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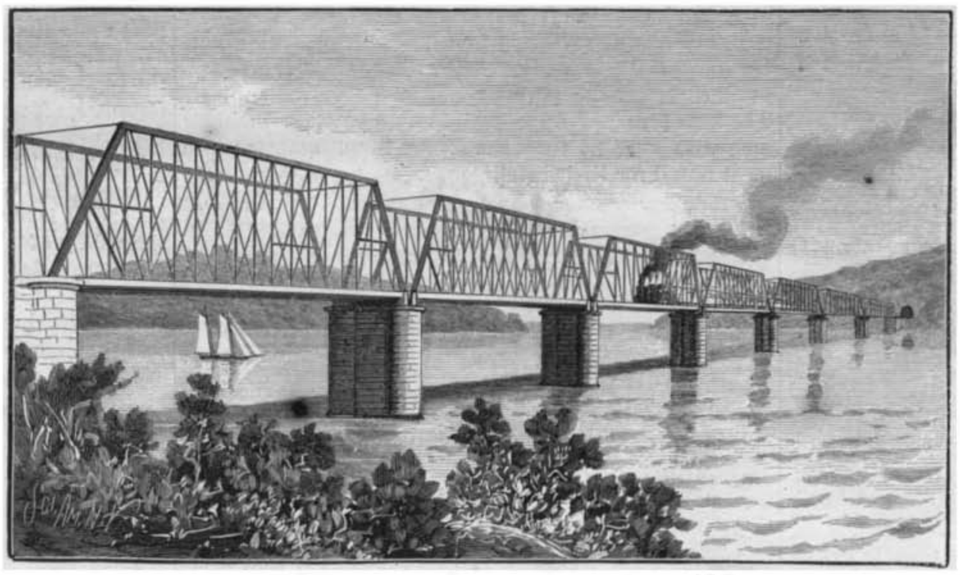
THE DEEPEST FOUNDATION IN THE WORLD.

In November, 1884, the Government of New South Wales, Australia, invited bridge builders throughout the world to send plans and tenders for building a double-track steel railway bridge across the Hawkesbury River, some thirty miles north of Sydney. This resulted in bids from firms in the United States, Canada, Belgium, France, England, Scotland, and Australia. The plans were referred to a commission of three eminent English engineers, who decided that although several of the plans for the superstructure were meritorious enough to warrant selection, the plans of the Union Bridge Company, of this city, for the foundations, were the only ones that could be recommended.



THE HAWKESBURY RIVER BRIDGE AUSTRALIA.

The bridge will have a total length of 2,896 feet, composed of five spans of 416 feet each between centers of piers, and two spans of 408 feet each. The width will be 28 feet between centers of trusses, the design of which is shown in the accompanying perspective view of the completed structure. All of the superstructure is to be of mild steel, having an ultimate tensile strength of not less than 67,000 pounds and not more than 73,920 pounds per square inch of section. One of the requisites is that when heated to a cherry red and cooled in water of 82°, the testpieces, cut either lengthwise or crosswise from the material, must bend double without flaw or crack to a curve having an inner radius of 1½ times the thickness of the plates.

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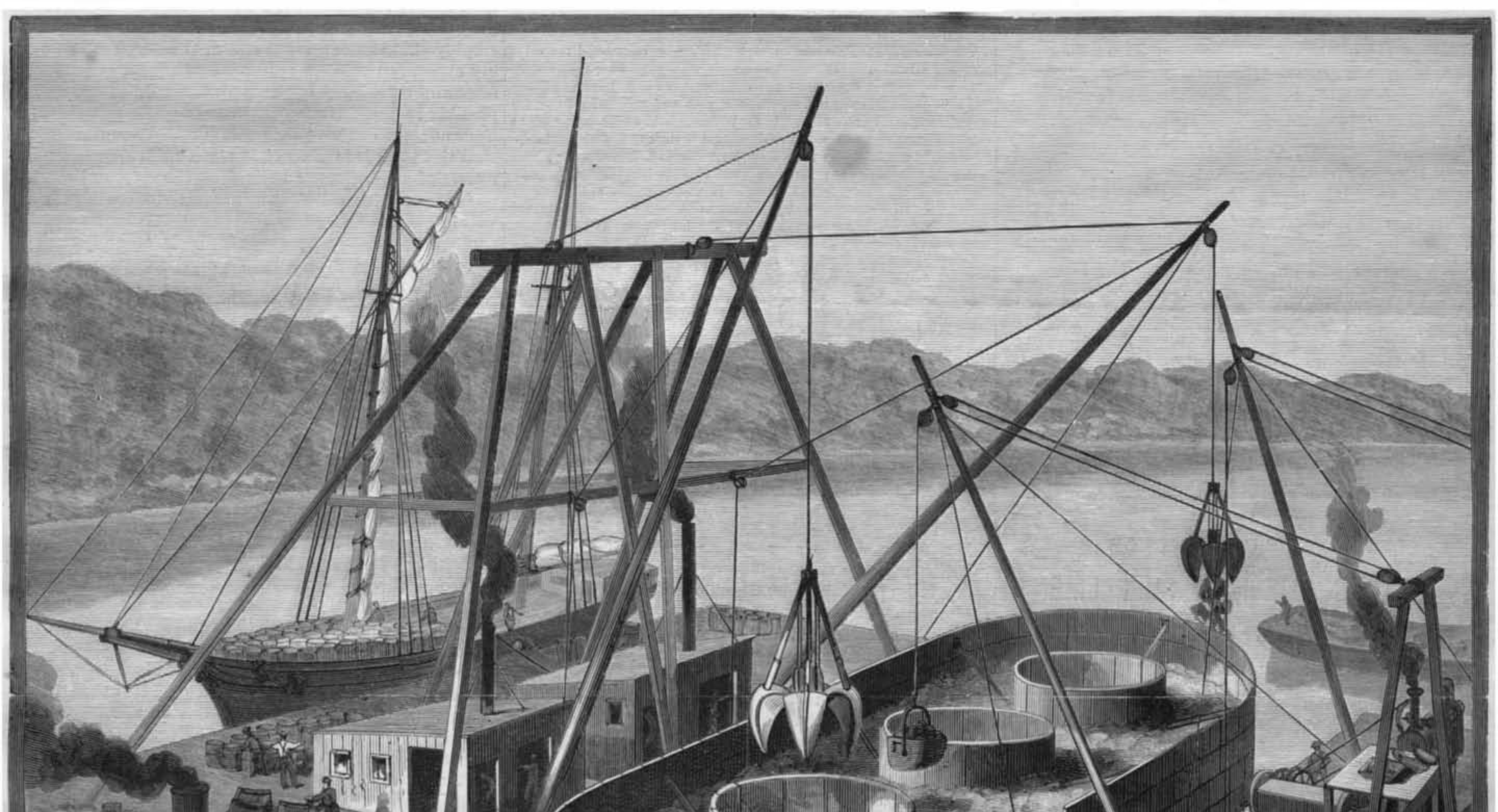


THE DEEPEST FOUNDATION IN THE WORLD.—SINKING THE PIERS FOR THE HAWKESBURY RIVER BRIDGE, NEW SOUTH WALES, AUSTRALIA.

The "Remington-Lee" Magazine Rifle.

Major Armstrong, late A. P. D., gave a description of this rifle at the English Royal United Service Institution, March 26. In the course of his remarks, he said that the best of soldiers are naturally inclined in the excitement of action to fire away their ammunition fast; and notwithstanding the strictest orders to keep the magazine in reserve, and use the arm as a single loader, until the occasion arose for a rapid and concentrated fire, the majority in any body of men would be pretty sure to draw on their magazines as long as there was a shot in the locker. An officer then could not possibly know whether his men really had magazine arms in their hands or not, unless he examined each arm separately, emptying from it and replacing all the cartridges.

Several attempts have been made to adopt a repeating or "quick firing" attachment to the ordinary breech loader, so as to convert it for the moment into a repeater, but they all leave much to be desired as regards strength, handiness, sightliness, quickness of action, and, above all, rapidity of adjustment and replacement; with none of them can the result be considered really a magazine rifle. "It is," said the lecturer, "in this direction that inquiry and experiment are naturally tending more and more, and I think there can be little doubt the arm of the future will be the best single loader obtainable, plus a good attachable magazine system. I think you will find that practically that ideal has been attained, as regards the latter half at any rate, in the 'Remington-Lee' rifle, invented and patented by Mr. Lee, and made by Messrs. E. Remington & Sons, of New York.

"It is at this moment a simple breech loading rifle, with bolt action differing little from other bolt systems except that it is simpler and stronger than most. This particular model is of 0·45 caliber, rifled with five grooves, taking a complete turn in 20 inches; weight about 9 pounds; and takes the United States Service cartridge of 70 grains of powder with a bullet of 405 grains, giving an initial velocity of about 1,350 feet per second. And the action is particularly quick and easy. The details given can, of course, be varied to any extent desired in the manufacture; the important feature is the independent magazine system. The arm can be used indefinitely in its present form as a single loader, until the necessity arises for the quickest and most concentrated fire obtainable, when it is converted in a moment, at the word of command, into an almost inexhaustible repeater of the most rapid action.

"Any desired quantity of reserve ammunition can be served out in the magazines, each containing five cartridges in no greater space than if they were in the ordinary paper packages. They are made of sheet steel in one piece, with a simple spring to propel and a 'carrier' to guide the cartridges—three pieces in all. They are specially contrived to combine the maximum of strength and efficiency with the minimum of cost, though, if retained, they can be recharged and used hundreds of times. The cartridges are stowed away in them in a moment, and yet are so firmly held that it is scarcely possible to displace them unintentionally, even with the roughest treatment; while the empty magazine is removed and replaced by a full one in less time than is required to insert a single cartridge in the ordinary single loader. This quickness of adjustment is a very important feature, for though the capacity of each magazine is small, it it so easily and speedily replaced that the magazine system is practically inexhaustible, being really limited only by the carrying power of the soldier.

"The rifle has been fired from the shoulder, as a repeater, fifty times in one minute, during an official trial in America, a rate much beyond that of any other magazine arm. The magazine in use offers no inconvenient projection nor unsightly feature, while its weight is so disposed that the center of gravity of the rifle is never disturbed, the balance of the arm remaining therefore always the same; and the cartridges lie always side by side in the magazine, where they are really better protected from all possibility of accident than they could be anywhere else. It is evident that the officer can see at a glance, even from a considerable distance, whether the arm is being used as a single loader in obedience to orders, or if any of his men has brought his magazines into play before the word of command. The charged magazines, moreover, would be carried apart from the loose ammunition until required, in separate pouches, so that to make use of them would involve a distinct and explicit drill motion."

WALLS laid up of good, hard-burned bricks, in mortar composed of good lime and sharp sand, will resist a pressure of 150 pounds per square inch, or 216,000 pounds per square foot, at which figures it would require 1,600 feet high of 12 inch wall to crush the bottom courses, allowing 135 pounds as the weight of each cubic foot. Walls laid up in same quality of brick and mortar, with one-third Portland cement added, will resist 2,500 pounds per square inch, or 360,000 pounds per square foot, which would require a height of wall of 2,700 feet to crush the bottom bricks.

THE DEEPEST FOUNDATION IN THE WORLD.

(Continued from first page.)

The location of the bridge is one that demanded extraordinary work, not in regard to the superstructure, but in relation to the foundations for the piers. The bed of the river is made up of mud and soft sand, hard gravel being reached at a depth of 185 feet below high water, and as the rails are to be 42 feet above high water the total height from the bottom of the piers to the rails will be 227 feet. Sinking piers to such a great depth has never been attempted, even in this age of wonderful engineering, and on this account principally the methods to be pursued have attracted much attention both in this country and Europe. The following description of how the work is to be done will, therefore, prove to be of interest.

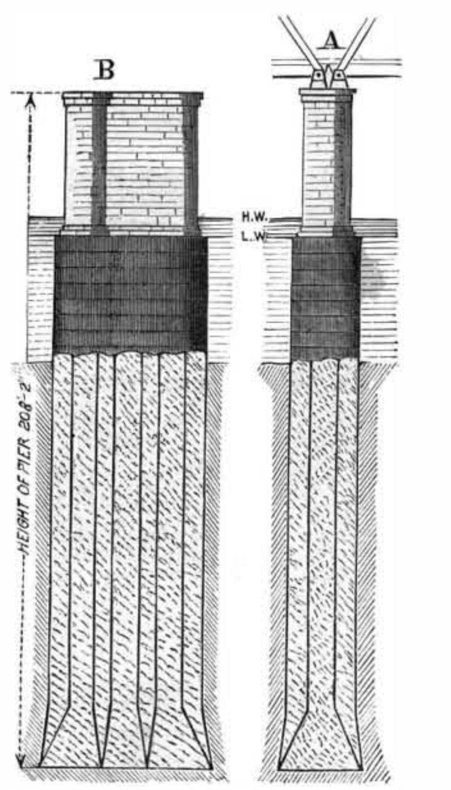


Fig. 3.—SECTIONAL ELEVATION OF PIER.

Like most of the methods of American engineers when called upon to perform an unprecedented work of great difficulty, the chief characteristic of these plans, as now contemplated, is simplicity. The principle governing this undertaking can be readily illustrated by any one. Take two pasteboard tubes, one about one-half the diameter of the other, and arrange them concentrically with the lower edge of the small one a short distance above the lower edge of the large one, and then join the lower edges of both tubes with a piece of pasteboard. This will form a thick cylinder, having a central opening, flaring at the bottom. If this be inserted, flaring end down, in a bucket filled two-thirds with sand and full of water, it will be found to be next to impossible to push the cylinder to the bottom of the bucket; but if the annular space between the two tubes be filled with sand, and then the sand be scooped out from the inside of the little tube, the cylinder will gradually sink to the bottom of its own accord. This is precisely what will be done in sinking the foundations for the Australian bridge, and what was done in sinking the foundations, to a depth of 125 feet, of the Atchafalaya bridge on the Texas and Pacific Railroad, three years ago.

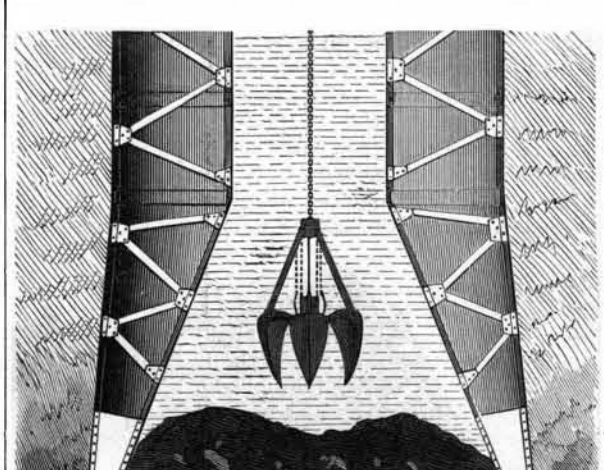


Fig. 4.—ENLARGED VIEW OF BOTTOM OF PIER.

The outer tube in this instance is oblong in plan, being 20 feet wide by 48 feet long. It is made of boiler plate, three-eighths of an inch thick, and the edges of the several sections are brought together and riveted to a T-bar placed upon the interior, thus making the exterior perfectly smooth and free from offsets. At a point 20 feet from the bottom the tube begins to flare, and the lower edge is 2 feet larger all around than the upper portion. Upon the outside of the bottom is secured a steel plate or cutting shoe, 1 inch thick, 2 feet deep, and projecting 6 inches below the edge of the tube; the lower edge of the shoe is sharpened. Within the outer tube are placed, at equal distances apart, three cylinders or dredging tubes, 8 feet in diameter, made of one-quarter inch iron, and united in the same manner as the outer one. The lower part of these tubes is extended to meet the cutting edge, and the inner and outer tubes are rigidly united by a system of bracing, as shown in Fig. 4, which also represents the bucket to be used. The space between these tubes will be filled as the cylinder sinks with concrete mixed in the following proportion: 1 Portland cement, 2 sand, 3 gravel, and 4 broken stone. After the cylinder has reached a solid resting place, the three inner dredging tubes will also be filled with cement, thus making a pier of solid cement from the bottom to the water level. From low water up, the piers will be of cut stone masonry.

In the sectional elevation, Fig. 3, A is a view at right angles and B a view parallel with the axis of the bridge.

Mixing cement will be done by machinery placed upon a float anchored alongside of the pier. The mixer consists of a square box 16 feet long, provided at each end with an outer ring or collar, which rests upon rollers. A toothed wheel at the outer end meshes with a pinion driven by an engine. The revolution of this box thoroughly mixes the sand and cement, which are introduced through a curved chute leading from a hopper on a platform just above the box. The requisite quantity of water is admitted at the same time. The mixed cement falls from the outer end into buckets, which are carried by cranes where needed on the pier and dumped.

Upon the opposite side of the pier is moored a large float carrying two sets of hoisting machinery. The booms are so arranged that either dredge can be worked in the center or one of the end dredging tubes. Thus, by making one dredge take two loads from its own end tube and one from the middle tube, the amount of material excavated from each of the three tubes can be equalized.

During the sinking of the piers, it is not expected to encounter any formidable obstruction such as a large rock. Trunks of trees may be met, but their presence would not hinder the work in the least, since the great weight of the pier would force the cutting edge of the shoe through them. Tree trunks were met during the building of the Atchafalaya bridge, and in one case where the weight was insufficient to force the shoe through, that part of the log projecting into the tube was grappled and the log broken, when the pier was sunk without further trouble.

The contract price of the bridge is £327,000. The contract for sinking the piers has been let to Messrs. Anderson & Barr, of this city, who superintended the erection of the Atchafalaya bridge.

A Shetland Tirl.

A Dumfermline tourist, who visited Shetland last year, says the *Miller*, of London, England, has given a graphic description in one of the local papers of what he saw in the course of his tour. One of the things which came under his notice was one of the primitive grinding mills called the "tirl" mills of Shetland. He had seen numbers of these in a half ruinous condition in the more northern parts of the mainland, indicating that they were being superseded by some superior system. These "tirl" mills are very low erections, generally built in the side of a brea, down which a stream from some hidden hill loch finds its way. By a simple sluicing apparatus the stream is turned when wanted to run under the floor of the mill in a steep, sloping artificial channel. In this channel is placed an upright circular shaped piece of wood, having an iron spindle in the center. The lower end of the spindle is fixed in the channel, while the upper end finds its way through the floor of the mill and is attached by a cross piece to the upper millstone. The circular shaped piece of wood is fitted with six projecting boards, against which the water strikes as it rushes down its prepared course, and so sets the upper stone in motion. Through an opening in the center of this stone the corn is fed in by hand, and the meal, as it is ground, percolates from between the stones, and falls on a clean clay or boarded portion of the floor, from whence it is gathered. The stones are about thirty inches in diameter and from three to five inches thick. Grinding mills of a more modern type are now, however, established in several districts among the islands, and gradually the "tirl" is being replaced by the superior article. Still the "tirl," and even the quera, driven by hand, are found in use in various parts of both Shetland and Orkney.

How Magenta is Made.

The London *Chemical Review* translates from Dingler's *Polytechnisches Journal* an article by P. Schoop on the arsenical process of manufacturing magenta, containing facts all the more interesting here, now that Americans are embarking in the anilin industry.

The melting pot used is of cast iron, 1·35 meters in diameter and 1 meter in height, set over a suitable furnace. The lid can be lifted, if need be, and pushed out of the way by means of a pulley and crane. The stirring apparatus is kept in action during the entire time of heating. A small aperture serves for taking out samples of the melt. The charge consists of:

Arsenic acid, 194° Tw	75 kilos.
Arsenic acid, 194° Tw. recovered, same sp. gr. as above.	300 "
Anilin for red	300 "
Liquid which has distilled over in former operations...	200 "

The firing up is so managed that the distillation begins in about seven hours, and that then 10 liters pass over every hour. After the lapse of twenty hours the heat is increased so that 20 liters may pass over hourly. When 400 liters have been distilled off, the melt will already have become thick, whereupon the fire is slackened. As soon as the contents of the pot become pasty they are scooped out, and the melt when cold is broken.

The distillate is mixed in a parting funnel with about 100 kilos salt, upon which the oil speedily separates. The salt solution is diazotized, precipitated with a solution of naphthol, and worked up into naphthol orange. More advantageously it is converted into saffranin.

The melt is ground up, wet to a fine, thin paste, in lots of 100 kilos, and passed through a filter press. The filtrate is evaporated in an iron steam pan for the recovery of the arsenic acid, while the press cake is again stirred up with lukewarm water and filtered once more. The filtrate from this serves for grinding up the next melt. The crude melt, after washing, is a yellowish-green powder, which is twice lixiviated in a suitable extraction kettle with boiling water. About a tenth part of the melt is treated in this kettle with 3,600 liters water and steam at a pressure of 1·5 to 2 atmospheres. After four hours the whole is passed through a filter press, and the residue again treated in a second kettle with 3,600 liters water in the same manner. This second decoction is run into the first kettle, which has in the mean time been charged again. The remainder, after this double extraction, forms one part of the poisonous, useless residues. The color decoction of one lot, after standing for half an hour and depositing certain impurities, is mixed hot with 200 kilos rock salt, whereupon, after heating, the muriate of the color separates out almost completely. In the liquid drawn off after standing for two days a little more color is thrown down by the occasional addition of a little milk of lime, and is worked up separately. The remaining lyes, containing much arsenic, are precipitated with lime, and this precipitate forms the second portion of the poisonous residue.

The precipitated crude magenta is purified by a systematic fractional precipitation. The crude magenta, forming one-fifth of the melt, is dissolved in a wooden cask in 1,000 liters water, boiling up by means of steam, and 40 liters of a 4 per cent solution of soda are gradually added. A greenish or golden resin separates out on the sides and on the surface. The liquid is then passed through a coarse filter into a wooden vat, and mixed with two liters muriatic acid to prevent the separation of chrysanilin and delay the crystallization of the magenta. Upon the liquid is laid a lid with wooden rods, which, as well as the sides and bottom, are in two days found covered with fine crystals. The mother-liquor is run off, the crystals are dried in the air and afterward in a drying room at 104° F. The yield is 20 kilos of crystals, while about 4 kilos magenta remain in the mother-liquor and 15 to 16 kilos resin are separated out. From the mother-liquor the color is precipitated by soda lye, and about 40 kilos of it are dissolved in muriatic acid. Here we proceed as in the purification of the crude magenta, about one-third of the coloring matter being separated out as a resin, and crystals of magenta being obtained on cooling. In this mother-liquor there remains very much chrysanilin. By precipitating with soda, and evaporating the colored mass with acetic acid, cinnamon brown is obtained.

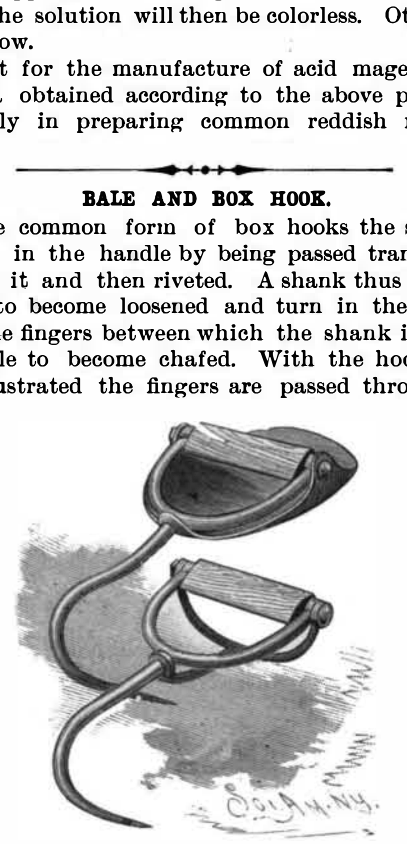
The resin which separated on purifying the crude magenta (resin No. 1) is dissolved in muriatic acid. On boiling the said liquor a resin separates out, consisting chiefly of mauvanilin, an almost worthless substance. By soda a portion of magenta is again separated, and on cooling the filtrate a little more is obtained. The lye, after the separation of this portion of magenta, is mixed with resin No. 1. Resin No. 2, obtained by purifying resin No. 1, is again dissolved in muriatic acid and boiled, when some more mauvanilin is deposited and is removed. From the hot solution salt precipitates cerise. After filtration the color is washed, neutralized with muriatic acid, and evaporated down in iron pans heated by steam, yielding thus the cerise of commerce. In the filtrate from the precipitate of cerise, the magenta remaining in solution is precipitated with soda, and the base mixed with resin No. 2, whereupon a further purification of the lye-products is undertaken, yielding grenadin and maroon.

To test the magenta for the presence of chrysanilin, muriatic acid is added to the hot solution in water, and zinc powder is added in small portions until the red color disappears. If the magenta was free from chrysanilin, the solution will then be colorless. Otherwise, it is yellow.

Except for the manufacture of acid magenta, the magenta obtained according to the above process is used only in preparing common reddish rosanilin blues.

BALE AND BOX HOOK.

In the common form of box hooks the shank is fastened in the handle by being passed transversely through it and then riveted. A shank thus fastened is apt to become loosened and turn in the handle, while the fingers between which the shank is passed are liable to become chafed. With the hook herewith illustrated the fingers are passed through the



THE SAN JOSE BALE AND BOX HOOK.

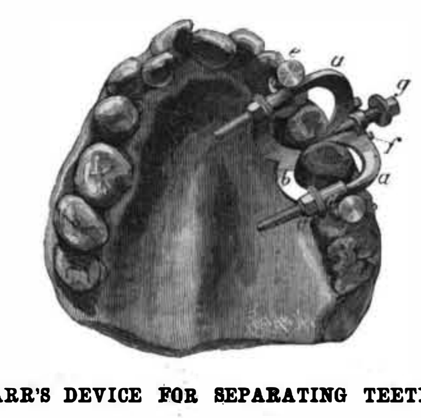
opening formed by the handle and the prongs of a fork formed on the upper end of the shank; the turning of the hook is prevented, and there is no wear between the fingers. To prevent the chafing of the outer sides of the fingers by their coming in contact with the box or bale, there is provided a leather guard, as shown in the upper view, or a metal frame, as shown in the lower view. The handle is slightly extended toward the front, thereby allowing a firmer grasp to be taken of it and a more easy and accurate guiding of the hook.

This invention has been patented by Mr. Philip J. Stockinger, of San Jose, Cal. These hooks can be seen at the San Jose Agricultural Works.

DEVICE FOR SEPARATING TEETH.

The separator of teeth invented by Dr. H. A. Parr, of New York city, is a continuous circular wedge, so constructed that teeth can be separated in a few minutes, with little pain, in most cases without any. When the arch is crowded, or the teeth are irregular, cavities form between them, by pressure and unnatural contact, and cannot be filled without separation; and when the position of the teeth is mechanically changed, absorption takes place when the pressure is either on the anterior or posterior surface, while a process of ossific deposit takes place in the space from which the tooth is moved.

In the system followed at present, the teeth are wedged apart by the aid of wood, cotton, rubber, or



PARR'S DEVICE FOR SEPARATING TEETH.

some such material, and often remain separated a number of days, causing pain to the patient and unnecessary labor to the operator. Frequently, the teeth have to be trained back to their former position. During the separation the ossific deposit formed has to be displaced, which in some cases it is difficult to do, and not unfrequently the teeth operated on remain separated for life. The herein described instrument was invented by Dr. Parr to do away with these difficulties.

The device may be adjusted to the centrals, bicuspids, and molars, and is particularly adapted for irregular teeth.

b represents an angular bar, tapered to a point, and terminating at each end in the sockets, *d*, through which pass the two semicircular bars, *a a*, the inner ends of which are tapered to a point and meet at an acute angle directly opposite to the angle of the bar, *b*. *a* and *b* may be brought together by turning the nuts, *c c*, which can be done with the fingers or with a wrench. In case the teeth have not been sufficiently separated by turning the nuts, *c c*, additional pressure may be brought to bear by means of the wedge, *g*, which may be used on the buccal or lingual surface. The vertical screws, *e e*, are for adjusting the instrument upon the teeth so as to prevent undue pressure upon the gums.

Rectangular Proportion.

W. Barnes.—Oblong rectangles are the forms of manifold planes in buildings and house gear—doors, windows, room sides, room floors, tables, boxes, bookcases, books, and pictures; and therefore it is worth while to learn whether there is a more or less comely form of rectangles, or of their outer frames. Of the square, which is a shapefast figure, and which, with the circle and equilateral triangle, makes a harmonic triad, there is no need that I should now discourse; but to many other cases of rectangular forms I think harmonic proportion may yield good effect. I like the effect which it has afforded in the framings of pictures. In the framing of a picture we have often found a third harmonic term to its length and breadth, and have then taken the whole, or a half, or a quarter of that third quantity for the width of the frame. On the taking of a half, the sum of the widths of the two sides, or two ends, makes up the third term of the triad, and on the taking of the quarter the third is found in the sum of the widths of the four frame sides.

If we would frame harmonically a print or drawing with a margin within the frame, we may get the width of both its frame and margin from a third harmonic dimension to the length and breadth of it, and then divide this third dimension into two parts, which shall be the latter two terms of a harmonic triad, of which the first is the whole dimension; and a square picture may be framed in harmony by taking for the harmonic triad (1) the width of the picture and two breadths of the frame; (2) the width of the picture; and (3) the twofold width of the frame.

I think that door frames, shutter frames, and the mantelings or frames of fireplaces may be often fitted for the better to the spaces they bound by harmonic proportions of widths; and though the lettering pieces of bound books are often set on their backs without symmetry either of width or place with the height of the book, yet, if the back of a book were divided into six spaces, and the lettering piece should take up the third from the top, it would be in harmony with the book's height both in place and measure, since the six spaces of the whole back and the three below and the two above the lettering piece would make a harmonic triad. So, again, I have reason to think well of the elevation of a church of which the heights of the tower, of the nave, and of the chancel are a harmonic triad, while another is made by the ground widths of the nave, of the chancel, and of the tower. It might be worth while also to try whether a steeple would not be graceful if, at three harmonic spaces of height, it diminished by a harmonic triad of widths, or whether a spiral line or a stream or path made to wind through a lawn would not be of graceful bends if at three harmonic spaces it went off from its axis by the measures of a harmonic triad of ordinates.—*The Architect.*

Expansion Produced by Amalgamation.

It has been accidentally observed by the authors that the amalgamation of brass is accompanied by great expansive force. If the edge of a straight, thick brass bar be amalgamated, it will be found that in a short time the bar is curved, the amalgamated edge being always convex, and the opposite concave. The authors imagine that a similar action may be the primary cause of the phenomena presented by the Japanese "magic mirrors." Japanese mirrors are made of bronze, and have a pattern cast upon the back, and although to the eye no trace of it can be discovered upon the polished reflecting surface, yet, when light is reflected by certain of these mirrors on to a screen, the pattern is distinctly visible in the luminous patch formed. In a paper before the Royal Society, they have shown that this is due to the polished side opposite the thinner parts of the coating being more convex than the others, a conclusion verified by the fact that the pattern is reversed when formed by a convergent beam of light. Such a condition of things would evidently result from a uniform expansive stress taking place over the reflecting surface, the thinner—and, consequently, the weaker—parts becoming more convex or less concave than the others. The authors have hitherto attributed this inequality of curvature to a mechanical distortion to which the mirrors are intentionally submitted during manufacture, to produce the general convexity of the polished surface; but they now think it possible that the use of a mercury amalgam in the process of polishing may have an effect in the production of this inequality of curvature.—*Profs. W. E. Ayrton and John Perry.*