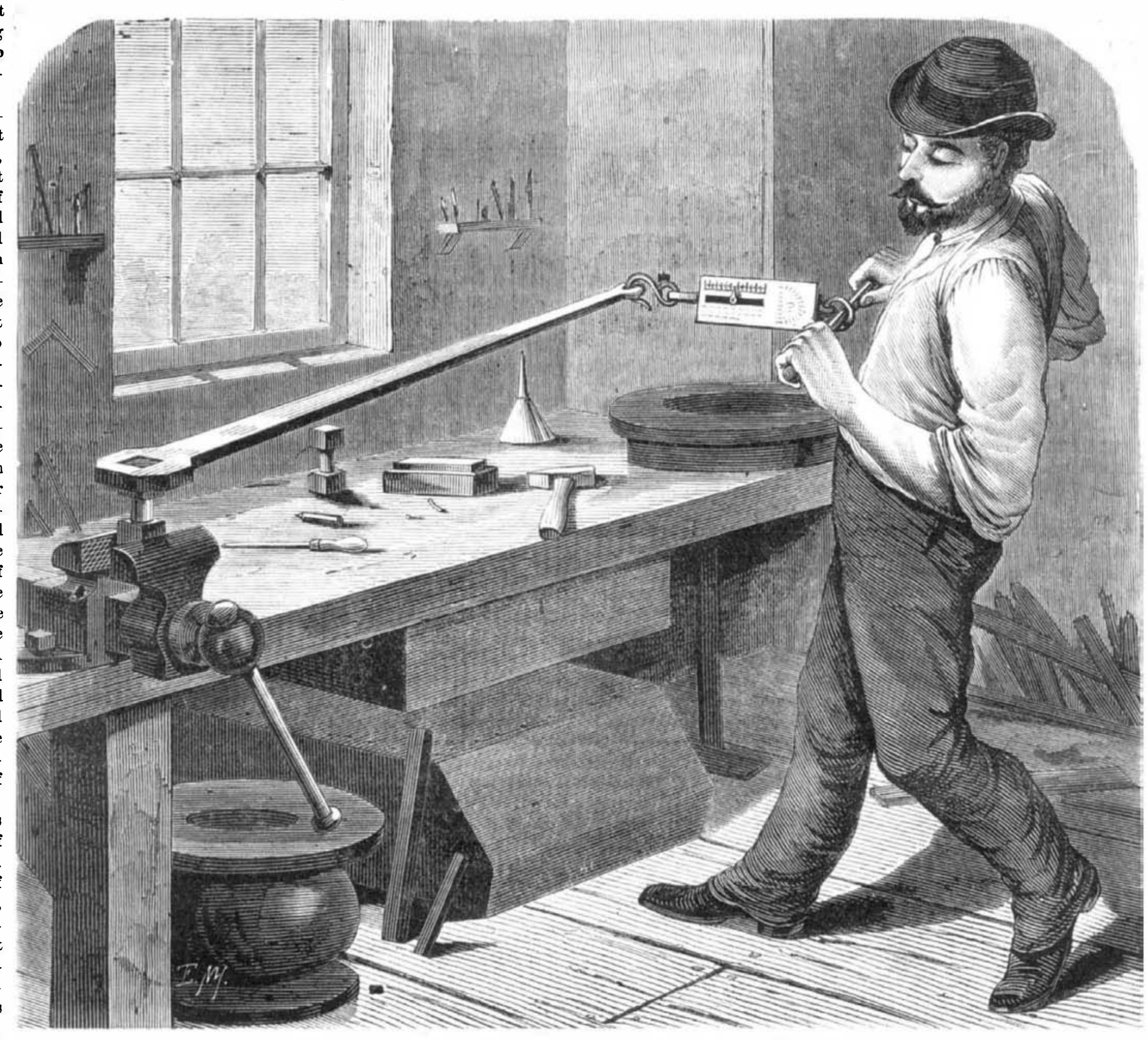
TESTING THE QUALITY OF IRON, STEEL, AND OTHER METALS, WITHOUT SPECIAL APPARATUS.

BY PROFESSOR THURSTON.

1. During the research which has occupied a considerable portion of the time of the writer recently, and to which reference has been made in the earlier numbers of the SCIENTIFIC AMERICAN, some very interesting facts have been observed; and much has been learned respecting the strength, stiffness, elasticity, ductility, and resilience of the metals used in engineering, which could only have been accurately obtained by means of apparatus capable of recording both the amount of distortion of the test piece and the coincident distorting force, at every instant during the experiment, up to the point of rupture.

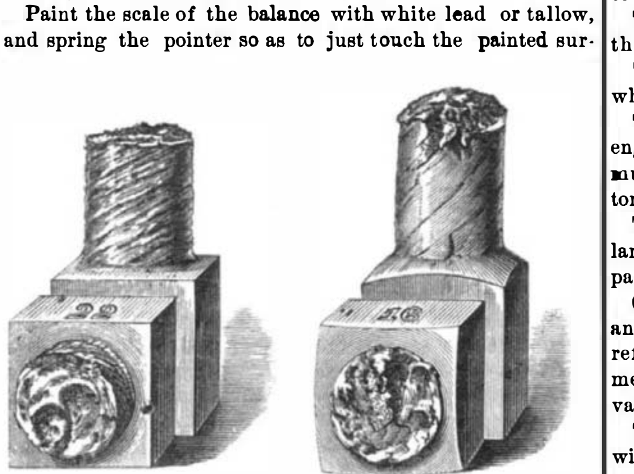


MACHINE FOR TESTING THE STRENGTH OF IRON.

2. Among these developments, and not the least important, has been the fact that the quality of any given material can be determined with some approach to accuracy, by adopting the *method* here in use, but without necessarily going to the expense of purchasing the powerful machines in general use for determining tensile strength, or even paying the two or three hundred dollars which is charged at the shops of the Stevens Institute of Technology for the recording machine with which these tests were made. A strong long handled wrench, a good spring balance, and a firm but delicate hand, afford all necessary means of procuring quite satisfactory results, as to mere strength of material; while a careful inspection of the fractured pieces, after a little experience, will assist greatly in the determination of the general characteristics of the metal.

3. The method of procedure is neatly illustrated in the large engraving, and would, in general, be as follows: Cut, from the bar or mass to be tested, pieces about three and a half or four inches long, and turn them off in the middle to a diameter of half an inch for iron or brass, and three eighths if of steel; make this neck one inch long. A square head is left at each end. Secure the piece vertically and firmly, by one end, in a strong vise; fit a solid ended wrench to the other end of the test piece; and to the extremity of the handle, which should be, for convenience, about five feet long, attach a spring balance capable of recording with accuracy up to fifty or sixty pounds.

Paint the scale of the balance with white lead or tallow, and spring the pointer so as to just touch the painted surface. The mark traced by the pointer then indicates the maximum force applied.



4. Commence pulling steadily on the balance, keeping the direction of pull at right angles to the wrench handle.

An apparently unyielding resistance will be felt up to a certain point, when the test piece will commence observably to give way. Note the indication of the spring balance at this point, which is the *limit of elasticity*, and record both that reading and, if possible, the distance through which the piece has twisted, the latter measure being an indication of its stiffness.

Continue twisting the piece until it has gone some distance beyond the limit of its elasticity, then stop and notice how far the arm springs back while gradually taking off the twisting force.

This distance is a measure of the *elasticity* of the metal, and is usually, if not invariably, the same, however great the set, even up to the point of rupture.

Renew the twisting force and break off the piece, noting the maximum angle which the piece has been twisted through and the maximum resistance, as indicated by the spring balance.

5. The *stiffness* of the metal is measured by the force required to twist it through the first small angle, say five degrees, should it yield so far without set. For half inch iron, this should be about fifty pounds on the end of a lever five feet long. For tool steel, it should be about thirty pounds, where the neck has a diameter of three eighths inch.

The *limit of elasticity* is determined by the force required to give it its earliest set.

The *degree of elasticity* is measured by the distance through which the wrench springs back when the force is removed after producing set.

The *ultimate tensile strength* is approximately proportioned to the force producing *rupture* by torsion.

The *limit of elasticity for tensile strength* is proportional to the force producing *set* by torsion.

The *ductility* of the metal is measured by the *angle* through which the piece twists before breaking.

The power of resisting shock, or *resilience*, as it is called by engineers, is nearly proportional to the product obtained by multiplying the breaking force by the maximum angle of torsion.

The *homogeneity* of the metal is determined by the regularity with which the resistance of the piece increases when passing its limit of elasticity.

6. By taking samples of well known brands of metals and pursuing this course, a standard is easily obtained, by reference to which a little practice will enable the experimenter to learn readily, and pretty accurately, the relative value of such other metals as he wishes to test.

7. Next, taking the fractured pieces, a careful inspection will assist wonderfully in pronouncing a correct judgment.

Thus, in our illustrations, No. 16 shows the side and the end of a fractured specimen of *wrought iron* of excellent quality, but seamy and not well worked.

The cracks extending around, in a spiral, through three fourths the circumference, and the appearance of irregularly distributed flaws on the end, prove the seamy character of the material, while the record of its test proves it tough, strong, and ductile.

Compare this with No. 22, which is the best piece of iron which could be found among a hundred tested specimens, and which is of almost wonderful toughness and ductility.

The surface of the neck, which, before being tested, was beautifully finished, has become greatly altered, and has assumed a curiously roughened and striated appearance. The spirals extend completely around the cylindrical portion, and the fractured end has the appearance peculiarly characteristic of very homogeneous and ductile metal. The record pencilled by the machine in this test shows it to have been fairly stiff, to have passed its limit of elasticity under a stress equivalent to about 30,000 pounds per square inch of tension, to have been more homogeneous than many specimens of shear or even than some cast steels, to have had a ductility exceeding that of any other specimen yet found of either iron or low steel, to have had a greater resilience, that is to say, power of resisting shock, than any other metal examined, and to have had an ultimate tensile strength of about 62,000 pounds per square inch.

This metal was made of selected scrap from refined charcoal iron, rolled into half inch bars, cut and *polished*, and rolled down to one inch square. Such care must evidently produce a splendid iron. Unfortunately, however, it costs sixteen cents per pound.

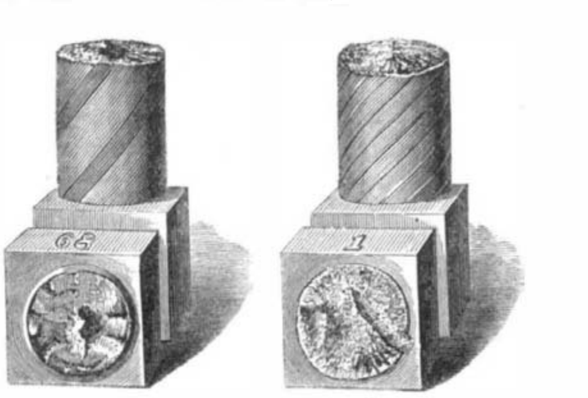
No. 1 is an iron of vastly different character. The record of the test shows it to be only a fairly good metal, and the end view exhibits a rough granular character of fracture, especially near the middle, and this proves its unreliability.

No. 23 is *cast iron* of a dark foundery grade, with a perceptible but slight ductility, and about half the strength of fair wrought iron.

The peculiar and almost mathematically regular form of the surface of rupture is noticeable in all irons of this class. No spiral markings are perceptible. The metal only yielded about ten degrees before fracture took place. Here the color and grain of the iron aid the judgment in forming correct conclusions after inspecting the record of test.

No. 30 is a hard white charcoal cast iron, such as is used for making "malleableized cast iron." It is a half stronger than the preceding, but is brittle, and has no ductility, snapping sharply at the limit of its elasticity.

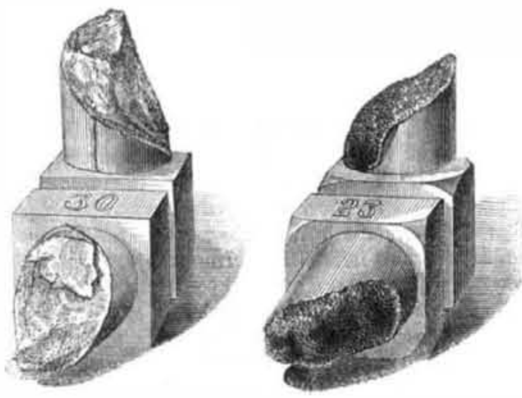
8. No. 35 is the same white cast iron *malleableized.* Its test indicates undiminished strength, combined with ductility exceeding, by several times, that of the toughest grades of cast iron, and even equaling some kinds of untempered steel. It is far less ductile, however, than wrought iron. The fracture exhibits its incomplete transformation, and the irregular distribution of the remaining carbon.



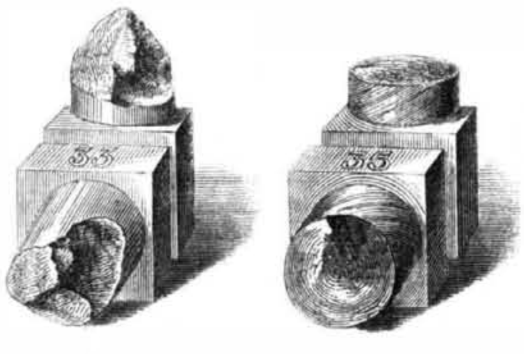
No. 35 is also a sample of similar character but much more thoroughly malleableized.

The test exhibits a strength equal to that of quite good wrought iron, and a toughness which is not very much less than that of some hard forged iron. The fracture indicates a very regular character, and freedom from defects, while the spiral markings prove its ductility. Such a metal as this is better for many purposes than much of the wrought iron in the market, and the cheapness with which awkward shapes can be made of it, as compared with forgings, give it special advantages in many cases where the pieces are small.

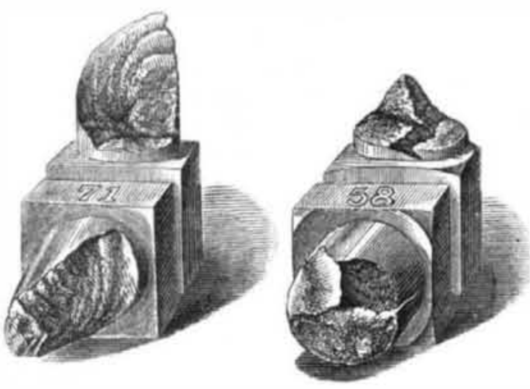
9. No. 68 is a specimen of low *steel*, and its peculiarities are those of "homogeneous" metal, or of steel made by either the Bessemer or the Siemens process. The test and an inspection of the fractured piece indicate its strength to be nearly double that of ordinary wrought iron, and prove its great ductility and resilience and its homogeneous character.



No. 71 is a piece of tool steel, having a strength twice as great as the best of iron, great elasticity, but a ductility only a fraction of that of good iron, excellent, in consequence of its strength and hardness, for tools and for resisting steady strain, but not so well adapted as steel of lower grade, or even as the better grades of iron, to meet shocks. Its jagged fracture and its fine even grain are evidence of the splendid quality of the metal and the perfect homogeneity of structure, which distinguish it from the fiberous wrought irons. The shear steels and the softer grades of tool steel usually exhibit an appearance very similar to 68, but are apt to crack along the side and through the neck, as is illustrated in No. 58.



10. Thus a little practice and careful observation will enable any good mechanic to test his materials even when he cannot afford to purchase a testing machine, and with a fair degree of confidence in the derived results, and at almost no expense.



A careful study of the accompanying illustrations, which the artist and engraver of the SCIENTIFIC AMERICAN have succeeded in making such perfect representations of the specimens placed before them, will assist greatly in the acquirement of this very valuable accomplishment.

Stevens Institute of Technology, Hoboken, N. J.
December, 1873.

The Vacuum Car Brake.

The vacuum car brake consists of a brass globe or bulb about fourteen inches long and five inches in sectional diameter in the largest part, and in shape very much like a lamp globe. The neck of the globe is about eight inches long. The enlargement is made to allow steam to surround a smaller pipe, which conducts the exhausted air. This part of the air pipe is about six inches long and two in diameter, reaching nearly to the neck of the bulb, leaving a space all around about one eighth of an inch wide; this tube is fitted tightly into the bottom of the globe so that none of the steam may escape below. To the lower part of this globe the air pipe is nicely fitted. In an enlargement of the end of this pipe, there is an air valve arranged to prevent the refilling the vacuum, and just below this is a relief valve to allow the air to enter. These valves are conical, so that the greater the pressure the more tightly they fit. Beneath each car, and connected with this apparatus by tubes, made so as not to collapse, is a cylinder with solid ends and flexible sides, which are kept from entirely collapsing by iron rings. The ends of this cylinder are connected with the brakes, so that, when the atmospheric pressure forces the ends together, the brakes are put on. The steam, being introduced from the boiler, passes out around the end of the air tube and removes the atmospheric pressures, producing a vacuum. By enlarging the cylinders beneath the cars, the power may be increased at pleasure.—*Polytechnic Bulletin.*

Ramming the Mold.

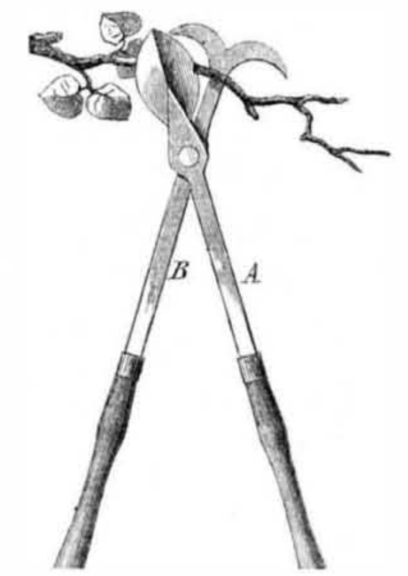
B. W. says: "In your number of November 22, 1873, you say that "ramming the mold is not a complicated performance, nor does it require the ability of a very skilled artisan." I have for many years been a close observer of losses in founderies, and I have found that about six tenths of the wastrels are on account of imperfect ramming, the latter being either too hard, causing the mold to blow and scale: or too soft, allowing it to strain as long as the metal retains its liquidity, and, when turned out, is too large to fit where it was intended. Hence the casting is condemned, in either case, on account of bad ramming. Any person posted in figures can calculate the pressure of fluids; but it requires the experience of years to know how much ramming is required to resist that pressure. He can only become skillful in the science of ramming by observing closely the result of every day's work, not only of his own, but of other molders also, so that he can ascertain the cause of any defect he may see on a casting, and thereby prevent the re-occurrence of the same. Ramming is a most complicated and important process; it amounts to but a very small portion of the cost of other work required to complete the job; but too hard, too soft, or irregular ramming, will cause all the work done on the job to be lost. The causes of the loss of the other four tenths are numerous, such as: Sand too wet, or too dry, inability of the molder to secure his mold before casting, lack of judgment in venting, lack of judgment in locating his gate to prevent warping and cracking in cooling, lack of judgment in stripping the casting so as to allow all parts of the casting to contract together, as that part of the casting that is allowed to contract last puts a great strain on a certain other part of the casting, and is likely to break it as soon as it is put to use. I hope the science of ramming will be further and more ably discussed in your valuable paper, and that you will be the means of getting molders to become more skillful with the ram, in which most valuable ability too many are lacking."

IMPROVED PRUNING SHEARS.

It is asserted that, to properly prune a tree, the limbs should be cut from the under side, and the blade should pass through them upon the outer side of the hook, resting upon the stump. In this way, horticulturists say, the end of the stump will not be splintered, and hence will be left in a better condition for rapid healing over.

Mr. Myron de Groodt, of Eaton, N. Y., has recently devised a pruning shears, acting on the above principle, by which the operator may cut off limbs upon opposite sides of the tree without shifting his position, on simply reversing the instrument.

The handle, A, connected with the blade, is grasped by the right hand, the handle, B, communicating with the anchor like hook with the left. In applying the shears, one of the arms of the hook is brought over the limb, and the handle, B, is held in a vertical position, while the other handle is elevated to open the jaws to a required distance. The blade then cuts through the limb from the under side and in an upward direction, with the hook bearing against the stump. To operate from the opposite side of the tree, it is only necessary to reverse the shears by simply moving the handles past each other without changing the hand, when the other edge of the blade acts with the hook precisely as before. In this way, the inventor says, a person may remain in one position and prune a tree nearly all around.



IMPROVED NUT LOCK.

The invention herewith illustrated is a new patent nut lock which, by the suitable combination with it of an elastic substance, is enabled to compensate for the longitudinal expansion and contraction of the bolt, thus preventing the nut from working loose under jars or shaking motions.

Our engravings represent two forms of the device as applied to railroad fish plates. In Figs. 1 and 2, which are perspective and sectional views between the two flanges, A A, is provided a chamber containing inside radial projections, B, which fit into corresponding notches in a washer, C. These notches and projections serve to lock together the nut so far as rotary motion is concerned, compelling the different portions to turn together. Into the chamber, between the flanges, A, are inserted a number of rubber balls, D, which are also received in suitable concavities in washer, C, Fig. 2. When the nut and washer are screwed together, it is evident that the balls are compressed and caused to spread until they fill nearly, if not entirely, the whole hollow space between the flanges, A. If the bolt becomes elongated by expansion, the balls take up the increase, through their own enlargement by elasticity, thus preventing the nut from working loose.

Fig. 3

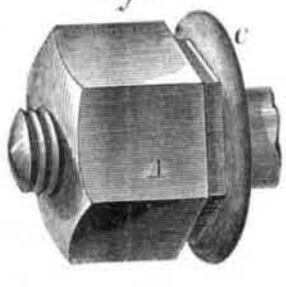


Fig. 1

Fig. 2

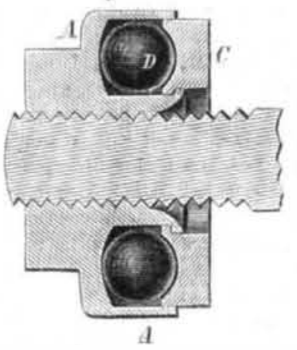
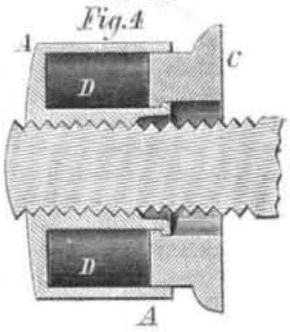


Fig. 4



In Figs. 3 and 4, small cylinders of rubber are substituted for the balls, D, and the washer enters directly between the flanges. The tubular end of the nut is upset on the hole of the washer, in order to prevent separation of parts. The device appears simple and practical, and doubtless will meet with extended application upon railroads.

Patented November 25, 1873, by Casper Dittman. For further particulars address Dittman & Landis, Leacock P.O., Lancaster county, Pa.

STARR'S COTTON BALE FASTENER.

We illustrate herewith a very simple and ingenious device designed as a clasp or fastener for the bands which surround cotton bales. The invention is simply a square buckle of iron, A, having at its outer end a rigid tongue, B. Both sides of the attachment are alike, so that, when the ends of the strap are brought together, the tongue of one buckle slips under that of the other, and interlocking takes place, as shown in Figs. 1 and 2. Figs. 3 and 4 are the same contrivance somewhat differently constructed, the tongue, B, being bent to form more of a hook. The device can be stamped or cut out of heavy sheet iron; and, if desired, a projection or stop may be combined with it to prevent the buckles slipping back after being once locked or hooked. The inventor states, however, that this latter precaution is entirely unnecessary, as a perfect double lock is afforded.

Fig. 1

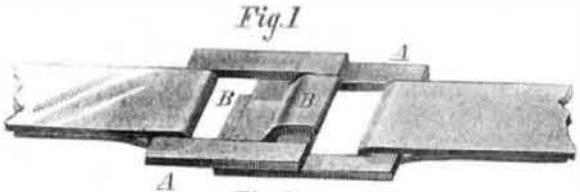


Fig. 2

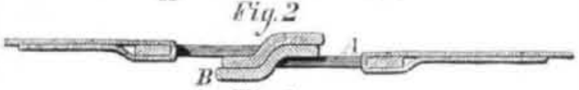


Fig. 3

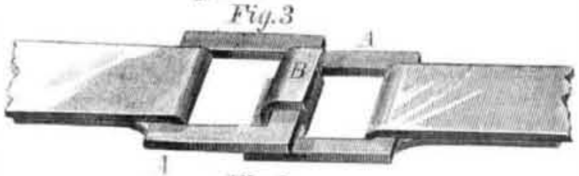
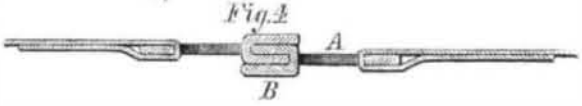


Fig. 4



The mode of operating is as follows: After the bale is in the box, duly pressed, etc., the band is put on the top, hanging over in front with one of the buckles attached, hook out. The band is then brought under the bale, through the channel made for the purpose, and thence up to meet the attached backle, when it is bent back on the inside. Over this bent end the second buckle is slipped, hook in. The two buckles are then brought together and locked as before described. The strap, it is stated, will not detach itself until the bale is put in the compress, when it can be easily manipulated.

For further particulars address the inventor, Mr. Henry D. Starr, Texana, Jackson county, Texas.

WOMEN DENTISTS IN EGYPT.—Dr. Edward Warren writes from Cairo, in Egypt, to a friend in Baltimore, that there is "a good opportunity for women dentists in Egypt, as the women are forbidden to consult with men." There are three or four English women practicing dentistry in Cairo already, according to Dr. Warren's letter. In all these eastern countries, there seems to be a wide field of usefulness and profit for woman doctors and dentists.