measurable quantity. But as the same quantity of gas is at the same temperature in each case, how has this excess of heat been disposed of so as not to be apparent, and yet capable of being recovered? Something else has been done besides heating the gas; the art of expansion involved the lifting a column of the atmosphere, and this work can be measured in foot-pounds. This work therefore represents the energy corresponding to the difference of the two heats. Various experimental conversions have been made resulting in the two figures of 772 foot-pounds and 1 pound 1° F. of water, which are received as the "mechanical equivalent of heat;" that is to say, the same quantity of energy will appear as either of the two forms, and one pound of water falling 772 feet would be heated 1° if it could be stopped so as to retain in itself the whole energy of the earth's attraction.

10. *Potential energy* is more difficult to conceive than kinetic, but our cricket ball may furnish some ideas. When it is flying through space it is not doing work, except as friction in the air; but it has the capacity to do work, and this friction work is a gradual exertion of that capacity. Its motion at each instant is therefore the measure of its remaining capacity, and is in fact the consequence of and the evidence of the energy *potential*, or latent in the ball. Now the unscientific mind would imagine that this energy was created by the striker, the production of his will; but science knows that the player no more created the energy than the bat did. The player in exerting his muscles burnt away a portion of their material or consumed some of the substance stored in his blood and derived from his food; in fact, he corresponds in function to a steam engine and boiler fed with coal. We come then to the result that he simply transferred *potential* energy to the ball, converting it first into *kinetic* energy or mechanical work in his muscles. The food itself simply stored up energy derived from the sun's beams, because the process of vegetable life is a continual *unburning* of hydrogen in water and carbon in carbonic acid, and the setting free of oxygen in the air, a process which requires an equivalent of energy to be imparted to the atoms, which energy they give up on their reunion, whether in the lungs and muscles of the cricket player or the boiler of the steam engine.

Boiler Settings and their Defects.

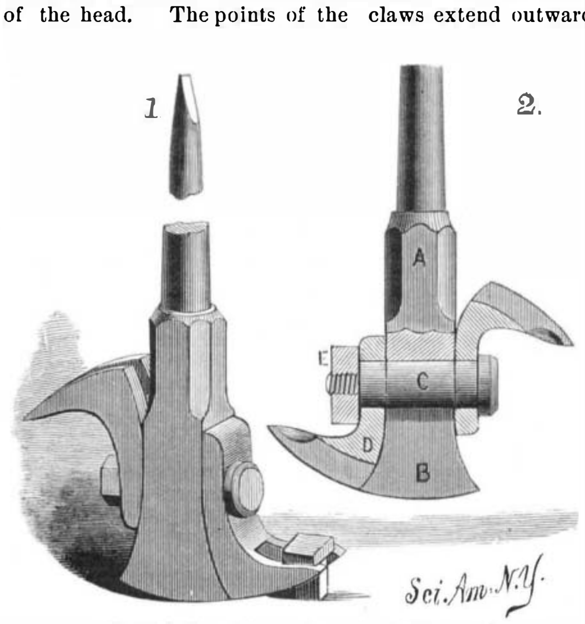
The *Locomotive* is a small sheet published monthly by the Hartford Steam Boiler Protection and Insurance Company; every issue contains a list of the boiler explosions and such other casualties, pertaining to steam appliances, which have occurred during the month prior to the issue of the paper.

The officers and engineers connected with the above company, from their experience derived in the inspection of boilers and their business as underwriters in this kind of risks, have more than ordinary opportunity for knowing which class of boilers are the best for the work required of them, as well of the best mode of setting them and the best attachments for insuring economy and safety. The May number has an article condemning the running of flues over the tops of boiler shells, as follows:

"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 brickwork 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 draught 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 upward 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.

IMPROVED CLAW BAR.

An invention patented by Mr. Hugh Robertson, of Breckenridge, Minn., relates to claw bars for drawing spikes from railroad ties and for similar uses. Fig. 1 is a perspective and Fig. 2 is a sectional view. The bar is chisel shaped on the extremity of the handle, and upon the opposite end is formed a convex head having concave sides. The end of the bar is slotted to receive a bolt that clamps the auxiliary claws to the sides of the bars, the inner faces of the claws being curved to adapt them to the concave sides of the head. The points of the claws extend outward

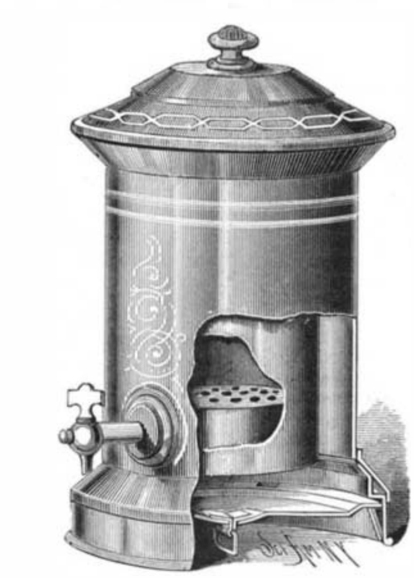


ROBERTSON'S IMPROVED CLAW BAR.

from the sides of the bar nearly at a right angle, and are slotted to receive the body of the spike to be drawn. The claws, near their points, are countersunk to receive the head of the spike, and the sides of the bar are similarly countersunk. The claws may be both clamped in position for use, when the head of the bar and the outer surface of the claws will form a curve of long radius. The bar may be used without the claws, or one of the claws may be attached in position for use and the other reversed. The bolt is flattened and fitted to the slot in the bar and to oblong holes in the shanks of the claws, which are thus prevented from turning. The chisel at the end of the handle can be used to form a cavity into which the claw may be inserted if there should be any difficulty in getting under the head of the spike.

WATER COOLER.

An invention recently patented by Mr. J. E. Welling, P. O. Box 100, Georgetown, Ky., is shown in the accompanying cut. The space between the removable water tank and the shell is filled in with some good non-conductor of heat. The faucet passes through apertures in the tank and shell, and is provided with annular shoulders which are kept pressed



WELLING'S WATER COOLER.

against the outer surfaces by a nut screwed upon the inner end of the faucet. On the back of the outer shoulder are two lugs which enter notches in the edge of the aperture in the shell, and thus prevent the faucet from turning.

The shell is provided with a removable bottom having a folding handle upon the under side. On the edge of the bottom is a series of notches, and the base of the shell has a corresponding number of lugs. To secure the bottom in position it is so placed that the lugs pass into the notches when it is turned so that its rim, between the notches, rests over the lugs. After the tank has been secured in the shell, the whole is inverted, the space is filled with sawdust, mineral wool, or other non-conductor, and the bottom fastened in place.

Antimony in Dyed Cotton Yarns.

BY DR. CARL BISCHOFF.

As is well known, it is at present a frequent practice to fix aniline colors on cotton yarns intended for stockings, etc., by means of tartar emetic and tannic acid. Commonly the yarn is first drawn through a sumac bath and then run into water containing the dye, together with the necessary quantity of tartar emetic in solution. In this way a tannate of antimony is formed, which is found to adhere well to the fiber, and acts as a fixing agent for the color, consequently the majority of dyed stocking yarns of all classes above the lowest contain appreciable quantities of antimony. Soluble antimony compounds, especially tartar emetic, when applied to the human skin in suitable and sufficient doses, cause a peculiar cutaneous irritation and inflammation.

Now, although the above mentioned method of fixing anilines may almost be called fast, owing to the colored antimony compound being difficultly soluble or pretty insoluble to water, yet under certain circumstances, among which may be mentioned insufficient rinsing, by no means unimportant quantities of soluble antimony compounds, more especially of tartar emetic itself, may remain in the finished yarns. In the last few months of 1883 a large firm of cotton stocking yarn dyers was induced to institute a research on a considerable collection of samples dyed in baths containing tartar emetic. Complaints of injury to health, etc., resulting from wearing miscellaneous goods which had been manufactured from these yarns, were the cause of this step being taken. The intention was to have determinations made of the quantities of antimony which might remain in such yarns after skilled dyeing and proper rinsing, also of the extent to which the aniline antimony tannate lakes remain soluble in water, and finally to ascertain how much antimony could be got out of the aforementioned lakes on the application of energetic dissolving agents.

The samples examined were fair average ones, not specially treated nor specially selected. After extraction of weighed quantities of yarn by means of hot water, the antimony was determined both in the aqueous extracts and in the yarns remaining therefrom. Digestion with concentrated muriatic acid, sometimes after addition of chloric acid, was the means employed for solution of the antimony firmly held in the yarns. Sulphide of ammonium was the precipitant employed, and when weighable quantities were obtained the precipitate was converted into and weighed as antimony pentoxide. The following scheme clearly and concisely exhibits the results obtained:

ANTIMONY IN DYED COTTON YARNS.

(Traces not determinable quantitatively.)

Color of Sample.	Soluble in Water. Per cent Antimony.	Soluble in Acid. Per cent Antimony.
1. Bluish violet	traces	0·11
2. Red (Bordeaux)	traces	0·26
3. Dark violet	0·012	0·12
4. Light reddish brown	traces	0·24
5. Pure blue	traces	0·13
6. Dark blue	0 008	0·25
7. Light red (Bordeaux)	traces	0·18
8. Bluish violet	traces	0·10
9. Scarlet	0·008	0·22
10. Dark red brown	traces	0·244
11. Dark red	traces	0·31
12. Red brown	0·0135	0·30
13 Scarlet	0·014	0·20
14. Light blue	traces	0·036
15. Water blue	traces	0·11
16. Orange brown	traces	0·121
17. Brownish violet	traces	0·20

It is well to be borne in mind that the weight of a pair of ordinary cotton stockings is about from sixty to seventy grammes. Hence the antimony contents of such articles made from these yarns would be with a maximum say 0·25 gramme. Only the quantity of antimony which is soluble in water can in this case be of physiological importance, and, according to the above table, this amounts to a maximum of 1 5 centigrammes per pair of stockings. We leave it to medical experts to figure out the influence on the health of the individual exercised by these quantities of antimony. We, however, do not by any means deny the *possibility* of cutaneous irritation, etc., in cases where the dyeing has been done in a loose, slovenly manner, no care given to the indispensable rinsing, and consequently the percentage of antimony soluble in water rendered comparatively high.—*Tex. Manuf.*

New Telegraph Cables between Europe and America.

A new cable is now being laid between Iceland and Nova Scotia, thence to this country, by Messrs. Bennett and Mackey. The cable used in the present enterprise is undoubtedly the best that has ever been made, representing the accumulated experience gained in the construction of all previous ocean cables. It was manufactured by the Messrs. Siemens at their works near London. Upward of 2,500 men are employed in the establishment, and 1,700 of these were employed on the present cables, for there are two of them, two to extend side by side from Ireland to Nova Scotia, whence one goes to Rockport Mass., and the other round Cape Cod to Fire Island, N.Y., and thence to New York. The aggregate length of the two is over six thousand miles. The shore ends are two and one-half inches in diameter, while the cable proper is but one inch in diameter. The conductor is formed of thirteen wires, consisting of twelve small wires coiled around a central wire one-tenth of an inch in diameter. The insulating material is gutta-percha, between which and the armor there is a cushion of jute.