placing a thin piece of metal or other material, between the cone and the follower, and screwing the nut up until the follower comes to a bearing upon the recess and edge of the rings; this answers all practical purposes, and is some cheaper. The conical plug is solid, and is fitted to the valve spindle and also into a ring which is made conical upon its inside periphery; outside of this ring are placed two rings, alike, but reversed; they are recessed on their outside edges to give a bearing for the followers; the outside ring is made a little wider than the port, otherwise it might spring out and catch when passing it; its edges are slightly bevelled, being a little wider upon its interior periphery to allow the two-joint breaking rings to grasp and retain it. The action of the arrangement is this:—By screwing up the set screws or nut, the solid conical plug is driven into its surrounding conical ring, which, being cut, is expanded, and through it the surrounding rings are also expanded, at the same time the distances from the center of the valve to any point or points of its exterior periphery are all equal, or the outside of the valve is true to the center, and the valve has all the advantages of a solid block, without the disadvantage of being obliged to insert new valves when they begin to leak.

These valves have been in successful use for the last four years, and the inventor has yet to hear of a case where they have not accomplished their object thoroughly. There are great numbers of vessels now running about, and from our harbors, which are wasting money for their owners almost as fast as they can earn it, and to all who own such vessels, the inventors wishes to say if they will call upon him he will satisfactorily demonstrate that they are wasting money, and will show them what he has done and can do to save it for them. Address Thomas S. Davis, Jersey City Locomotive Works.

Correspondence

Award of Premiums at the American Institute Fair.

Messrs. Editors:—When we put our machinery on exhibition at the late Fair of the American Institute, and thereby contributed a share to make it interesting, we did it in the simple belief that, according to the programme by which they solicited our contribution, entire impartiality would be shown in the distribution of prizes; and that, as they explicitly stated, no premiums would be given, directly or indirectly, to any member of the Board of Managers of the Fair, or any Committee or officer of the Institute. It has, therefore, surprised us not a little to find that, in direct contradiction to their public announcement, two of the managers have received—if not directly, at least indirectly—the first premiums, that on steam pumps was awarded to the Woodward Steam-pump Company, of which, we suppose, Mr. Geo. M. Woodward is the principal; and on oscillating engines to Messrs. Wm. D. Andrews & Bro., whose superintendent or partner is Mr. David G. Starkey, who, together with Mr. Woodward, was a prominent member of the machinery department.

You, Messrs. Editors, as impartial judges, must acknowledge with us that this thing looks dubious, to say the least, and ought to be inquired into, in order that exhibitors, and the public in general, may know in the future how much value they can attach to the judgment of the American Institute, which they pretend to express through their premiums and awards.

A. & F. Brown & Co.

Progress Machine Works, New York, Oct. 25, 1865.

The Way to Zinc Cast Iron.

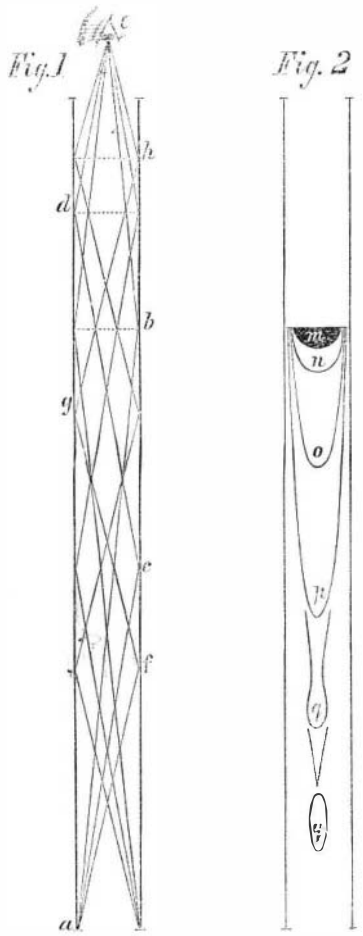
Messrs. Editors:—For the information of E. D., and others, I place at your disposal some experiments made by myself in galvanizing small cast-iron articles, such as gears and other small parts of machinery. I heated the castings to be galvanized to a red heat; I then plunged them into a bath of clear muriatic acid, to detach the scales and to thoroughly clean them; they are then immersed in a bath of melted zinc. As soon as the iron has attained the melting heat of the zinc they are removed. In this way I have made some beautiful galvanized castings. Great care should be taken, or in plunging the articles into the zinc, while wet, the zinc will be thrown in the face of the operator. The zinc should be covered with sand, and the casting must be immersed very slowly.

E. H. Hill.

Worcester, Mass., Oct. 14, 1865.

Straightening Gun Barrels Illustrated.

Messrs. Editors:—In your issue of 9th Sept. last, a correspondent asks for a statement of "the theory of the process of straightening gun barrels by looking through them at the light." The process referred to is, no doubt, that which is called by the workmen "straightening by the shade." This art is based upon a beautiful group of scientific facts or principles, and is, therefore, one of much scientific interest. It is also an art of great practical value, because it affords the means of straightening the barrels of fire-arms with a far greater degree of precision than is attainable, or even approachable, by any other process. The theory of the art, if I mistake not, is little understood even by those who practice it successfully; and, so far as I know, it has never been satisfactorily set forth, and explained in any work. I therefore offer, for the Scientific American, a brief exposition of the process, and of the scientific principles involved in it.



When the eye looks into a gun barrel, as shown at *e*, Fig. 1, the interior surface appears to be spread out into a plain circular disk, as far from the eye as the other end of the barrel. Through the center of this disk is a circular orifice, and surrounding this, at equal distances from it and from each other, respectively, are four or more well-defined concentric circles, dividing the disk into as many bright concentric rings, each of an apparent breadth, precisely equal to the diameter of the central orifice. The central orifice is the other end of the caliber as seen by direct vision. The several concentric circles are so many images of the end of the caliber reflected to the eye from different points along its length. The first of these circles, or that nearest the central orifice, is an image formed by light once reflected. The second, third, fourth, fifth, etc., respectively, are images formed by light reflected twice, three times, four times, five times, etc. In order to see how these images are formed, and to find their respective loci in the caliber, consider that a ray of light from each point in the end of the caliber, as *a*, may pass to some point, *b*, on the other side of the caliber, and be thence reflected to the eye, thus forming, at *b*, an image of the end of the caliber by one reflection. Another ray from the same point may pursue the route, *a c d e*, forming an image at *d*, by two reflections. Another ray may take the route, *a f g h e*, forming an image, at *h*, by three reflections—and so on for the other images. Now, since, in the formation of each of these images, respectively, the angles of incidence and reflection are equal, it follows that the locus of the image, *b*, formed by one reflection of light, is at one-third of the distance from the eye to the further end of the caliber; that formed by two reflections, *d*, is at one-fifth; that by three reflections at one-seventh, and the succeeding ones one-ninth, one-eleventh, etc., of the same distance.

Hence we see that all three images are located within the third part of the length of the caliber nearest to the eye. Consequently there are two-thirds of the entire length of the caliber in which none of these images appear. It is to this part of the caliber only that the workman directs his attention, for it is here only that he can cause the "shade" to appear which discloses the crooks in the caliber, if any exist. When this part is straightened he inverts the barrel and works from the other end.

When we would examine a plain mirror for the purpose of ascertaining whether its reflecting surface is a true plane, we cause objects to be reflected from it to the eye at small angles of incidence. If, under these circumstances, every part of the mirror gives an image true to nature, we pronounce it perfect; for the slightest deviation from a true plane, would cause a manifest distortion of the image. In the process of straightening gun barrels by the shade, crooks in the caliber are detected upon the same principle. The internal surface of the barrel is a mirror, and whatever objects are reflected to the eye from that portion of it that lies beyond *b*, will be reflected under very small angles of incidence. It is not a *plain* mirror, to be sure, and therefore the reflected image will not be true to nature. But if the caliber be straight, the image will have no other than that normal distortion which is due to the transverse or cylindrical curvature of the mirror; while, if there be longitudinal flexures also, there will be an abnormal distortion of the image which will reveal the defect.

Having thus presented the theory of the process in a general form, we will look for a moment at its practical application.

The workman fastens a piece of board horizontally across a window at a distance of 10 or 12 feet from his working stand point, the lower edge of the board being straight and six or eight feet above the floor. This we will call the shade board. He fastens another strip of board to an upright post or other object near his stand point, having, in its upper edge a notch in which he may rest one end of the barrel while he looks into the other. He places one end of the barrel on the rest and directs it at the window a few inches below the shade board; then looking into the caliber, and directing his eye to the lower side of it and to the point just beyond the image, *b*, he gradually depresses the end which he holds in his hand, bringing the direction nearer and nearer to the shade board. Soon he sees a dark shade, as shown at *m*, Fig. 2. This is the reflected image of the shade board; the curved part of its outline being the image of the straight edge of the board. As he depresses the end more and more the shade lengthens to *n o p*, etc. If the caliber be perfectly straight, the shade will always maintain a true and symmetrical parabolic form, growing more and more pointed at its apex, until it reaches the further end of the caliber. But if there be the slightest flexure in the caliber, the barabolic figure of the shade will be distorted. As soon as the workman discovers a distortion of the figure, he slowly revolves the barrel about its axis with his fingers, at the same time alternately elevating and depressing it slightly, until the shade assumes a form in which the two sides near the apex are equally drawn in toward each other, as shown at *q*; (or if the crook be considerable, the two sides may be drawn quite together, cutting off a portion of the shade at the apex, as at *r*). He now knows not only that there is a crook at *q*, but also that the caliber is concave downward at that point. If he is an experienced workman he will be able to judge correctly how far that point is from his eye; and he will reach

his hand forward, and put his finger on the under side of the barrel at the precise spot where pressure or a blow must be applied to correct the defect.

B.

New Haven, April 18, 1865.

Zincing Cast Iron.

MESSRS. EDITORS:—A correspondent of the SCIENTIFIC AMERICAN states a difficulty in galvanizing cast iron, and at the same time exhibits his process.

The use of chloride of zinc as a flux in covering cast iron with zinc will surely defeat him as often as he tries it, for it is decomposed by a heat considerably less than the melting point of zinc. But for tinning, at a heat of about 450°, it may be used with great advantage in combination with sal ammoniac (chloride of ammonium). Thus, to a saturated solution of chloride of zinc, add to saturation sal ammoniac—decant it clear; and I would recommend the addition of an equal bulk of distilled or rain water with this compound, clean, or sometimes—with tact—dirty metal will become tinned without friction, except iron and steel.

These latter metals being perfectly clean, may sometimes be tinned with the aid of this double chloride without friction, but always with, preferably, a brass wire or brush.

I suspect that the lack of success of your correspondent is due to a failure in presenting the iron to the zinc chemically and perfectly clean. The dilute sulphuric acid should be thoroughly washed off in hot water, so that, as well as being clean, the cast iron will be instantly dry, and the whole process should be finished at once. There are, however, various means of preventing the oxydation of the metal for a short time, if necessary, with which he is doubtless acquainted.

R. H. A.

Baltimore, Md., Oct. 16, 1865.

An Acknowledgment.

MESSRS. MUNN & Co.:—Your letter, together with my French patent for knitting machines, is received. Allow me to return you thanks for the very satisfactory manner in which you have thus far conducted my business. I have received my patent from the United States Patent Office for setting up apparatus for knitting machines, granted Sept. 12th, and have read notice of allowance of my other case, in two weeks time, making two American and one French patent received through your hands during this month—the three aggregating the large number of thirty-five claims.

You have already successfully conducted my business in every case entrusted to you, having secured for me five separate patents. You have three more cases for the United States belonging to me yet in your hands, and I anticipate sending three or four more to you during the year. You have, in short, given most *perfect* satisfaction in every case, for which you have my hearty appreciation,

I. W. LAMB,

Office of I. W. Lamb's Knitting Machine, Rochester, N. Y., Sept. 26, 1865.

[Mr. Lamb has patented in this country and some foreign countries several valuable improvements in knitting machinery.—EDS.

The Most Reasonable Explanation of the Razor Question.

MESSRS. EDITORS:—Having observed in your valuable paper the controversy as to whether a razor cuts better when hot, I will give you my reasons, aside from my experience, for believing it does. I cannot agree with the gentleman that the expansion of the razor by heat would contract its teeth, but believe they must be affected the same as the razor. The reason of its cutting better when hot is from the dissolving or softening power of the heat that it gives off to the beard when the hot edge of the razor comes in contact with it in the drawing cut; hair being of the same nature as horn is effected by heat in the same manner—heat softens it. When boiling hot it may be cut as easily as cheese; when cold it is very hard. Yet in this state, I believe a tool heated to a degree that would still preserve its temper would cut much better than a cold one. I have used them without temper. A given degree of heat would cause a tool to melt its way through a piece of horn. A hot knife will readily sink of its own weight into a lump of hard butter, which, when cold, it would have made no impression on.

RICHARD LEWIS.

Williamsburgh, N. Y., Oct. 17, 1865.

The Teeth of Wheels.

MESSRS. EDITORS:—The pitch of a gear is the distance between the centers of two adjacent teeth, measured in a straight line; and these centers are all situated in an imaginary circle, called the "pitch circle." In treating of gears, it is customary to consider the pitch as an arc of this circle instead of a straight line or chord, and the rules usually given for proportioning the number of teeth, and the diameter of the pitch circle, are based upon this assumption. When the number of teeth in the gear is large, or where the gears to be matched are of the same size, or nearly so, these rules are sufficiently accurate for practice, but every mechanic who has had occasion to make gears of differing sizes mesh together, particularly if of coarse pitch, has found that teeth determined by circular pitch will not run properly, and he has been compelled in such cases to find the true diameter by a series of trials. The less the number of teeth in a gear, the greater the disparity between the true and the circular pitch. If there are but three teeth, to take an extreme case for an example, the variation amounts to over twenty per cent of the true pitch.

For some time past I have used the following formulæ for determining the diameter of the pitch circle—the true pitch being given, and *vice versa*, and find them simple and convenient:—If n represent the number of teeth; p the pitch, and D, the diameter of the pitch circle, then

$$\frac{p}{\text{nat. sin } (180 \div n)^\circ} = D \quad \text{and,}$$

$$\text{nat. sin. } (180 \div n)^\circ \times D = p.$$

Or, in the form of rules:—

Divide the given pitch in inches by the natural sine of one-half the angle subtended by a tooth and space, and the result will be the diameter of the pitch circle in inches.

And—

Multiply the natural sine of one-half the angle subtended by a tooth and space, by the diameter in inches, and the product will be the true pitch.

With a table of natural sines at hand, these rules will be found to be of ready application, and gears proportioned by them will run properly in all cases.

It will be observed that the diameters of two gears having the same pitch are not in the exact proportion of the number of teeth, as is generally taught. For example, take two gears, of $2\frac{1}{2}$-inch pitch, one with twelve, and the other with ninety teeth, their pitch diameters, as determined by the above rule, are respectively 9·66 and 71·64 inches, being in the proportion of one to 7·416, while the proportion of the number of teeth is as one is to 7·5. Consequently the formula,

$$n \times p \times .32 = D$$

given by Haswell is incorrect, as it ignores that fact. In the case of the two above-mentioned gears, Haswell's formula makes the lesser one $\frac{1}{10}$ths of an inch too small, and the larger $\frac{3}{5}$ths of an inch too large.

G. H. BABCOCK.

Providence, R. I., Oct. 8, 1865.

FOREIGN SUMMARY.

HISTORY OF COKE.—The following advertisement given in "Notes and Queries," fixing the period when coke first came into public use in this country, will no doubt be acceptable to any future historian of our coal trade:—"There is a sort of fewel made by charking or calcining Newcastle coals which burns without smoak, without fouling the furniture; and altogether as sweet, and is much more lasting and profitable than wood or charcoal; it kindles suddenly, and is useful either for chambers, roasting of meat, drying of malt or hops, woolcombing, distilling, preserving, or any such like employment. His highness the Lord Protector, with the advice of his Council, have encouraged and authorised the making thereof in order to the preservation of the woods of the nation. If any shall desire to make tryal of it for any of the use aforesaid, which will cost little or nothing the experiment, they may repair to London at Northumberland Wharff, near Chearing Cross; and according to the satisfaction they receive therein, they may be supplied from time to time with what quantity they shall have occasion to use. Those that have made tryal of it, finde it very profitable to all those uses abovementioned. It is also very useful for the tobacco pipe burners."—*Public Intelligencer*, No. 139, from Monday, August 16, to Monday, August 23, 1658, p. 764. This advertisement appears also in the succeeding number for August 30, but apparently not in any of the previous numbers.—*London Artizan.*

IMPROVING CITIES.—A paper on "improvements applicable to the City of London and other large towns to improve health and preserve life," by Mr. G B. Galloway, was read at the recent meeting of the British Association, in which it was suggested that the Corporation of London or a joint-stock company should purchase all bad-house property and rebuild the houses on an improved plan, a part of which would be the placing of iron bridges across the streets at intervals from one house to another as a means of avoiding crossings. Further facilities for crossing the Thames, and extra footways on the outside of the bridges, were suggested. As regards the purifying of the air of the streets, it was advised that at every window in every house and in every open space plants and flowers should be grown.

THE water pipes in several parts of Paris are being replaced by tubes of a larger caliber. This operation is being performed at present on the Pont au Change and the Pont St. Michel. These tubes are placed either under flags or under paving stones covered with cement. All along the Boulevard du Palais the water pipes are placed in the sewers. When the subterranean canalization of Paris is completed, the sewers will inclose not only the water and gas pipes, but likewise the electric wires by which the telegraph offices communicate with each other.

AT a recent meeting of the Horological Institute, Lord Caithness in effect declared that the art of clock making was going out of England. Statistics prove that France and America are doing for us the work which we should do and profit by at home. From Switzerland especially the importation of watches, from France of Ormolu clocks, and from America brazen clocks, has, of late years, enormously increased, and this cannot be without its effect upon our artisan classes.—*London Artizan.*

TRACTION CARRIAGE.—The specification of Messrs. Bernier & Godard Desmarest's invention describes a steam carriage, in which the motive power, instead of being imparted to wheels, is transmitted by cranks to a set of legs, having an alternating or rising and falling motion, and bearing at the down stroke against the ground, rail, or surface to be traveled over, so that they propel the carriage in a manner somewhat similar to the action of the legs of a horse. An arrangement of rods, working in slotted brackets, and actuated in levers, is also described for bringing the legs in and out of action.

PROF. WHEATSTONE ascertained that the duration of the electric spark does not exceed the twenty-five thousandth part of a second. A cannon ball would appear stationary in its flight if illuminated by the spark, and the wings of an insect that move ten thousand times a second would seem at rest.

ACCORDING to Prof. Bottger, the mixture of cotton with linen may be detected by unraveling a piece of the tissue, both warp and weft, and plunging it into a solution of aniline and fuchsine. It should be taken out, washed, and, while moist, dipped in ammonia. The cotton threads will then lose their color, while the linen will remain red.

DR. SJOGREEN, a Swedish naturalist, states that the particles of pure iron found in the Swedish lakes result from the deoxydizing action of certain insects. Their larvæ absorb oxygen from the oxide of iron and form a cocoon of pure metal.

THE presence of a one hundred thousandth part of phosphorus may be detected in a body by Mitscherlich's process; and Dr. Herapath has found it perfectly possible to discover the ten-thousandth part of a grain of strychnia in solutions.

FROM analyses of cows' milk it has been discovered that the quantity of butter present in the evening milk is more than double that of the morning. The quantity of sugar of milk is greatest at mid-day, and decreases towards evening. The albumen, caseine, etc., remain almost constant.