(No Model.) 2 Sheets—Sheet 1.

B. A. FISKE.

TELESCOPIC SIGHT.

No. 561,383. Patented June 2, 1896.

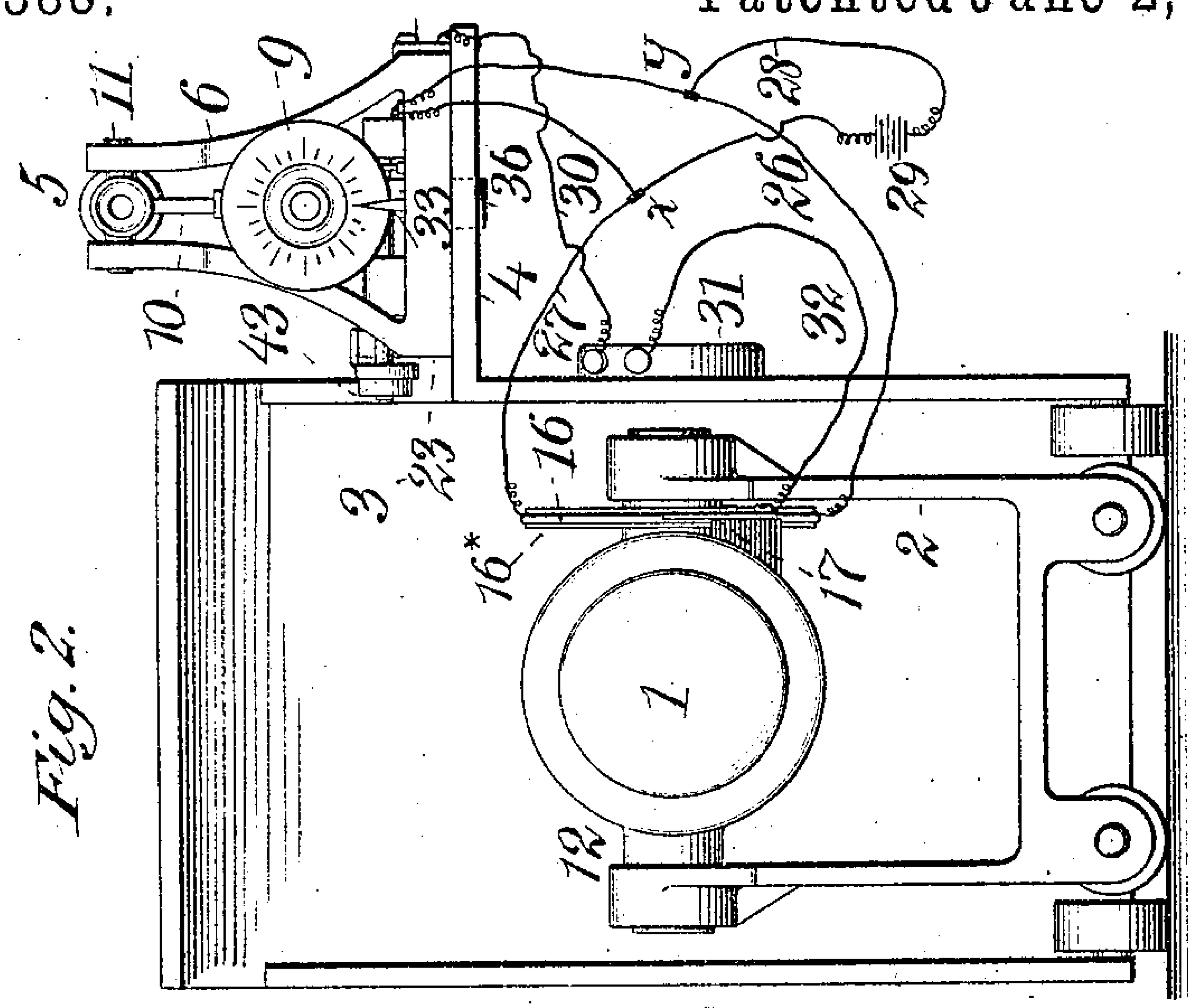

Fig. 2.

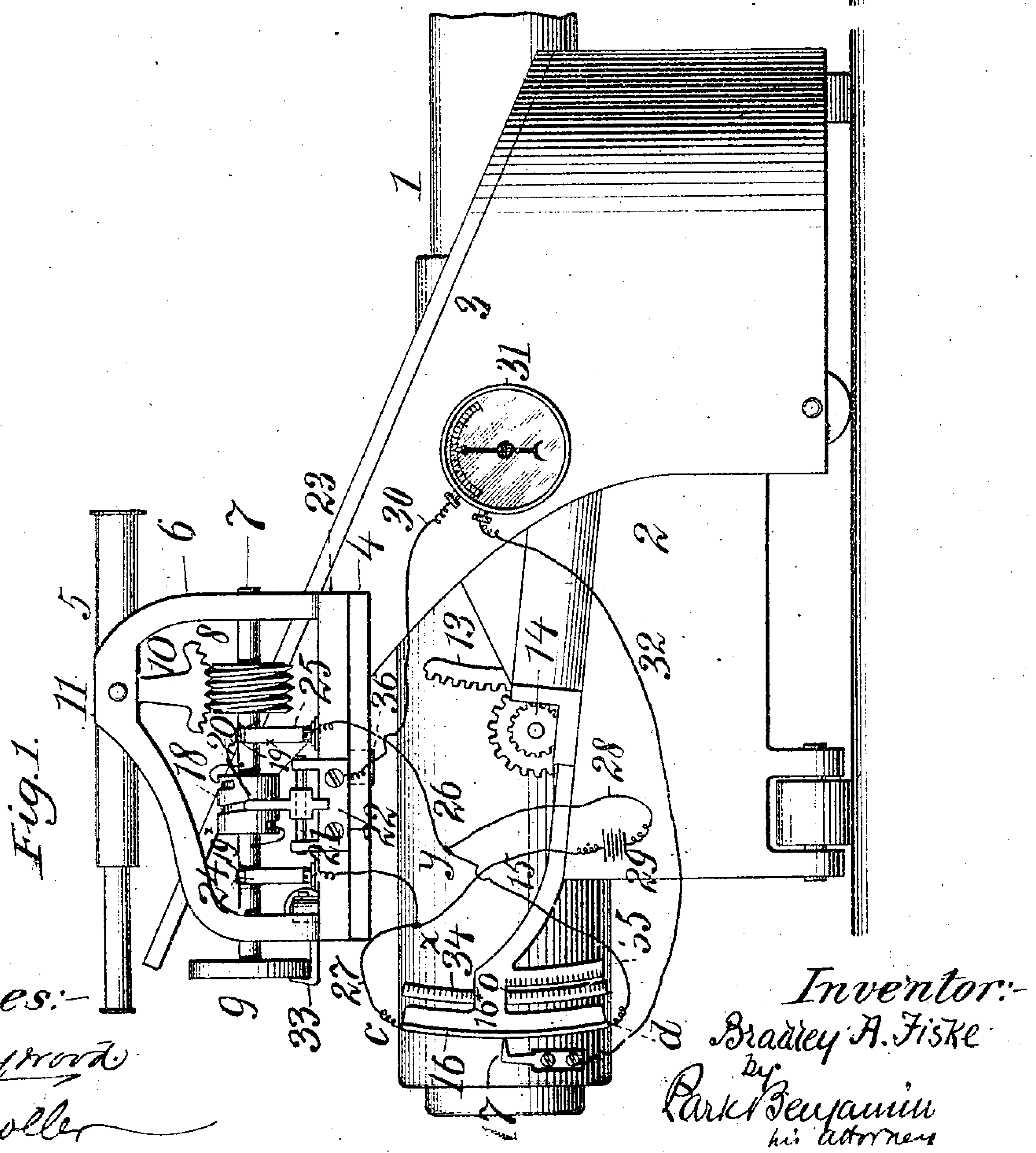

Fig. 1.

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his attorney

(No Model.) 2 Sheets—Sheet 2.

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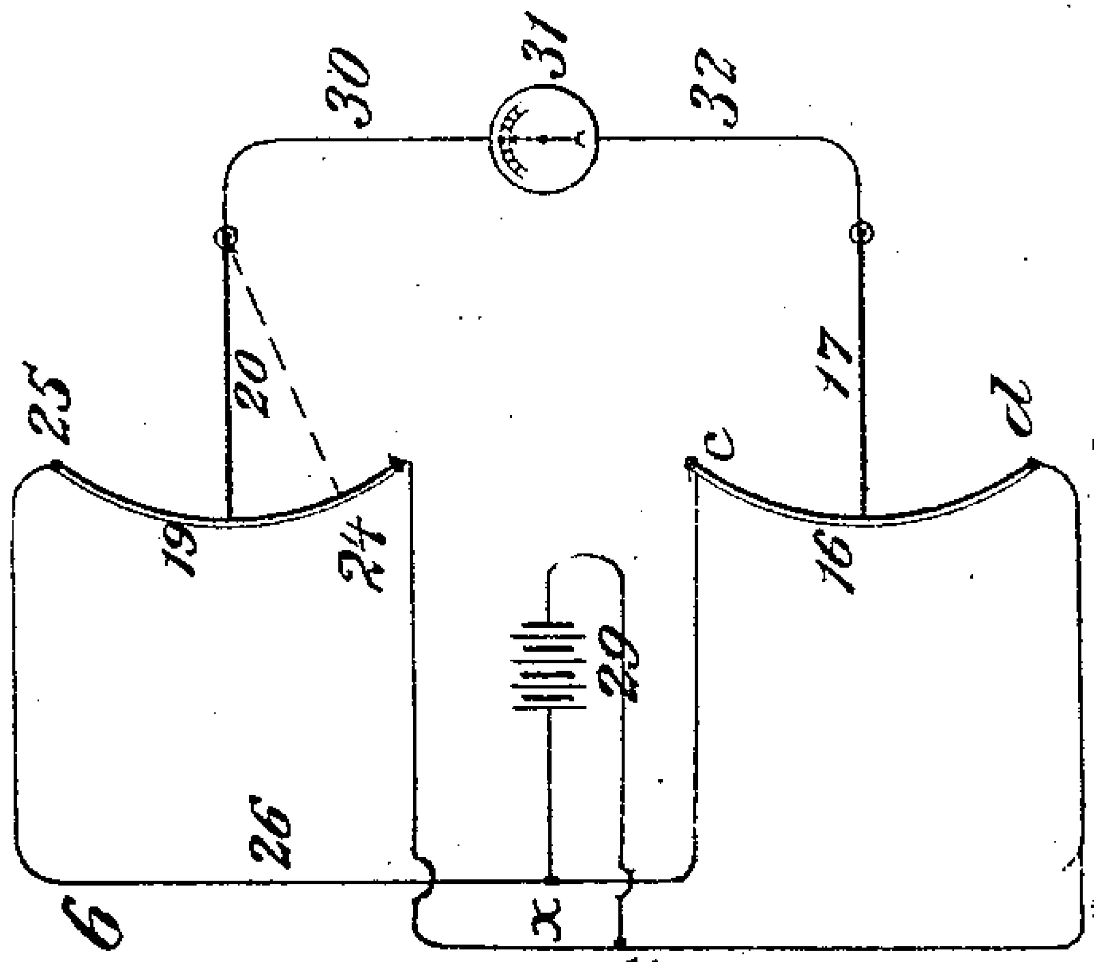

Fig. 6

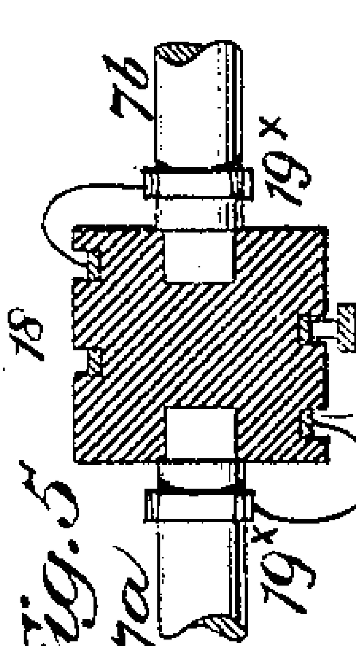

Fig. 5

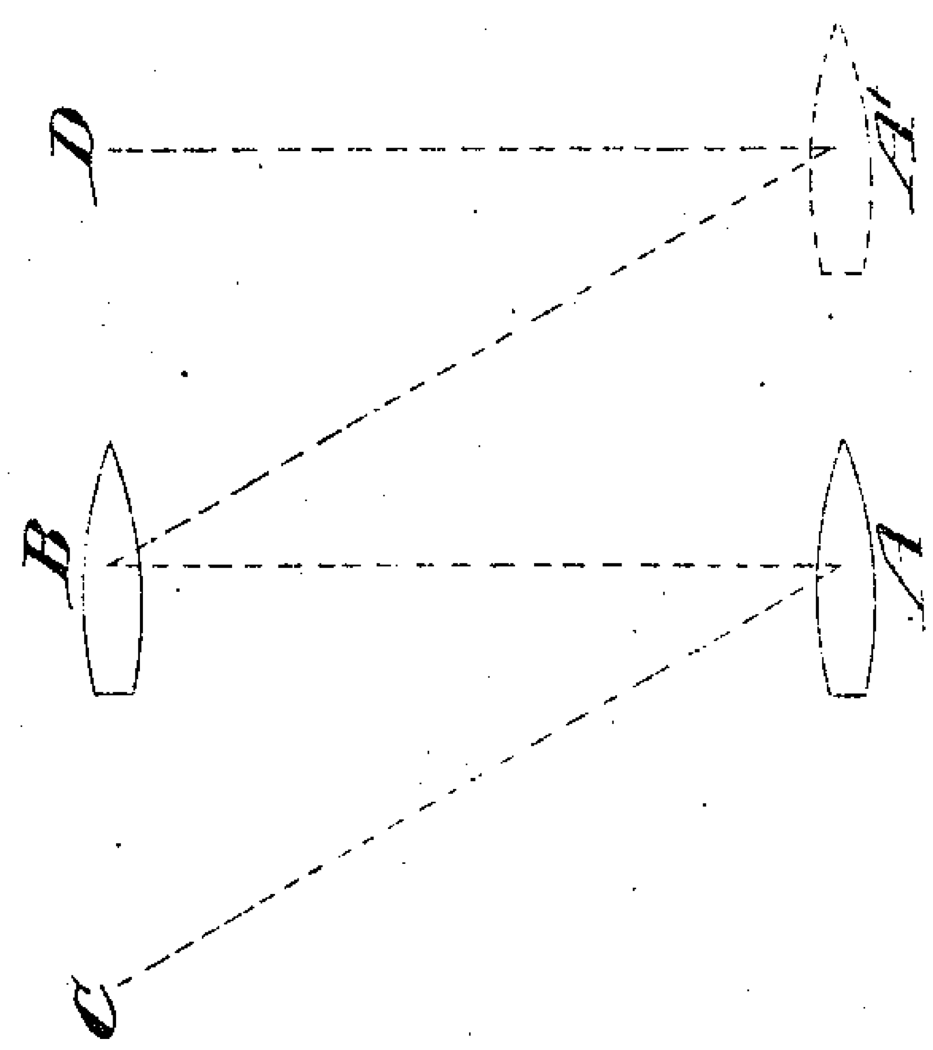

Fig. 7.

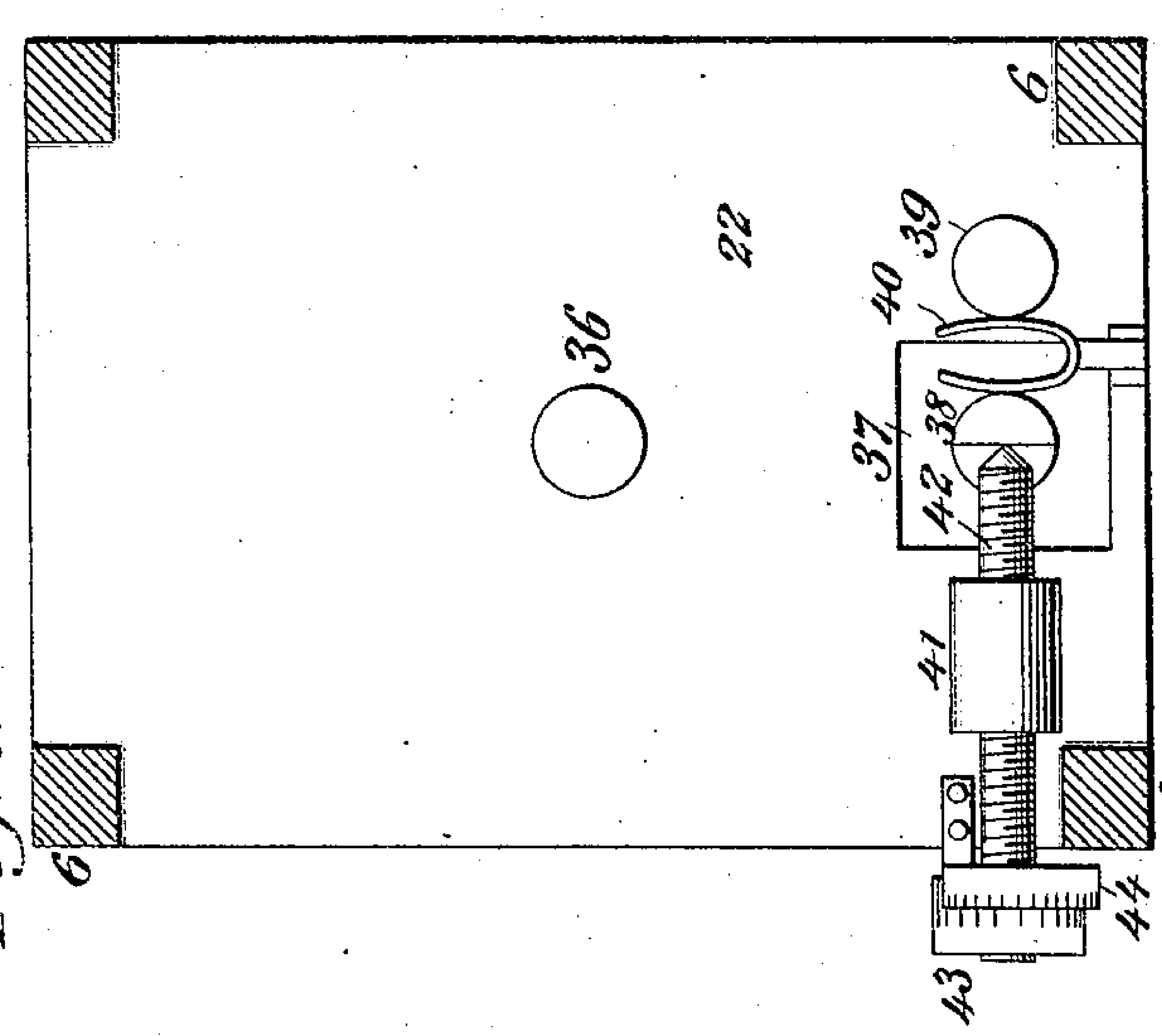

Fig. 3.

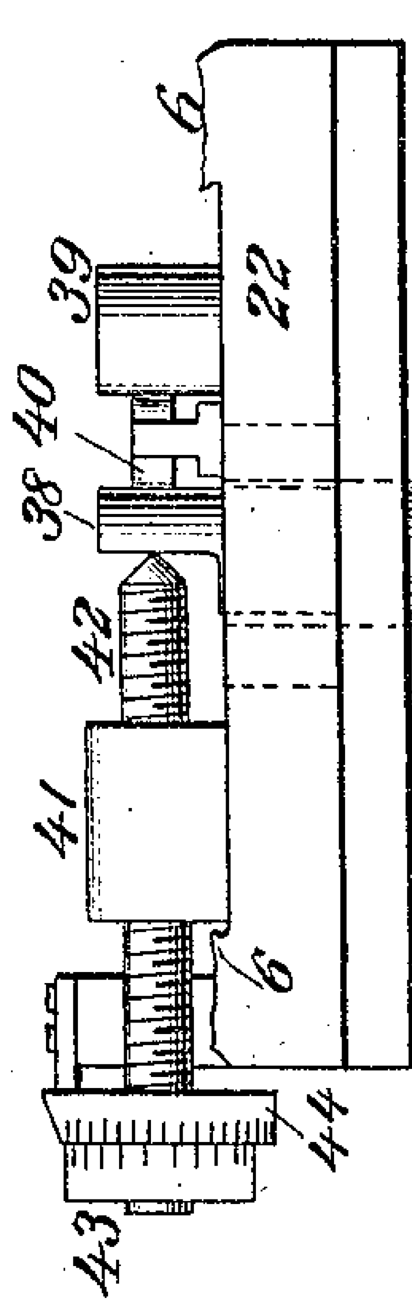

Fig. 4.

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UNITED STATES PATENT OFFICE.

BRADLEY A. FISKE, OF THE UNITED STATES NAVY.

TELESCOPIC SIGHT.

SPECIFICATION forming part of Letters Patent No. 561,383, dated June 2, 1896.

Application filed May 20, 1893. Serial No. 474,872. (No model.)

To all whom it may concern:

Be it known that I, BRADLEY A. FISKE, of the United States Navy, have invented a new and useful Improvement in Telescopic Sights, of which the following is a specification.

My invention relates to an apparatus for sighting guns.

My invention consists in the combination of a telescope or sight-bar and a gun, each movable about a transverse horizontal axis, and means for indicating the angle in a vertical plane between the longitudinal axes of said telescope and gun; also in apparatus for electrically indicating said angle; also in apparatus for compensating for the error in the line of sight due to the bodily movement of the gun, the target, or both; also in apparatus for compensating for the drift of the projectile when the gun is rifled; also in the various instrumentalities and combinations, mechanical and electrical, as hereinafter set forth, and more particularly pointed out in the claims.

In the accompanying drawings, Figure 1 is a side elevation of my device applied to a ship's gun. Fig. 2 is a rear elevation of the gun. Fig. 3 is a plan view of an attachment to my apparatus for the purpose of supplying a correction to compensate for the movement of either the ship or the target. Fig. 4 is an end elevation thereof. Fig. 5 is a detail view of the drum of insulating material represented at 18 in Fig. 1. Fig. 6 is an electrical diagram illustrating the connections in the apparatus.

Similar letters and figures of reference indicate like parts.

1 represents so much of an ordinary naval gun as is necessary to illustrate the application of my device thereto.

2 is the gun-carriage.

3 is the gun-shield. On one side of said shield there is a shelf or ledge 4, upon which my telescopic sight is supported.

5 is an ordinary telescope or spy-glass, preferably provided with cross-hairs in its objective for the purpose of more accurately bringing the line of sight upon the target. The telescope 5 is mounted in trunnions 11 in the standard 6. Journaled in the standard 6 is a shaft 7, which carries a worm-wheel 8, and which on its outer end is provided with a hand-wheel 9. The telescope carries the curved rack 10, with which the worm-wheel 8 engages, so that by turning the hand-wheel 9 the telescope 5 may be moved on its trunnions 11, and its elevation in a vertical plane thus adjusted. The gun 1 also turns on its trunnions 12 in a vertical plane. A variety of mechanism for thus elevating or depressing the guns is in common use, and no special description thereof is necessary. For example, however, there is here shown a rack 13, connected to the gun, with which a pinion 14 engages. By turning the pinion 14 by means of any suitable crank-handle the gun may be elevated and depressed as desired. Of course this arrangement of rack and pinion 13 14 is no part of my invention, inasmuch as the gun to which my device is attached may be elevated or depressed by any suitable means.

Connected to the carriage 2 by means of the arm 15 is an arc 16*. This arc carries a strip of wire 16 or other conducting material, insulated from it.

17 is a contact-point of metal which is fastened upon the gun, but insulated therefrom, and which bears against the wire 16. The arc 16* is struck from the trunnion 12 of the gun as a center, so that when the breech of the gun is raised or lowered the contact-point 17 always bears against said wire 16, the arc moving, of course, in front of the contact-point. The shaft 7 is made in two parts 7^a and 7^b, as shown in Fig. 5, and these parts terminate in a drum 18, of hard rubber or other insulating material. In the periphery of the drum 18 is cut a spiral thread, and in this thread is laid a strip of metal or wire 19, which exactly corresponds to the wire 16 in its resistance from end to end. Of course this could be produced by making the wire 19 precisely similar to the wire 16 in point of material, cross-section, and length.

20 is a contact-arm which slides freely upon a rod 21, which is supported in the insulated bracket 22 upon the table 23 of the apparatus. The contact-arm 20 may be provided with a point, as shown in Fig. 5, which point always bears upon the wire 19. Consequently as the wheel 9, and hence the shaft 7, is rotated the arm 20 remains in the spiral groove of the drum 18, and of course follows that groove, this movement being permitted by the sliding of the arm 20 upon its rod or support

21. Therefore contact between the arm 20 and the resistance-wire 19 is always maintained. As best shown in Fig. 5, the ends of the wire 19 on the drum 18 are connected, respectively, to insulated sleeves $19^{\times}$ on the sections 7^a and 7^b of the shaft 7. Secured upon the table 22 are two insulated contact-springs 24 25, and these bear, respectively, upon said insulated sleeves.

I will now describe the electrical connections in the apparatus. From the end *d* of the wire 16 a wire 26 extends to the contact-spring 25. From the end *c* of the wire 16 a wire 27 extends to the contact-spring 24. Between the points *x* and *y* of the wires 26 and 27 extends a wire 28, which includes a battery 29. From the bracket which supports the arm 20, which bears on the wire 19 in the drum 18, extends a wire 30 to a galvanometer 31. From the galvanometer 31 extends another wire 32 to the contact-point 17. The relation of these connections will be more conveniently traced on the skeleton diagram, Fig. 6. This diagram, as is obvious on inspection, represents the connections in the well-known Wheatstone-bridge relation; and here it will be obvious that when either of the arc-wires 16 or 19 is moved along the contacts 20 or 17, or, what is the same thing, if the contacts 20 or 17 be moved over the arc-wires 19 or 16 the arms of the bridge will be lengthened or shortened, or, in other words, the resistances balanced in the bridge will be varied, and hence its equilibrium will be disturbed.

Now supposing that in Fig. 6 the parts marked 20 and 17, being the contact-points, are pivoted arms so arranged as to sweep over the arc-wires 16 and 19, when these arms 20 and 17 stand parallel, touching the same points on the respective arc-wires 16 and 19, clearly then the bridge will balance and the galvanometer 31 will give no deflection. If, however, the supposed arm 20 be moved so that its end meets the arc-wire 19 at the point 24 of that wire, then, clearly, we have lengthened the arm x^{24} of the bridge and shortened the arm y^{24}, and the bridge will then be thrown out of equilibrium and the galvanometer 31 will indicate the extent of this disturbance, which will of course depend upon the resistance of the length of the wire 19 included between the original position of the arm 20 (full lines) and its new position. (Indicated by dotted lines.) Now, as the arc-wire 16 is assumed to be exactly like the arc-wire 19 in point of resistance per unit length, and as the electromotive force of the battery is also assumed to be constant, plainly if we move the supposed arm 17 to over an equal distance of the fixed arc-wire 16, or, in other words, to the point *d* on that arc-wire, then the remaining arms of the bridge will become, respectively, *yd* and *dx*, or, in other words, we shall have compensated for the disturbance in the bridge made by the movement of the supposed pivoted arm 20, and therefore the galvanometer 31 will once more balance. The net result of all this is simply to show that the galvanometer 31 will always indicate zero whenever the two supposed pivoted arms 20 and 17 are placed on corresponding points of their arc-wires 16 and 19—that is to say, whenever they are relatively parallel one to the other—but whenever they are not parallel then the galvanometer 31 will give a deflection which is proportional to the length of arc-wire which is included between the angle which they bear one to the other. Thus, if the arm 17 is left as shown in full lines and the arm 20 be moved to make contact at 24, as shown by dotted lines, then the galvanometer 31 will give a deflection due to the resistance included between the two positions of the arm 20. Of course exactly the same thing would happen if the arms 20 and 17 of Fig. 6, here supposed to be movable, were fixed and the arc-wires 16 and 19 were moved in front of the arms.

Returning now to Fig. 1, it will be plain that when we rotate the wheel 9 we move the wire 19 on the drum 18 beneath the contact-point 20, and at the same time by means of the worm 8 and rack 10 we turn the telescope 5 on its trunnions. Therefore there is a relation between the length of wire which passes beneath the contact-point 20 and the angle over which the telescope 5 is turned. Similarly when we elevate or depress the gun, which likewise turns it upon its trunnions 12, we at the same time move the arc-wire 16 in front of the contact-point 17, so that there is a relation between the extent of angular elevation or depression of the gun and the length of the arc-wire 16 which moves in contact with the point 17. Now if these parts be so adjusted, as in fact they are, that when the telescope 5 is elevated or depressed over a certain angle and the contact-point 20 therefore moves over a certain length of the wire 19, the gun, on being depressed or elevated over that same angle, will cause an equal length of the arc-wire 16 to move in front of the contact-point 17. Then clearly we shall have between the axis of the telescope and the axis of the gun the same relations, with reference to the arc-wires 16 and 19, as have the two supposed pivoted arms 17 and 20 in the diagram, Fig. 6. The shelf 4 is so placed on the shield that when the axis of the bore of the gun and the line of sight of the telescope are parallel one to the other the contact-points 17 and 20 will stand on the same relative positions to their respective resistance-wires 16 and 19, and the galvanometer 31 will show no deflection, so that thus we have ever after a means of knowing, by the indication of the galvanometer being zero, when the line of sight of the telescope and the axis of the bore of the gun are relatively parallel. Of course these connections in practice are adjusted once for all, and therefore the use of the device becomes, in fact, exceedingly simple, for all that the observer has to do if the galvanometer 31 shows any deflection at all is to move either gun or telescope on its trunnions until the galvanometer shows no deflection, and then he knows that gun and telescope are parallel.

The relations of the parts now being established, I will explain their practical use. In order to make the projectile thrown by a gun reach its target, it is necessary to elevate the gun over a certain angle (dependent upon the distance of the target) above the line of sight drawn from the observer's eye to the target. This distance may be determined by means of a range-finder or other apparatus especially adapted for that purpose, and the ordinary proceeding is, after the range has been determined or estimated, to suitably adjust a sight-bar on the gun, so that a notch in the upper part of this bar and a fixed projecting point or front sight at a distance therefrom along the gun shall be at a known angle to the axis of the bore equal to the requisite angle of elevation of the gun. The observer ranges his eye so as to note the instant when these two points come into coincidence with the target, and then he fires the gun by any suitable means. Now on board ship this is a matter of considerable difficulty and requires long training on the part of the person who is to direct the gun. It is an exceedingly difficult matter, especially when the ship is moving, to catch the instant when the sights and object come into alinement, because the pupil of the eye must be kept exactly on the line produced joining the front and the rear sights. What I accomplish in this present device is greatly to increase the accuracy and rapidity with which the sighting of the gun can be accomplished. This will be apparent from the following description: For all practical purposes the axis of the telescope, when parallel with the axis of the bore of the gun, may be considered as coincident. In other words, the displacement of the axis of the telescope above or laterally to the axis of the bore of the gun is so small with reference to the distance over which the shot is thrown that any error due thereto may be neglected altogether. Assuming, for convenience, that in the beginning both gun and telescope stand parallel to the plane of the deck, as shown in Fig. 1, the galvanometer 31 then giving no deflection, the telescope 5 is brought to bear upon the object, so that the object comes at the intersection of its cross-hairs. The necessary elevation to be given to the gun, having been determined by the range-finder, is known. Corresponding thereto is a certain deflection of the galvanometer 31. The needle must go to a certain point on the galvanometer-scale corresponding to the extent to which the bridge will be thrown out of equilibrium by the known and desired elevation of the gun. Instead of marking the galvanometer 31 for differences of potential dependent upon these changes it may as well be marked for yards corresponding to the potential differences. Therefore the observer, knowing the range—say, for illustration, two thousand five hundred yards—has simply to adjust his gun so that the galvanometer-needle shows that range, and this he does by the ordinary elevating or lowering apparatus of the gun. When the galvanometer-needle does show that range, then he knows that the gun is adjusted with regard to the line of sight already established at the proper angle to throw its shot over that distance. Of course in practice these observations are not made by one man. One observer standing at the telescope and having in his hand the firing-button directs the telescope upon the object. An assistant operates the gun-elevating apparatus and watches the galvanometer. All that the first operator has to do is to direct the telescope properly, and all that the second operator has to do is to elevate or depress the gun until the galvanometer-needle indicates the desired range. When that range is reached, the first operator fires the gun as soon as the rolling of the ship brings the cross-hairs on the target. The first operator has nothing to do with the elevation of the gun or its adjustment for range. He may not even know what the range is. The second operator has nothing to do with the sighting of the gun and cannot know when the gun bears on the object. All errors from maladjustment of sights or inaccuracy in alinement of sights and object are practically obviated.

I now pass to another part of my invention, which consists in a means which serves the double purpose of verifying the accuracy of the galvanometer reading and also of accomplishing the same results already stated by mechanical means in case of any injury to the electrical connections. On the face of the wheel 9 (see Fig. 2) I make graduations and arrange in proximity to said wheel an indicating-point 33. As will readily be understood, by means of these graduations, which may be, say, in degrees, I can indicate the extent of elevation or depression of the telescope 5. I also attach to the gun a graduated arc 34, the graduations on which correspond exactly to the graduations on wheel 9. On the arm 15 is a projection 35, which is parallel to the graduated arc 34, and this projection may be likewise graduated in the same units as the arc 34. Now the relation of the graduations on the wheel 9 and the fixed arc 34 on the gun are to be such that when the axis of the telescope is parallel to the axis of the bore of the gun the same graduation-mark on the wheel 9 which comes opposite the pointer 33 will be the same as the graduation-mark on the arc 34 which comes opposite the zero-point on the projection 35. This zero-point may be located as desired. For convenience I have shown it as being substantially the horizontal lower edge of the arm 15 between the part which carries the arc 16 and the projection 35. Or, in other words, when the pointer 33 indicates two degrees on the wheel 9 and the zero-mark on the arm 15 is opposite the two-degree mark on the arc 34 which is on the gun and then telescope and gun will be parallel, and so on for all other corresponding graduations. As the projection 35 is also graduated, it is clear that by this means the angle between gun and telescope can be easily read. For example, if the reading of the wheel 9 is three degrees and the two-degree mark on the projection 35 is opposite the three-degree mark on the arc 34, then it is clear that the bore of the gun is inclined at an angle of two degrees to the telescope, and, similarly, if the reading of the wheel 9 is three degrees and the one-degree mark on the projection 35 is opposite the three-degree mark on the arc 34, then the gun is inclined at an angle of one degree to the telescope, so that by means of these graduations on the wheel 9, the arc 34, and the projection 35 it becomes easy to give the gun and telescope any relative angular convergence that may be desired. In this way also, clearly, these graduations give a check to the indications of the galvanometer 31, because, whatever may be the position of the telescope and gun, the mark on the projection 35 which is opposite to that mark on the arc 34 corresponding to the reading of the wheel 9 should be the same as the indication in similar units of the galvanometer 31, so that, further, even supposing all the electrical connections to be destroyed, the gun and telescope can be laid parallel and the gun laid at any angle with reference to the telescope simply by observing the relation of the graduations on the parts named. Of course in practice the electrical apparatus is much more rapid, and in other respects preferable; but the value of the last-described arrangement as a check on the galvanometer and as a means of meeting casualties in action will be readily appreciated. Of course instead of graduating 35 in degrees it may be graduated in yards or meters once for all, because for any given gun, as already stated, the distance to which the shot will go is entirely dependent upon the angular elevation of the muzzle above the line of sight from gun to target.

I now pass to another part of my invention, which consists in means for applying to the apparatus a correction for relative movement of gun and target. This of course involves the following conditions: Either the target is fixed and the gun is movable, as in the case when the ship which carries the gun is under way, or the gun is fixed and the target is moving, which is the condition when the ship which carries the gun is stationary and fires, for example, at a moving ship, and, third, when both the ship which carries the gun and the target which is fired at are moving one relatively to the other. Of course in both the first and last cases the projectile will have not merely the velocity due to its impelling charge, but also the velocity of the ship, acting in a different direction and tending to carry it in advance of the point aimed at. In the second case, when the target is moving, the projectile will tend to fall in rear of the point aimed at. A single illustration will suffice to make this clear. If, as in Fig. 7, the ship A fires at the ship B and meanwhile advances to A′, the shot will not strike B, but D, the distance B D being merely equal to the distance A A′, so that the gun must in fact be pointed not directly at B, but at an angle represented by B A C from the line of sight A B equal to the angle D A′ B. This angle can be easily deduced for any and all speeds of ships, the speed or velocity of the shot being known. In fact, it is always now deduced for every gun on board ship for use in, say, the ordinary sights, and it is usually called "the correction for speed." The same is true for the correction of the speed of the other ship B, bearing in mind, of course, that the correction must be in the opposite sense. I compensate for this in the following manner, (see Figs. 3 and 4:) The base 22 of the instrument is secured to the shelf 4 on the gun-shield 3 by means of a strong vertical bolt 36, about which the table 22 may be rotated as on a pivot. In the table 22 is cut a rectangular opening 37, and on the shelf 4 there is a pin 38, having one side flat and the other side curved, which projects up through this opening. On the plate 22 is a fixed pin 39, and between the pins 38 39 is interposed the bent spring 40. On the plate 22 is also a threaded support 41, which receives the adjusting-screw 42, which is provided with a graduated head 43. The end of the screw 42 bears against the flat side of the pin 38. When the screw 42 is turned by means of its head 43, the table or base-plate 22 will be rotated around the pivot 36, the spring 40 acting in opposition to the screw 42, so that this adjustment may be made in either direction. It is also clear that if the pitch of the screw 42 be known and the head 43 be appropriately graduated the telescope 5, which is supported on the base-plate 22, may be turned to any desired angle by simply rotating the head 43 and noting the graduation. In practice this angle is seldom, if ever, as great as two degrees, so that the construction described abundantly provides for this necessary limited extent of movement. It will be readily understood that by this means the telescope may be moved in azimuth to compensate for the displacement of either the target or the ship which carries the gun. It is also plain that the micrometer-head can be at once marked in units of speed instead of in degrees and minutes of arc.

There is also another small, but important, correction necessitated by what is termed in gunnery the "drift" of a projectile when fired from a rifled gun, this drift being a deviation from the line of fire to the right or the left, a right-handed rifling causing the projectile to deviate to the right and a left-handed rifling causing the projectile to deviate toward the left. The distance to the right or left to which the shot is thus deviated increases with the distance to which the shot is fired, and it becomes necessary, therefore, to apply a correction which also increases with the distance to which the shot is fired. With the ordinary sight-bar this correction is accomplished by placing the support of each sight-bar to one side of a line parallel to the bore of the gun from the front sight and by inclining it at an angle, so that the rear sight-bar as it is raised does not rise in a vertical plane, but in one at an angle thereto. In my present device I provide for this correction in the following manner: Upon the base-plate 22 and in proximity to the graduated head 43 is supported a small fixed graduated arc 44, which is graduated in degrees and minutes of arc, or preferably in terms of the ranges corresponding to these angles of drift. In the ordinary use of a micrometer the reading is that of the graduation on the micrometer-head, such as 43, which is opposite to a certain fixed zero or reference mark. In using the micrometer-head 43 I bring the speed-graduation thereon opposite to the zero-mark on 44 in the supposititious case where the distance of the target is zero; but as the distance is of course not zero I bring the speed-mark on 43 opposite to the graduation-mark on 44 which corresponds to the distance of the target. In case, for example, the speed of the ship were ten knots and the distance of the target fifteen hundred yards I bring the mark "10" on 43 opposite the mark "1500" on 44; and in case the distance is two thousand yards and the speed zero, as when the firing ship is at anchor and the target stationary or when both are going in the same direction at equal speeds, I bring the zero-mark on 43 opposite the "2000" mark on 44. Of course the relations of these parts depend upon known determinations with which all persons skilled in the art are fully familiar and which need no description here, so that it is evident by this arrangement I am able, quickly and conveniently and with sufficient accuracy, to make at the same time the two corrections for speed and drift.

I claim—

1. The combination of the gun 1, movable on a transverse, horizontal axis, the elongated body 16 of conducting material and contact-arm 17, the said body 16 and arm 17 being movable with reference one to the other by the movement of said gun on its said axis; the telescope 5 also movable on a transverse, horizontal axis and supported in proximity to said gun, shaft 7, intermediate mechanism, for communicating motion from said shaft to said telescope, drum 18 on said shaft 7 carrying the elongated body 19, contact-arm 20 bearing on said body 19, a source of electricity, an electrical indicating apparatus and circuit connections arranged in Wheatstone bridge, substantially as described.

2. In combination with a telescope, 5, a gun and a support, 3, movable bodily with said gun and carrying said telescope 5, the base-plate 22 pivoted on said support and having an opening, 37, a fixed pin, 38, on said support in said opening, an abutment, 39, on said base-plate 22, a spring, 40, interposed between said pin 38 and said abutment 39, a screw, 42, journaled on said base-plate 22 and bearing upon said pin 38, substantially as described.

3. In combination with a telescope, 5, a gun and a support, 3, movable bodily with said gun, a base-plate, 22, carrying said telescope pivoted on said support and having an opening, 37, a fixed pin, 38, on said support in said opening, an abutment, 39, on said base-plate 22, a spring, 40, interposed between said pin 38 and said abutment 39, a screw, 42, journaled on said base-plate 22 and bearing upon said pin 38, and a micrometer-head, 43, on said screw and a fixed mark or index in proximity to said head: the said head being suitably graduated to enable the telescope to be adjusted in azimuth to compensate for displacement of the projectile due to the movement of the gun, or said distant object, or both, substantially as described.

4. In combination with a telescope 5, a base-plate, 22, carrying said telescope, pivoted on said support and having an opening 37, a pin 38 on said support in said opening, an abutment 39 on said base-plate, a spring 40 interposed between said pin 38 and said abutment, 39, a screw 42 journaled on said base-plate and bearing upon said pin 38, a micrometer-head 43 on said screw and a fixed, graduated arc 44 in proximity to said micrometer-head: the said head 43 being suitably graduated to enable the telescope to be adjusted in azimuth to compensate for displacement of its line of sight to a distant object due to the bodily movement of said telescope or said distant object, or both, and the said fixed arc 44 being suitably graduated to allow of adjustment of said telescope in azimuth to compensate for drift of the projectile thrown from a gun, substantially as described.

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