*	15 *l*	15 *l*	15 *l*	15 *l*
9,000	8 *h*	10½ *l*	10½ *l*	10½ *l*	10½ *l*	12¼ *l*	12¼ *l*	12¼ *l*	15 *l*	15 *l*	15 *l*	15 *l*	15 *h*
10,000	10½ *l*	10½ *l*	10½ *l*	10½ *l*	12¼ *l*	12¼ *l*	12¼ *l*	15 *l*	15 *l*	15 *l*	15 *l*	15 *h*	15 *h*
11,000	10½ *l*	10½ *l*	10½ *l*	12¼ *l*	12¼ *l*	12¼ *l*	15 *l*	15 *l*	15 *l*	15 *l*	15 *h*	15 *h*	15 *h*
12,000	10½ *l*	10½ *l*	10½ *l*	12¼ *l*	12¼ *l*	15 *l*	15 *l*	15 *l*	15 *l*	15 *h*	15 *h*	15 *h*	15 *h*
13,000	10½ *l*	10½ *l*	12¼ *l*	12¼ *l*	15 *l*	15 *l*	15 *l*	15 *l*	15 *h*	15 *h*	15 *h*	15 *h*	
14,000	10½ *l*	12¼ *l*	12¼ *l*	12¼ *l*	15 *l*	15 *l*	15 *l*	15 *h*	15 *h*	15 *h*	15 *h*		
15,000	10½ *l*	12¼ *l*	12¼ *l*	15 *l*	15 *l*	15 *l*	15 *l*	15 *h*	15 *h*	15 *h*			
16,000	12¼ *l*	12¼ *l*	12¼ *l*	15 *l*	15 *l*	15 *l*	15 *h*	15 *h*	15 *h*	15 *h*			
17,000	12¼ *l*	12¼ *l*	15 *l*	15 *l*	15 *l*	15 *l*	15 *h*	15 *h*	15 *h*				
18,000	12¼ *l*	12¼ *l*	15 *l*	15 *l*	15 *l*	15 *h*	15 *h*	15 *h*					
19,000	12¼ *l*	15 *l*	15 *l*	15 *l*	15 *l*	15 *h*	15 *h*	15 *h*					
20,000	12¼ *l*	15 *l*	15 *l*	15 *l*	15 *h*	15 *h*	15 *h*						

Amount of Sediment,

COLLECTING IN A STEAM BOILER WHEN EVAPORATING 1,000 GALLONS OF WATER PER DAY AND 6,000 GALLONS PER WEEK, OF 58.318 GRAINS EACH.

When a gallon of feed-water evaporated to dryness at 212° Fahrenheit leaves of solid matter in grains.	The amount of solid matter collecting in boiler per day will be		The amount of solid matter collecting in boiler per week will be		When a gallon of feed-water evaporated to dryness at 212° Fahrenheit leaves of solid matter in grains.	The amount of solid matter collecting in boiler per day will be		The amount of solid matter collecting in boiler per week will be	
Grains.	Pounds.	Ounces.	Pounds.	Ounces.	Grains.	Pounds.	Ounces.	Pounds.	Ounces.
1	....	2.286	....	13.714	60	8	9.142	51	6.857
2	....	4.571	1	11.428	65	9	4.571	55	11.428
3	....	6.857	2	9 143	70	10	......	60	......
4	...	9.143	3	6.857	75	10	11.428	64	4.571
5	....	11.428	4	4 571	80	11	6.857	68	9.143
6	...	13.714	5	2.285	85	12	2.286	72	13.714
7	1	......	6	......	90	12	13.714	77	2.285
8	1	2.286	6	13.714	95	13	9.143	81	6.857
9	1	4.571	7	11.428	100	14	4.571	85	11.428
10	1	6.857	8	9.142	110	15	11.428	94	4.571
15	2	2.285	12	13.713	120	17	2.286	102	13 714
20	2	13.714	17	2.284	130	18	9.143	111	6.857
25	3	9.142	21	6.855	140	20	......	120	......
30	4	4.571	25	11.426	150	21	6.857	128	9.142
35	5	......	30	......	160	22	13.714	137	2.285
40	5	11.428	34	4.571	170	24	4.571	145	11.428
45	6	6.856	38	9.143	180	25	11.428	154	4.571
50	7	2.285	42	13 714	190	27	2.286	162	13.714
55	7	13.713	47	2.285	200	28	9.143	171	6.857
					210	30	......	180	......

The foregoing table was prepared by F. E. Engelhardt, Ph. D., of the American Dairy Salt Company, Syracuse, New York. It will be found interesting and valuable to those having to do with steam boilers.

This table represents the total amount of solid matter, or sediment, deposited under the conditions of the boiler making steam without any water being drawn or blown off, or any cleaning whatever, and shows the necessity for such cleaning even in the case of a good feed water.

In practice, before the solid matter would all be deposited, it would be impossible to run the boiler, as some salts, as chloride of calcium, which might be present, are deliquescent, dissolving in a very small amount of water; while others, as common salt (which is rarely absent), sulphate of soda, and sulphate of magnesia, are very soluble, and would not be deposited till the water was very concentrated. These are generally completely prevented from depositing by sufficient blowing off the boiler.

In general, though of course varying greatly with different water, the scale-making material deposited will be found to average about one-half the amount given by the table; and of this, when it is deposited under favorable conditions, or is of an easily-managed character, much can be removed by the blowing off, as the carbonates of lime or magnesia, though themselves very insoluble, are deposited in a granulated or powder-like form.

Sulphate of lime, a very common constituent of water, is soluble in about 600 times its weight of water. This limit is soon reached in evaporating water in a boiler, but the solubility is much increased in presence of common salt and other soluble salts that may be in the water, so that much of it may be prevented from depositing. When once in the form of sediment it becomes very difficult to treat.

Water that contains more than fifty grains of solid matter to the gallon is rarely used, and an average feed-water in the Eastern States, away from limestone regions, would not contain more than 15 grains of solid matter to the gallon, 8 or 10 of which might be productive of scale.—(Ed. Locomotive.)

Dr. Arvine on Lubricants.

During the discussion on lubricants in the last meeting of the Mechanical Engineers' Society, Dr. Arvine, analyst for the Standard Oil Company, gave many interesting facts of his experience. To a practical man, who wants to know what he needs to put upon his engine, the value of the "coefficient of friction," is extremely important. We know perfectly well that it depends upon many conditions that are difficult to maintain and to understand. Even the wisest admit that there is very little yet found out which throws practical light upon this subject. For instance, we know perfectly well when they decide the coefficient of friction of paraffine oil on two polished surfaces made to fit perfectly, we gain no light at all on what we need to use on bearings that do not fit equally well, or have the same finish. If we are to decide how to construct a bearing, what its proportions would be, how large a segment it should cover, all of these researches would be directly to the point. But if we have an engine that runs hot, or a certain construction of railway bearings that makes it difficult to find a suitable lubricant, these investigations afford us no light whatever. Crediting all possible value to researches regarding the coefficient of friction, what we most want to know is vastly beyond that. For instance, an engineer comes and says, "I was using such a paraffine and my engine ran cold. I am now using such a paraffine and my engine runs hot." We find on examination that there is no practical difference between the two, but when we come to apply them to a bearing we find that for some reason the oils do not work alike. When we apply them to spindles we find that two paraffine oils often bear no relation to each other in their practical behavior. We find that one will run at a much higher temperature, for some obscure reason. We might think it due to velocity, but we find by our instruments that it does not depend upon that. In some instances, too, the results we obtain are exceedingly contradictory. The Rochester & Pittsburgh Railroad Company run their cars with a bearing the surface of which is composed, apparently, of lead—it appears to be lead spread over the inner surface of the composition box, which looks as though it might be gun metal. They say they can run an oil on this soft bearing that I know positively fails under simular circumstances and on the same class of cars on the New York, Lake Erie & Western, the New York Central, and the Delaware & Lackawana—just why, I cannot say. A shaft will sink down in that bearing, and yet it runs cold, and runs on a very cheap oil.

One of the oil companies manufactures an oil which is composed largely of a mineral base united with fatty acid. All things considered that oil has been the most successful for running cold of any oil used on railroads. And yet that fails to equal some cheaper oils on the friction testing machines. We have lately made comparative tests on fast-running Sawyer spindles. We have half-a-dozen oils from Europe, and several made in this country. Adapting a dynamometer to this I expected to find that oils having the best body would be the best oils for these spindles, but I found that I did not know anything about it. After having read many papers and listened to a great deal of talk from gentlemen who knew a good deal about it, I found that the spindles did not bear out anything I expected. A spindle that was nicely fitted behaved in one way, but a spindle that was badly fitted behaved very differently. The effect of this was to establish a friction of its own in addition to the friction we generally speak of as due to the oil itself. If we put on oil that has a great body the heat increases very rapidly. Now, we say at first that that was an objection to that oil. But we found, after running them for a short time, that the oils which gave us the best results in the economy of power were the ones that produced the most rapid wear. We found after running constantly at some 6,500 revolutions a minute, that it lost as much as one-tenth of one gramme in actual weight. When we took another paraffine of oil the wear was not half that, and there seems to be no apparent reason for it. One reason these Sawyer spindles ran so well was that they run in a flooded bearing. The question of wear on bearings, as ordinarily found, is more important than the cost of oil. One large mill owner came recently and said he wanted an oil for his spindles. He did not care what it cost so long as it was efficient, for after running eleven mills for many years he had discovered that so great loss was sustained from wear due to poor lubrication as to make the mere price of oil unimportant.

When the engines of the Brooklyn Bridge were started up, the faulty construction of the bearings of journals caused rapid heating. The main bearings were made in such a way that the bearings pinched the sides of the journals, and the binding increased with the rise in temperature, the expansion of the metal producing this effect.

We generally find that where we can use oils of a higher viscosity, ordinary machinery bearings run colder; but in some instances of high speed and heavy pressure, only thin oils answer at all, and the bearings must be flooded. The engines that run the Edison dynamos in Pearl street are rated at 75 horse-power, and run at the rate of 375 revolutions per minute. The oil they are using on these bearings is about 32 degrees Beaume gravity, which is almost as light and fluid as common kerosene, and it is the only kind found to run cool, but it requires to be supplied constantly.

I have come to think that this arranging of a steady current of thin oil is a very desirable plan, wherever it can be practically carried out, as in various spindles and nicely finished and fitted bearings of large dimensions, such as those in machines devised for testing oils. With bearings nicely finished, and journals carefully scraped and ground to fit, an abundant and constant supply of thin oil will give the best possible result in keeping the bearings cold and saving power. With such machines you may learn much of the proper proportions of bearings and of the conditions of friction in relation to pressure and speed; of oils, too, under the exact conditions of these machines, but nothing of the requirements of machinery in common use. Some experimenters think of a journal and bearing as two cylindrical surfaces in perfect contact. It would be more scientific and practical to regard the fit of ordinary bearings like that of a pea in a bushel basket. In many instances, one point of contact would be too much to expect, and the body or viscosity of the oil must make the fit. The result in testing heavy lubricating oils on testing machines do not correspond with the practical working of these oils on railway axles and other machinery; and any engineer to whom you might supply oils selected from such data would soon come back to you, as the saying is, "with tears in his fist and his eyes doubled up." We have been there—both sides.

The fact is the most important conditions under which the tests are made are the very ones that can only be maintained under special and unusual circumstances, and are never found in the great mass of machinery that must be lubricated. This makes the friction tests by special machines worthless as a means of selecting lubricants, and a delusion to those whose opinions of oils are thus founded.

I believe that the great value of these friction tests, and the machinery by which they were made, lies in another direction; for we know that scientific research lies at the root of all industrial progress. But I think we must try an engine-oil on an engine, a spindle-oil on a spindle, and a wagon-grease on a wagon, all as nearly as possible under the ordinary conditions, to learn anything of the real value of the lubricant.

While speaking of spindle oils I should have added that I found the bearing parts did not wear bright. I considered their frosted looks as indicative of a friction I saw no way of estimating, although it was attended with rapid wear. With oils of higher viscosity and heavier gravity the bearing surfaces polish like a mirror, even though the friction, judging by the power consumed, is much greater with the more viscous oils. I infer that we cannot judge of the actual friction occasioned by the moving surfaces in contact, while we are unable to estimate separately that friction attributed to the oil itself. For using a thin oil, we decrease that one friction so greatly that we cannot note any lesser increase in the other which occasions wear. If it be true that the question of wear is frequently of paramount importance in choosing special oils, then a low coefficient of friction is no measure of value, and our frictional tests are worthless as a means of judging.

It is frequently said that we have petroleum oils which alone answer all requirements of lubrication. It is not so. Practical experience fully proves that in many instances compounded oils are the best. Sometimes a thin petroleum oil, with a small portion of animal oil, gives better results. There are instances where the best petroleum oils do not answer on an engine, when lard oil, or a mixture principally lard oil, keeps the engine cold and in every way satisfactory. This is sometimes the case whether the petroleum be of heavier or lighter gravity than the lard oil. But these are rare instances where petroleum oils do not answer every requirement.—*American Machinist.*

Utilization of Culm or Coal Waste.

At the meeting of the Scranton, Pa., Board of Trade, on Tuesday, Nov. 25th last, the president, Mr. J. A. Price, delivered the following address upon the subject of culm and its utilization as fuel:

It is eminently proper that the people of this vicinity should maintain an eternal vigilance in regard to the methods and processes of culm utilization, nor should they lose sight of the thought and speculation that are constantly devoted to the subject. The locality is central for experiments, and the position is formidable upon one of the most extensive anthracite coal fields. It may reasonably be expected that many of the problems will be solved here, and with proper encouragement and activity it may be safe to predict that such will be the case. Agitation will stimulate attention upon the very important subject, and may produce a final and a complete disposition of the enormous waste to beneficent and useful purposes.

Germany, France, and Belgium are still devoting themselves with persistent energy to various kinds of cements, manufacturing the slacks or waste into briquettes by mixture and pressure for commercial purposes. Coal-tar and asphalt, reduced to the smallest proportionate quantity, are used, and the effort seems to be perpetually embarrassed by that of the cost of the artificial fuel thus produced when placed in market in competition with coals. One hundred years of experiment with cements and mixtures would seem to have exhausted this source of expectation. It cannot in the present day stand against the remorseless competition of the mines. The desire to accumulate rapidly, selfishness, and avarice are insatiable to the pursuits of the greater, to the neglect of the smaller, object of gain.

In this country there is a substantial progress in the right direction. The owners of mines are adapting machinery to a finer selection of material than has ever been made. A few years ago chestnut size was the smallest extracted; to this, in due time, was added "pea" size, and later still that which is now known as "buckwheat" size. One smaller size still is contemplated. It may properly be named "pin head." As one size after another in the downward scale is extracted, the true economic principle is everywhere evident. But when there is no further possible mechanical subdivision, there is yet a vast waste of still finer particles of pure carbon crystals. By a system of washing some further saving might be practiced. It is, however, doubtful to what extent it would be made to yield profitable results.

We have then to deal with the subject after the most complete processes of mechanical elimination or subdivision have become exhausted. There still exists a cruel waste. By the application of steam pressure, blast and mechanical grates, a part of this waste material may be and is used. Manufacturing industries will seek the locality of the culm deposit as in former years they sought the water-power of streams and waterfalls. This feature will still fail. The output is and must continue to be greater than the largest possibility of the centralization of industry in the coal-field. The question yet remains, over and above these economic treatments and uses of the waste, what shall be done with residue of output over consumption in its most favorable aspect?

The scientific world is waiting at the laboratory doors of Jablochkoff and the German investigators, and it gives an attentive and believing ear to the statements of Edison and other electricians, when they pronounce the prediction that the time will come when a tremendous electric force will be derived directly from the carbon, where it lies a sleeping giant, without the intermediary of boilers, furnaces, engines, and dynamos. The conversion of coal into electricity involves only its combustion and the means, not yet discovered, of extracting the electric fluid. Even with this immense economy, supposing it probable, we are still as far from the utilization of the waste as ever.

It may be asserted as an axiom, that combustion of carbon by its union with oxygen must take place before any power can be derived. We then fall back upon the principles of combustion. Here, after all, is the keystone of all researches—the end to which every energy must be directed. The fine dust, which has been hitherto the impassable barrier, has all the elements of usefulness of the best coal in the bed; it only awaits the mechanical means of extracting its imprisoned energy. That means will be found.

It is my belief that the use of this factor for power purposes rests in the ability to sustain combustion with a powerful fuel. And why not? The lump of coal in the furnace only burns upon its exterior surface, while the internal mass is without activity. The dust is but the smaller, or an infinite subdivision of the lump, and all the advantages of a fiercer combustion can be maintained among the particles of the dust. The surface presented for the action of the oxygen in the powdered, is infinitely greater than in the mass of coal, hence it is reasonable to conclude that powdered coal possesses in reality the larger element of usefulness, and that the combustion of coal in the lump is not the best and by far from the most economical use of the fuel in question. As the chemical change goes on only at the surface, where atom combines with atom to produce motion, heat, power, and as the surface of the divided mass is extensively broader, it follows as a mathematical deduction, at once conclusive and absolute, that, with certain properly adapted mechanical appliances for sustaining combustion, we shall reduce to powder all the carbon that comes from the mines before using. In this light our present waste is nearer the proper mechanical condition for use than that which we value so highly. To this standard, it is my firm conviction, we shall come. Powdered coal is the fuel of the future.

I am satisfied, from certain experiments already made with imperfect appliances, that it is not only a possible but a highly probable attainment. The introduction of the fuel to the furnace by a proper method of stoking, and a corresponding adaptation for the supply of oxygen and hydrogen, a process that must be automatic and continuous, solves the question before us. I am also satisfied that the heat energy in a pound of powdered coal is several times that of the same in mass, and that the waste of combustible gases is less in the process, while the ash is reduced to its minimum. What more can be desired from combustion? We fail only in our appliances. The purely mechanical difficulties once removed, we shall have all the vast waste of culm deposits transformed into value. Such a consummation will be a public benefaction, a profit to the present age, as well as a boon to the ages to come. Let us unite to hasten the day of its glorious inauguration.

I believe the board will bear with me in extending my observations in regard to the utilization of waste coal, observations which are the result of an earnest desire to see so valuable an accomplishment. While what I have to offer in addition in no way accentuates the results of experiments and thought upon the utilization of waste coal for the purpose of generating power, yet it is in no less a degree a step toward the final benefit to be derived from the present wasteful culm deposits.

The assertion that waste anthracite may be used with practical effect in the preparation of land for agricultural purposes may, at first, startle some who are otherwise credulous as to the possibilities of culm. I believe it to be a fact, however. I have witnessed the influence of a darkened color to a naturally light soil in the promotion of plant life and growth, and believe that our culm deposits can be prepared for agricultural purposes and used with decided effect.

A dark soil will sustain a more vigorous existence in the plant than a light soil, other things being equal. The reason for this is apparent when it is considered that dark colors absorb rays of light and light colors reflect them. The more sunlight that can be absorbed by the earth and the plant, the more vigorous the growth. The myriad rootlet mouths of the plant will discover the hidden ray and devote it to its use. The dark colored soils are warmer in cold periods, and they are colder in hot, by reason of the lessened reflections from the surface. Every argument is in favor of the dark soil. Witness the richness in growth of the soils made dark by the carbon of decaying vegetable matter in the great West and in bottom lands generally. The color partially accounts for the vigor of the soil.

On all dark soils the season begins earlier and lasts later. The dark soils imprison the sunshine by absorption, and hold it for gentle distribution to the need of the plant, while from the light soil it rebounds with arrowy and destructive intensity. In the reflection of the sun's rays from any object they are gathered together and are more severe than the direct rays. The burning glass is an example.

If we examine the leaf of a plant, we discover that the upper surface has a glazed, hardened, or shield-like quality, but underneath it is soft and porous. It receives its substance from below. Hold a polished surface under the leaf with the sun's rays playing upon it and reflected beneath, if a confirmation is desired. The sickening effects will soon become manifest. A light-colored earth, in proportion to the degree, does the same thing in the very same way. It tends to exhaust the natural vigor of the plant. The introduction of this prepared material will also tend to make the soil more soft, porous, and spongy, which in turn fits it to become the storehouse from which vegetation is fed.

If adequate measures are adopted to transform this waste into usefulness, the agricultural community will not be slow to perceive its advantage. In this way the culm deposits may be turned from its present unsightly waste to a certain benefit to mankind. Even in its present state in the dump, farmers can use it with good effect, but it should be reduced to a powder.

The use of carbon as an absorbent is unquestioned. The preparation of culm waste for agricultural purposes may, and sometimes will doubtless be, supplemented by its admixture with the sewage of cities, thus utilizing two great wastes, while the destructive tendencies of sewer discharges will in a measure be diminished. But it is not my purpose to dwell at greater length upon the important features of the work of utilization.

Sufficient has been advanced to merit attention. The purpose of this presentation is that this board of representative business men, appreciating the folly, if not the crime, of allowing the waste of dust coal to go on indefinitely, shall institute measures at once, invoking the aid of the State in investigation, examination, and experiments. An appropriation of public moneys to this end can never be misplaced, and may result in untold advantage to the resources of the State. A commission with means to conduct the investigation thoroughly and persistently may be asked of the coming session of the legislature. The question is now before you. It remains with you to say whether the aid of the State be asked upon this most important and vital question of social and material economy.—*Coal Trade Journal.*

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