4 Sheets—Sheet 1.

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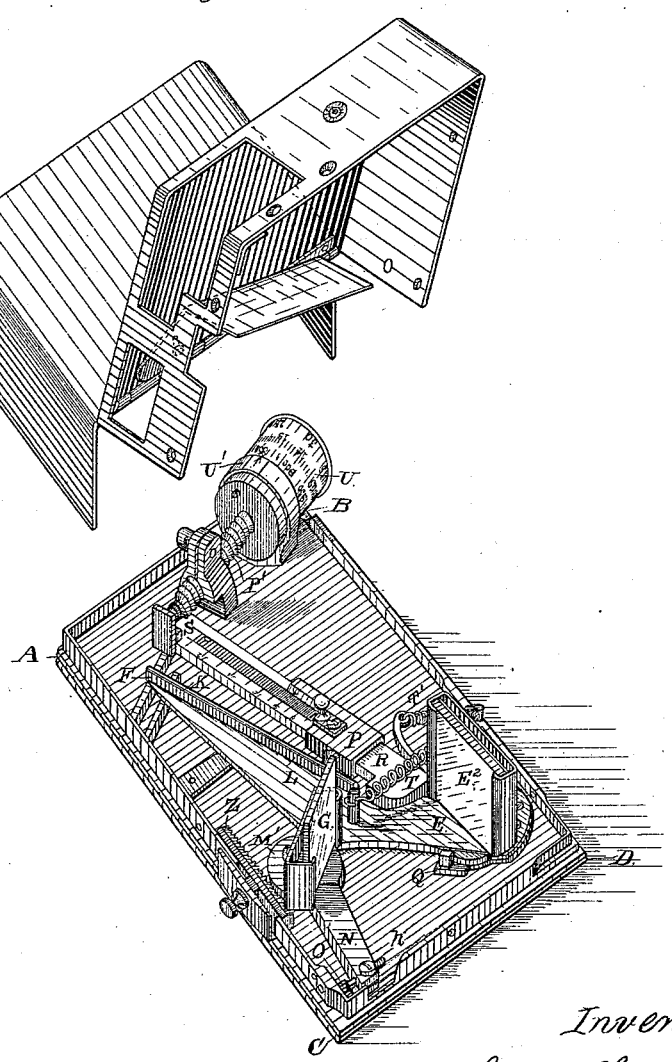
Surveying Instrument.

No. 213,018 Patented Mar. 4, 1879.

Fig. 1.



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Attest:

Geo. T. Smallwood Jr.

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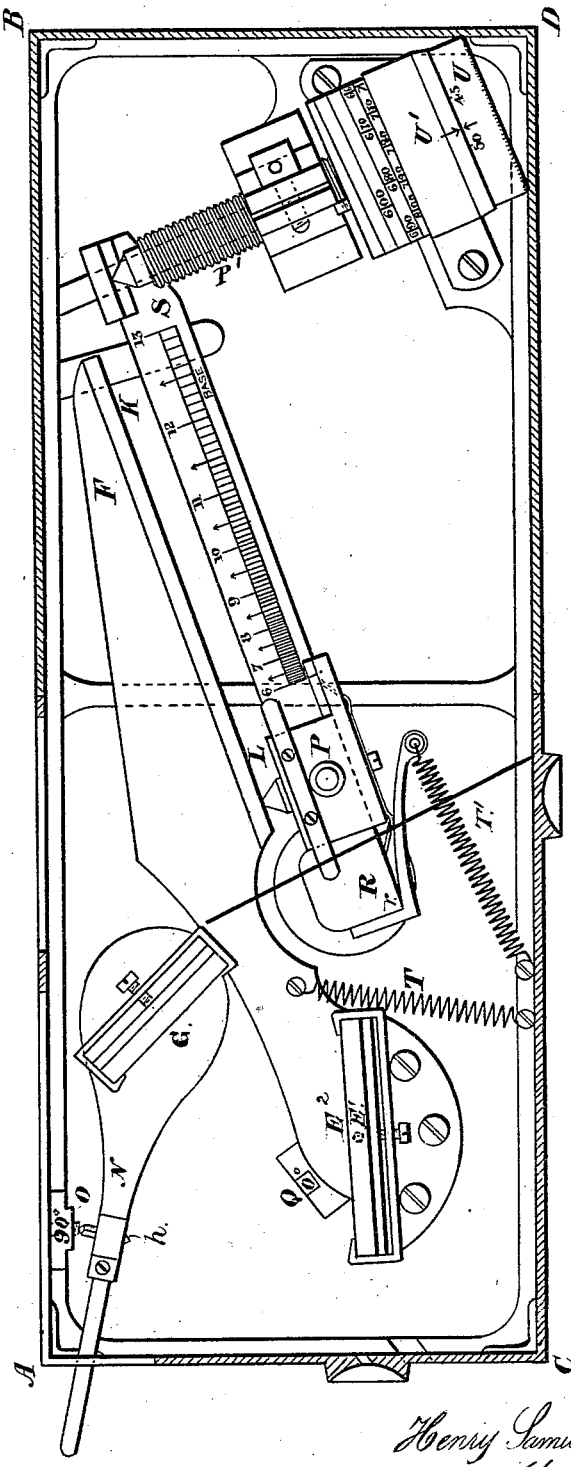

Fig. 2.

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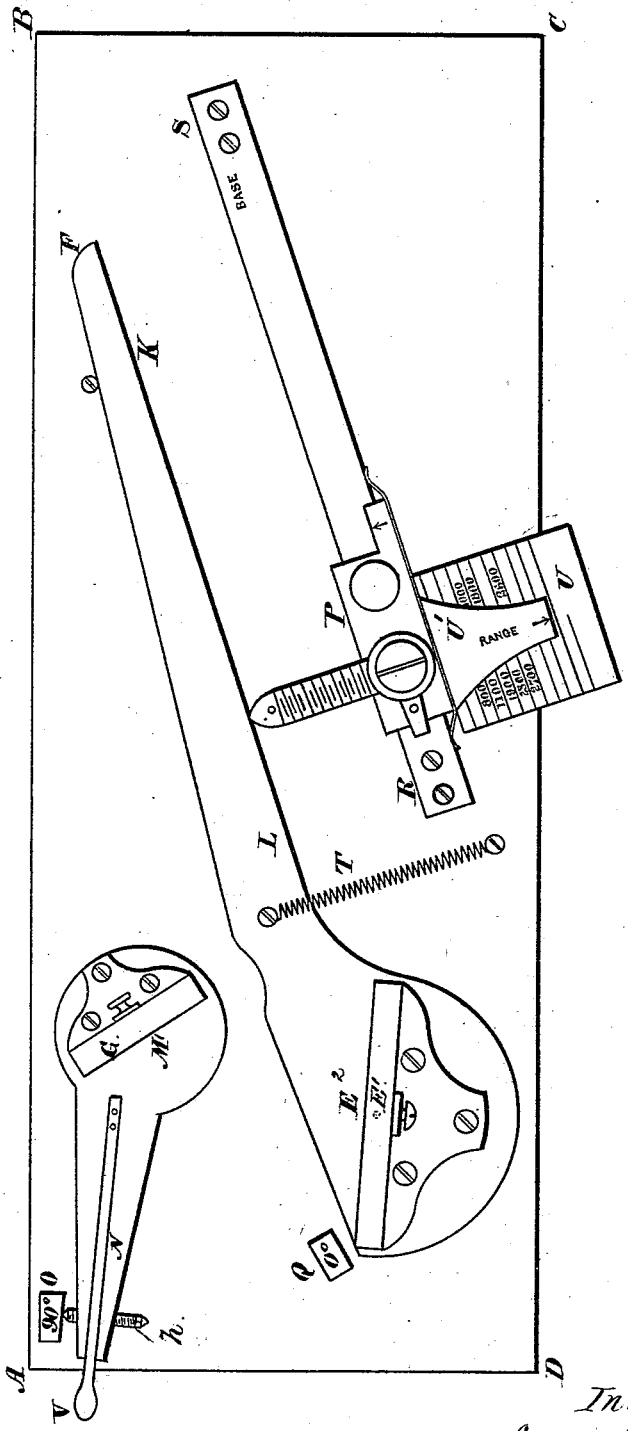

Fig. 3.

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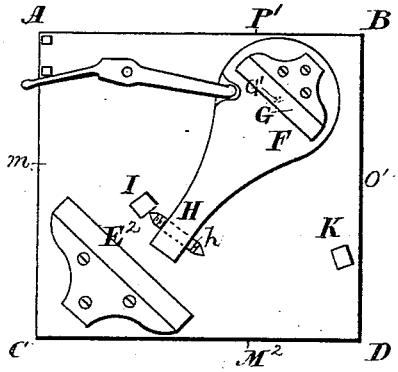
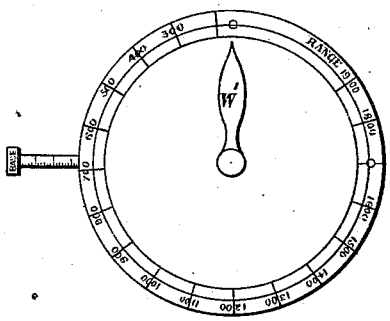
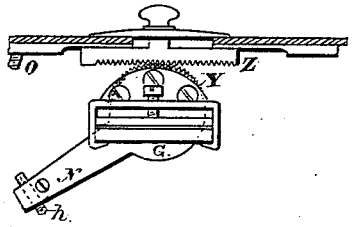
Fig: 4.





Figs. 5

Fig: 6.



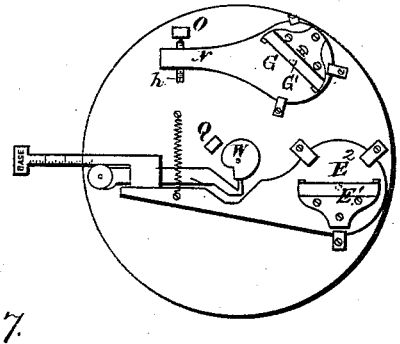
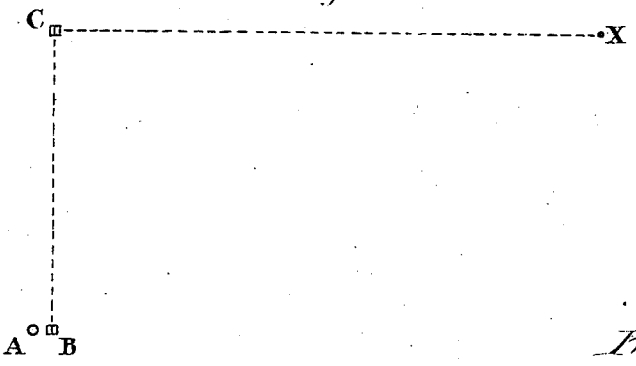


Fig: 7.



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UNITED STATES PATENT OFFICE.

HENRY S. S. WATKIN, OF WOOLWICH, ENGLAND.

IMPROVEMENT IN SURVEYING-INSTRUMENTS.

Specification forming part of Letters Patent No. **213,018**, dated March 4, 1879; application filed September 28, 1878; patented in England, November 3, 1876.

To all whom it may concern:

Be it known that I, HENRY SAMUEL SPILLER WATKIN, of Woolwich, in the county of Kent, England, captain royal artillery, have invented new and useful Improvements in Instruments for Obtaining Right Angles and Ascertaining Distances, which improvements are fully set forth in the following specification, reference being had to the accompanying drawings.

This invention relates to improvements in instruments for obtaining right angles and ascertaining distances; and consists, first, in the construction of a self-adjusting optical square, which contains within itself the means of instantly testing and adjusting a true right angle; secondly, in a range-finder, in which the above principle is applied, together with a screw, angle, and range-reader, by which angles, or their corresponding distances, can be read for fifteen degrees on either side of the zero without the aid of a vernier, and angles or their ranges from fifteen degrees on either side of the right angle, a collar or slide sliding on a bar, which enables the range of any object being instantly given without any calculation or mechanical calculator and with any required base.

The invention will be clearly understood by the following description and the annexed drawings.

Figure 1 represents a perspective view of the apparatus when used as a range-finder, the cover being removed. Fig. 2 shows a plan view of the same on a larger scale. Fig. 3 shows a modification of the same. Fig. 4 represents an optical square. Fig. 5 shows the apparatus as adapted for military and naval use. Fig. 6 is a detail view of mechanism for operating the arm carrying the horizon-glass.

The optical square is represented at Fig. 4 with the covering removed. A B C D is a square or circular plate of metal or other material, having an index-glass, E^2, of a sextant screwed on or otherwise fixed to it. The horizon-glass G is fixed onto an arm or piece of metal, F H, capable of pivoting round the center G. At the end of the arm H, and at right angles to it, is a steel screw, conical at both ends, and provided with a square shoulder. On the bed-plate are soldered or otherwise fixed two metal blocks, I and K, so arranged that the total possible traverse of the arm F H, with its screw, is an exact angle of forty-five degrees. It follows from this that, no matter what the position of the screw *h*, whether screwed in or out, the total traverse of the arm will be the same, for as the end toward the block I is withdrawn the point toward the block K advances exactly the same amount, and vice versa. Should, then, the arm H be pressed by a spring or otherwise against the block I, and the eye applied to the position M^1, the horizon-glass may be so adjusted by the screw *h*, with the aid of a key fitting onto the square shoulder, that the image of a distant object, as seen by double reflection and by direct vision, shall be coincident in the same manner as adjusting a sextant. Now, if the arm H be pressed against the block K, and the eye applied at the point M^2, at which is the eye-piece or aperture in the case, objects O′ will be seen by double reflection, and those at right angles to them by direct vision in the direction P′. Thus an optical square is produced which admits of adjustment to an exact right angle without the aid of any other instrument, should the mirrors be at any time displaced or taken out. This method can be applied with equal facility to the index-glass, and also to non-reflecting instruments.

The application of this principle to the common sextant enables angles to be read up to one hundred and eighty degrees or more, if required. This will be easily understood from the following considerations: If in the ordinary sextant the limb be at zero, the horizon and index glasses will be parallel to one another, and thus the same object will be seen by direct vision and by double reflection. If the former be now moved through an angle of forty-five degrees and the position of the eye also shifted, as already described for the optical square, objects subtending ninety degrees will be seen to coincide. Should the limb be now moved along the graduated arc, objects subtending angles from ninety degrees to nearly one hundred and eighty degrees can be made to coincide, the reading on the arc plus ninety degrees being the true angle subtended.

The range-finder, Figs. 1 and 2, consists of a bed-plate, A B C D, with an arm, E F, pivoting at E^1, on which is fixed the index-glass, the prolongation of the side L K passing through the pivot E^1; G, the horizon-glass, screwed to an arm, M^1 N, having a screw, N′, as described, for the optical square playing between two blocks, O Q. V is a spring for the purpose of pressing the arm against either block, notches being provided in the cover for this purpose. A bar, R S, is fixed to the bed-plate, having a collar or bar sliding along it. An accurately-constructed screw, P′, of a suitable pitch, having a steel end turned to a conical point, works in a block on this sliding piece, in prolongation of this screw, and attached to it is a cylinder, U. From the sliding piece proceeds an index-arm, U′, the end of which nearly touches the upper surface of the cylinder. A spiral spring, T, tends to keep the arm E F pressed against the conical tip of the screw. If, now, the screw be withdrawn, the arm E F and the mirror thereupon will be moved through an angle, and the end of the index-arm will describe a spiral on the cylinder. It will only be necessary to mark this spiral in degrees or minutes, or the ranges corresponding thereto, (in a right-angled triangle,) for, say, a base of a hundred yards. Now, if the sliding piece be moved up or down the bar R S, certain positions will be found in which the same scale of angles or ranges will correspond to other bases—say from fifty to one hundred and thirty yards—because the same movement of the screw will produce a different movement of the arm E F, depending upon the distance of the point of the screw from the pivot E^1.

Another form is shown in Fig. 3. Here, instead of the bar R S being fixed, it pivots on a point. The block through which the screw works is fixed to the bed-plate, and the sliding collar has a steel point fixed to press against the surface L K. The remainder of this instrument is the same as has been already described in respect to Figs. 1 and 2.

Instead of using a spring-lever to actuate the arm carrying the horizon-glass, the circular end of such arm may have a toothed segment, Y, formed or fixed thereon, and be operated by a sliding toothed rack, Z.

The method of working the range-finder is as follows, and is represented at diagram Fig. 7. Two pickets, A B, are planted about one hundred yards from the observer at C, at a distance apart of eighteen feet, the sliding bar or collar being pressed up to the stop and the cylinder turned to zero-point. The observer at C looks at the object, X, the range of which is required, and moves backward or forward until the picket B coincides with the object. As the arm M^1 N has been pressed against the block O, the angle X C B will be a right angle. The observer then plants a picket at C and turns toward pickets A B. The arm M^1 N is now pressed against the block Q, and the one picket reflected onto the other by revolving the cylinder. The reading will be the exact distance of B from C. The sliding bar or collar is then moved along the graduated bar to this distance. The observer now moves to the picket B, replacing the arm in its original position, and looks at the object by direct vision. By moving the cylinder the reflection of the picket C is made to be coincident with it. The reading then will give the exact range, the whole time occupied in taking a range (including unpacking the instrument) being one and a half minutes.

For long ranges and obscure objects a telescope is provided, which can be inserted at the eye-holes to obtain exact coincidence, the approximate adjustment having been obtained with the naked eye.

The advantages claimed for this invention are, first, the ranges taken must always be correct, as any index error in the instrument is at once detected; second, the instrument is entirely self-contained, and capable of exact adjustment without the aid of other instruments; third, no calculation or mechanical calculator is required, the ranges being read direct; fourth, the instrument measures and works with any base; fifth, no tripod or stand of any description is required; sixth, great portability is obtained, as the instrument is carried in a sling-case over the shoulder.

The same instrument can be adapted for infantry and naval use, and would, perhaps, most conveniently take the form shown in Fig. 5. The mirrors and arms are arranged as before; but for giving motion to the arm a cam, W, may be conveniently applied. The whole is inclosed in a case much the same in size and shape as an ordinary box-sextant. To the spindle of the cam is attached a pointer, W′, acting with a zero-point and scale of yards.

The method of using this instrument is the same as those already described, except that instead of turning the cylinder with its attached screw the cam W is moved by means of the index-arm, and the range is read off on the dial. The bar projecting on the left of the instrument actuates the sliding collar, and adjusts for different lengths of bases on the screw principle. As in the other instruments, a cam also may be applied for this purpose.

For naval purposes the bar would be adjusted for the height of the observer above the sea-level, the range-scale being so graduated as to allow for the dip of the sea-horizon.

Having thus described the nature of my said invention, and the mode in which I carry the same into effect, I would have it understood that I do not confine myself to the precise details of construction herein shown and described; but

What I claim is—

1. A self-adjusting optical square consisting in the combination of plate A B C D, index-glass E^2, fixed to such plate, horizon-glass G, fixed to a pivoted arm or piece of metal, F H,

provided with a screw, *h*, conical at both ends, and metal blocks I K, fixed to the plate A B C D, in manner and for the purpose substantially as herein shown and described.

2. In a range-finder, the bed-plate A B C D, pivoted arm E F, index-glass E^2, horizon-glass G, arm M^1 N, double-pointed screw *h*, blocks O Q, bar R S, collar P, screw P′, cylinder U, index-arm U′, and springs T T′, substantially as and for the purposes set forth.

H. S. S. WATKIN.

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W. TH. MURCHISON,
Citadel, Plymouth.