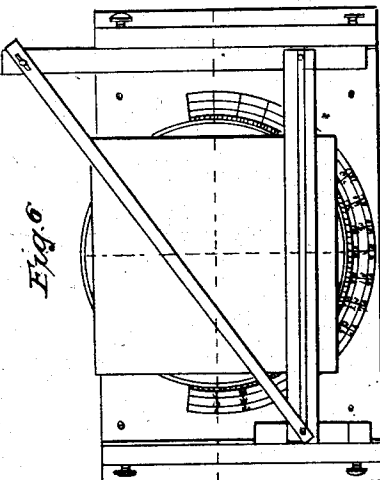
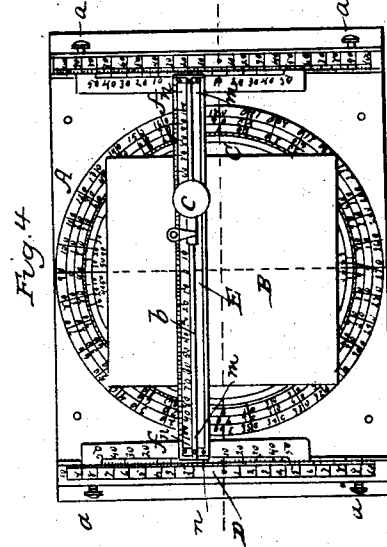
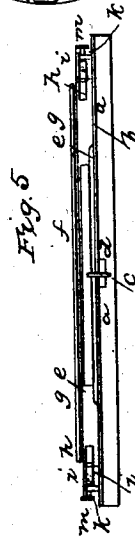
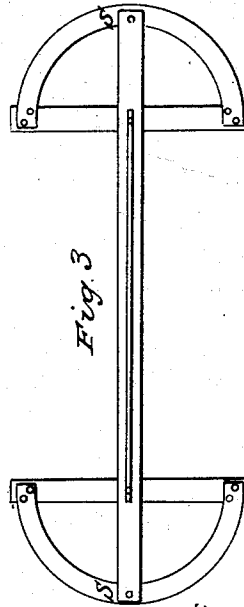
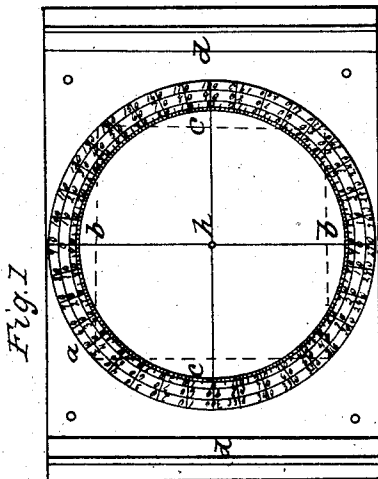
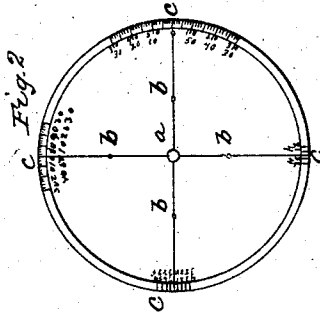
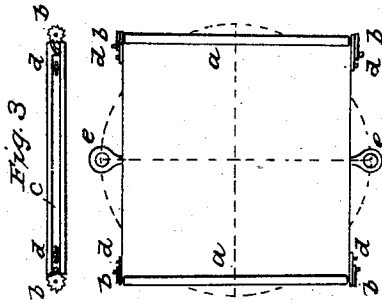


W. T. STEIGER.
Drafting Protractors.

No. 907.

Patented Sept. 7, 1838.



UNITED STATES PATENT OFFICE.

WM. T. STEIGER, OF WASHINGTON, DISTRICT OF COLUMBIA.

PROTRACTING-TABLE.

Specification of Letters Patent No. 907, dated September 7, 1838.

To all whom it may concern:

Be it known that I, WILLIAM T. STEIGER, of the city of Washington, in the District of Columbia, have invented a new and useful Improvement in an Instrument denominated a "Protracting-Table" for use of engineers, surveyors, navigators, &c., and the following is a full and exact description of the construction and operation of the said table as invented or improved by me.

The instrument consists of three principal parts, to wit; the protractor, the drafting-board and the parallel, the construction of which severally and of their appendages I shall describe in the order enumerated.

The protractor.—Having constructed a substantial square table of well seasoned pine, mahogany or other wood and of dimensions proportionable to the size of the largest drafting board which it is designed to employ; I secure to the top thereof by screws, a plate of brass, steel, iron or other metal; the Russia sheet iron now in common use, if of good quality I have found to answer the purpose very well, as also sheet zinc after being polished either of which may be employed when it is an object to save expense, or when heavy brass or copper plates cannot be conveniently procured. This plate might cover the entire top of the table, or at least so much of the same as will be necessary to contain the circle of the protractor to be drawn upon it, as hereafter described. At or near the center of the plate, pierced with a round hole for the purpose, I fix permanently a small cylindrical pin of hard metal, so as to project perpendicularly half an inch, more or less, above the surface of the plate, either by forcing or screwing it into the table, or by any other convenient means, so as to keep it firm in place and perpendicular to the surface of the plate. Since this pin constitutes the foundation of the whole instrument, and on it depends the accuracy of all its future operations, particular pains should be taken to insure its permanency of position and, it should be turned in a lathe to a true cylindrical form, of a diameter reduced as far as it may be considered safe to risk its being bent by the slight lateral strain of the drafting board, during the revolutions of the latter. The better to secure these objects, the pin might be made to pass through a double or treble thickness of the plate, by counter-sinking suitable pieces of the same material

into the top of the table and securing them by screws previous to attaching the plate, or a solid block of metal might be employed for the purpose. The pin being thus prepared and secured in its place, the circle of the protractor is next laid off upon the plate from the pin as a center, making the inner circle, of a diameter one inch, more or less, greater, than that of the largest drafting-board to be employed; I have found a thin strip of hard wood or of metal with a hole at one end fitting the pin closely and proper gage points of well tempered steel, fixed in the outer extremity, to be the most convenient, if not the only instrument for performing this operation, in such a manner that the axis of the cylindrical pin shall be, mathematically and accurately, a true center to every part of the arch, also the etching process in ordinary use may be employed with advantage.

After all the circles of the protractor are drawn, the inner one must be graduated into arches of ten degrees each, these into degrees, and the latter, into halves, quarters, eighths, &c., or the subdivisions thereof extended as far as the scale of the instrument will admit of their being made with the most perfect accuracy; the graduations are then numbered in the ordinary way, by a single, double, or treble series of numbers, taking care that those two diameters of the circle, which pass through the four cardinal points of the protractor shall be parallel, or nearly so, to the sides and ends of the table also if but one series of numbers are employed the numbers go for convenience in handling the instrument ought to stand next the front and back edges of the table.

The drafting-board.—The drafting-board is made square in the ordinary way with clamped ends to prevent warping, or it may be made of the boards glued together, so that the grain of the one shall run transverse to the grain of the other. Its bearing, to which, provided the intention is to apply only one board, it may be permanently attached by screws from the underside, but if more than one, then short steady-pins, projecting from the upper surface may be employed, for the convenience of being able to detach the board with facility, is a disk or circular plate of metal of the diameter of the inner or graduated circle of the protractor, with an aperture at its center, in which the center pin fits neatly so as to permit the

plate to revolve freely upon it but no lateral motion, the circumference is beveled to a fine edge so that when applied it will exactly coincide with the inner circle of the protractor, and the four cardinal points or quadrants of the latter are carefully transferred thereto, which if accurately done, the plate becomes a revolving instrument, by which the correctness of every division in the protractor arch may be tested and should there be an error, however small, it cannot escape detection, moreover this investigation by the aid of proper glasses, may be carried to any degree of accuracy required. I have found it convenient in practice that the graduations of the protractor arch, and of this plate should be made simultaneously, as by this course the operator is enabled to correct any errors in the points first ascertained, before the lines are permanently drawn through them. At each of the four points thus made in the circumference of the revolving plate, a separate nonius arch may be laid off, or a nonius arch may be made, the fourth part of which shall be at each point and by these means the smallest divisions on the protractor arch, may be subdivided to any desired extent.

The parallel.—The blade is made of a thin broad plate of metal, somewhat longer than the diagonal of the drafting-board, so as to remove the ends or side pieces thereof, out of the circle described by the angles of the board; a straight square strip of wood or metal which extends from one end of the blade to the other, is firmly attached by three or more screws to its upper side at the center line, for the double purpose of stiffening the blade, and serving as a rest for the hand of the operator, for which latter object an elastic or hair cushion made upon a block of wood with a groove on its under side that fits the above named strip, is provided, by which the operator is enabled to shift the position of his hand resting on the cushion to any point of the blade, without raising it and without the assistance of the other hand; the block is also prolonged on the left side of the cushion, and a strap of metal attached to its upper surface, by a central screw, with a circular opening at the outer extremity to receive a magnifying glass of any power, the length of the strap being such as to place the center of the glass perpendicularly over the edge of the blade, by the aid of which the operator is enabled to see, without difficulty the finest point that can possibly be made upon the paper and at the same time the most minute division of the scale which he may employ; for the purpose of making the points a fine piece of wire with a needle's point, is permanently fastened to the outer extremity of the strap and descends toward the edge of the blade first obliquely, then for a short distance perpendicularly, until the

point arrives nearly in contact with the surface of the drafting board, and the point on the paper is made by simply pressing with the finger on the outer end of the strap, while the eye is directed through the glass at the division of the scale. In operations of extreme delicacy, a wire with a blunt point may also be attached, to the strap and descending parallel to that first mentioned, may be made to operate as a stop or gage, subject to perfect regulation, so as to produce punctures of uniform size and of any required degree of fineness. The edges of the blade, after being wrought perfectly straight and exactly parallel with each other, should be beveled on their upper side to a fine but not a cutting edge. The ends of the parallel consist of two strong metallic plates of, from one to two inches, or more broad, and in length equal to the side of the largest drafting board employed; these are attached to two strips of hard wood, half an inch thick of the same length, so that one edge after having been wrought perfectly straight, may project beyond the wood from one eighth to a quarter of an inch, which projections form the bearings of the parallel, upon the guide strips hereafter mentioned, or the ends may be made entirely of metal with a proper rabbet or shoulder for the purpose last mentioned. The blade and the end pieces when connected form nearly a letter H, the extremities of the former being attached to the centers of the latter, by screens which pass through the square strip already described as a part of the blade, and which acting as centers, admit of a slight angular motion in the end pieces; also two slots are cut at each end of the blade, near its opposite edges, through which four screws are inserted that take into the plates of the end pieces, and being supplied with washers, serve, when forced tight, to hold the ends immovable. The object of this kind of connection is, to render the end pieces, susceptible of exact regulation, as regards the parallelism of their outer edges with each other, or their rectangular position to the edges of the blades. The parallel which is carried over the drafting-board, so as to command every part of it, by a rectalinear sliding motion, has its bearings on two transverse guide pieces of sufficient length supported and regulated as follows: First, two strips of hard wood of the same length as the guide strips and half the thickness of the drafting-board, are secured transversely to the top of the table, at equal distances on each side of the circle of the protractor, the distance between the strips, corresponding to the length of the parallel, to their outer edges are fastened edge-strips, also made of hard wood, each pair forming a rabbet, to receive the guide strips, these last are likewise made of hard wood of about the same breadth as the

end pieces of the parallel and half the thickness of the drafting board, to their upper sides, plates similar to those on the end pieces are secured in such a manner, that the inner edges of the plates (those next the protractor) having been first made perfectly straight and true, shall recede from the inner edges of the wooden strips a distance nearly equal to the projection of the plates of the end pieces heretofore described, by which arrangement the metallic edges alone of the guides and end pieces come into contact and operate against each other; also the plates are made broad enough to project over the outer edges of the strips, so as to cover the tops of the edge pieces, which serves to steady the guide pieces and at the same time gives a better finish to the instrument; the inner edges of the plates are graduated into inches, and tenths, twentieths, or thirtieths, &c., or which I prefer one of them into fifteenths and the other into twentieths, and for subdividing these a set of nonius divisions may be made on the plates of the end pieces of the parallel, the division and numbering of the former to be commenced at those points of the plates, which are opposite to the cardinal diameter of the protractor and extended both ways, and those of the latter to commence in a line with either edge of the parallel. For the correct adjustment of the guide pieces, two regulating screws pass through each edge-piece, a short distance from the ends thereof, which take into the guide strips, and being provided with appropriate stops or checks, either end of the guide piece or both, may be drawn back or advanced at pleasure, by which means their parallelism with the transverse cardinal diameter of the protractor, and with each other, may be regulated with unerring accuracy.

Although I have described the guide strips as being made partly of wood they may be made wholly of metal, by introducing such alterations in their dimensions, &c., as will suggest themselves to any skilful workman. Also in the description of the drafting board, I have omitted to mention the application at the ends thereof, of two rollers with ratchet wheels, for the purpose of attaching the paper by which a long sheet may be passed over the board and the protraction made thereon by sections, and likewise the stationary magnifying glasses of any power, which may be attached to the center of the ends of the board and to the extremities of the blade of the parallel, so as to command the graduations of the protractor arch, and of the side scales in every position of the instrument. Moreover in the description of the parallel I have omitted to mention that its edges may be graduated or movable scales attached thereto, nor have I described other modes of construction which

I may employ, to wit, by making it in three pieces arranged in the form of two sides and the diagonal of a square and confined together by a single screw at each angle, one end of the diagonal side, having a slot and washer by which to adjust the right angle when applied to the guide strip or by attaching the blade of the parallel to two straps acting on centers near the back edge of the table and operating precisely on the principle of an ordinary parallel ruler. The protracting arch may likewise, instead of a complete circle be a semicircle. All these I consider mere variations dependent on and inseparable from the principles of my invention, and have therefore in the description confined myself to the requisitions of the patent law by describing those forms only which I prefer.

In order to elucidate the foregoing description of the instrument and the better to comprehend its operation and uses I have hereunto annexed drawings thereof, in detail which I shall now explain.

Figure 1, represents the top of the table, *a, a*, the circles of the protractor; *b, b*, the transverse, and *c, c*, the longitudinal diameter; *p*, the center pin. *d, d*, are the strips which form the rabbet or bed for the guide strips.

Fig. 2, represents the circular bearing of the drafting-board, *a*, the aperture at its center; *b, b, b, b*, the steady pins; *c, c, c, c*, the nonius arches.

Fig. 3, represents the top and edge views of the drafting-board, *a, a*, rollers at the ends to which the paper is attached, *b, b*, ratchet wheels and pawls; *c*, one of the metallic straps which connect the rollers; *d, d*, regulating screws; *e, e*, magnifying glasses.

Fig. 4, is a top view of the table and its parts united, *A*, is the protractor; *B*, the drafting-board, *C* its circular bearing, *D, D*, the guide strips and graduations, *a, a, a, a*, regulating screws; *E*, is the blade of the parallel, *b*, the center strip, *c*, the movable rest or cushions and magnifying glass, *f, f*, end pieces and graduations, *m, m*, center screws, *n, n, n, n*, regulating screws.

Fig. 5, represents a vertical longitudinal section of the table through the center pin; *a*, is the top of the table; *b*, the protractor plate; *c*, the center pin; *d*, the block of metal which receives it; *e*, bearing of the drafting board; *f*, the drafting board; *g*, the blade of the parallel and center strip; *h, h*, end pieces and top plates, showing their projections and bearings; *i, i*, the guide strips and top plates; *k, k*, edge strips, *l, l*, bed pieces of the guide strips; *m, m*, regulating screws.

Fig. 6, represents a table with a semicircular protractor and a parallel in the form of a right-angled triangle.

Fig. 7, represents another mode of regu-

lating the parallel by semicircular arches and the screws, S, S.

Operation.

5 The first operation is to adjust the instrument which is done as follows: Turn the indices of the drafting board to the cardinal points of the protractor and carry the edge of the parallel toward the center of the board taking care to keep one end piece, say the right hand, pressed against the corresponding guide; then having made two fine points at the edge of the parallel near the right and left hand margins of the board, reverse the board, that is, revolve it through a semicircle, and the edge of the blade being brought to one of these points if it be parallel to the cardinal diameter of the protractor, will likewise coincide with the other point, but if not, then measure the included angle on the arch of the protractor, and having bisected said angle by revolving the board, make two new points, these last when the indices of the board are again brought to the cardinal points of the protractor will be in a line parallel with the diameter of the latter. Having by means of the regulating screws, adjusted the edge of the parallel to the points just ascertained, carry it near to the upper or remote margin of the board and make a fine point opposite the middle of the scale or opposite to a mark made thereon for this purpose, on the center of the blade; then carry the parallel to the lower or nearest margin and make a similar point, revolve the board one quadrant and the edge of the blade being brought to one of the points, should the end piece and guide be already parallel to the transverse cardinal diameter of the protractor it will likewise coincide with the other point, if not, then measure the angle of the error, and by means of the regulating screws, make one half the requisite correction on the end piece, and the remaining half on the guide piece. Again, let the parallel be carried to the upper margin of the board and make a point opposite the middle of the scale as before, reverse the board and make a like point; then carry the parallel to the lower margin of the board and by a similar mode of proceeding having made two other points bisect the distance between each pair of points, the two central points thus ascertained shall be in the transverse cardinal diameter of the protractor projected on the board and the guide strip must be advanced or drawn back as the case may require, until the middle or beginning of the scale on the parallel shall coincide with each of the points respectively. Again, revolve the board a quadrant and reverse the parallel in its bearings, then adjust the left (now the right hand) end piece, by the central points last found, after which

advance the opposite or left hand guide, so as to press equally on every part of the edge of the end piece first regulated, and the instrument will be ready for use, before using it however, it may be again tested by proceeding as above, and by proper care with the help of a good glass any desired degree of accuracy may be attained; also the regulating screws of the parallel should be well secured so as to prevent derangement when used.

Having attached the paper to the drafting board the following problems will serve to illustrate some of the uses to which the instrument may be applied and the manner of using it.

Problem I.—To project the lines of a regular polygon, the number of sides and the semidiameter perpendicular to one of the sides being given.—Carry the edge of the parallel above or below the longitudinal cardinal diameter of the protractor, a distance (which may be measured on the side scale) equal to the given semidiameter of the polygon and having divided 360 by the number of sides, revolve the board through successive arches each containing the number of degrees thus found, drawing a line past the edge of the parallel at each motion these lines between the points of intersection will be the sides of the required polygon; thus, for a square, revolve the board through quadrants. It is also worthy of remark, that any two diameters from opposite sides or angles will intersect at the center of motion; *i. e.* the projected center of the protractor.

Problem II.—To project the points of a regular polygon the number of sides and the radius of its circumscribing circle being given.—Find the center of motion of the board by projecting a square and drawing the diagonal diameters, bring the parallel thereto and the center point of the blade will coincide therewith, then slide the cushion to the right or left until the protracting pin comes to the given radius measured on the blade—divide 360 by the given number of sides as before, and revolving the board through successive arches make a point for each movement, until the entire revolution is completed, the points thus ascertained will be the points of the required polygon. By a similar mode of proceeding the degrees, minutes, seconds, &c., of a circle of any given diameter may be projected.

Problem III.—To project the points of a polygon the same being given as in Problem I, together with the length of a side.—Slide the cushion until the protracting pin stands to one side of the center of the blade, a distance equal to half the length of the given side, then carry the parallel above or below the longitudinal diameter of the pro-

tractor, a distance measured on the side scale equal to the given semidiameter, after which proceed as in the last problem.

Problem IV—To lay down a series of courses and distances, of a survey, traverse of a ship, meanders of a river, road, canal-route, &c.—Having assumed a convenient point on the paper for a beginning, bring the indices of the board to the cardinal points of the protractor, and carry the blade of the parallel to the point of beginning then to the right or left of said point (as the paper admits) having made a second point close to the edge of the blade, these two points will express the meridian, call the first N (north) and the other S, (south) and having revolved the board a quadrant so as to bring the point N, or beginning, next the farthest cardinal point of the protractors revolve the board right or left to the given degree of the course, and having brought the edge of the blade to the point N, it will give a line therefrom in the course required; upon which from the point N, by a sliding scale applied to the blade lay down the length of the line, by sliding the cushion until the protracting pin arrives at the proper graduation of the scale; again, turn the board to the degree of the second course, and having brought the edge of the blade to the point last made lay down the second distance, and so on with the rest. Or thus: After having made the points N, S, and revolved the board as before to the given degree of the course, revolve it one quadrant more, which will throw the line to be protracted parallel with the side scales of the instrument; then carry the edge of the blade to the point N, slide the cushion until the protracting point comes to the point N, and note the graduation on the side scale opposite to the edge of the blade, after which, slide the blade back or forward to the required distance measured upon the graduations of the side scales and make the point. Proceed in like manner for the second course and distance and so on for the rest.

Problem V—After laying down the lines of the survey or traverse, to measure the dif-

ference of latitude and departure on each line.—Turn the indices of the board to the proper cardinal points of the protractor for laying down a true east and west line, then carry the edge of the blade, to the beginning of the 1st line, and having noted the graduation on the side scale, move it to the end of the line and note as before the graduation cut on the side scale, their sum or difference will be the difference of latitude on the line; proceed in like manner to find the difference of latitude on all the lines; then, revolve the board one quadrant, and by a similar proceeding the departure on each line is measured. Or the measurements may be made by a movable scale applied to the blade of the parallel though the side scales are preferable on account of the nonius divisions which may be used with them.

Many other problems might be given, but the foregoing will serve to illustrate the manner of using the instrument, in addition, it may be remarked generally, that any line in or about a circle may be projected and correctly measured on the drafting board, and any number of points ascertained in any course whatever, of which the chords and their included angles can be calculated, by actual protraction, with a degree of accuracy and despatch not hitherto attained by the instruments in common use.

Now what I claim as new and as my invention in the foregoing instrument and for which I ask Letters Patent, is—

The manner in which I have connected and combined the stationary protractor arch, having a fixed center pin; with a revolving drafting board and with the parallel and guide strips, regulated and operating in the manner and for the purposes herein set forth and described.

In testimony, that the foregoing is a full and true description of my said invention, I have hereunto set my hand this eleventh day of June 1838.

WM. T. STEIGER.

Witnesses:

JNO. M. MOORE,
S. D. KING.