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THE FISKE RANGE-FINDER.

IT has long been recognized as a prime necessity of effective gunnery at sea that the gunners shall know at each instant the exact distance of the ship or object at which they are to shoot. To realize this, we must reflect, that, if two ships are approaching each other at the rate of even twelve knots each, their distance apart is changing at the rate of 13⅓ yards per second. This means that in less than 4 seconds the distance or range will change 50 yards, which represents the distance apart of two consecutive graduations of the sight-bar of a modern rifle-gun: in other words, the sight-bars of high-powered guns are usually graduated to 50 yards, and it is necessary for effective shooting that an error of 50 yards must not be made in estimating the distance and timing the discharge of the gun as the ship rolls from side to side. But if this change of 50 yards be made in 4 seconds, it is plain that we must have an instrument that will give the range with less than 4 seconds' delay, and give it, at the very least, with less than 50 yards error. Such an instrument is called a "range-finder." A description of a new and exceedingly clever, as well as thoroughly scientific device, for ascertaining the range and position of distant objects, designed by Lieut. Bradley Allan Fiske, forms the subject of this article.

The invention consists of a new method of finding the range and position of a distant object, which depends upon the determination of a fractional portion of a conducting body bearing in length a ratio to the angle included between two lines of sight directed upon said distant object and the measurement of the electrical resistance of said length.

The accompanying drawings are (Fig. 4 excepted) all electrical diagrams, not drawn to scale, and symbolically represent the invention. In Fig. 1 is shown a Wheatstone bridge, in one member (*a*) of which is arranged a body of conducting material in arc form, and a movable arm traversing the same. In Fig. 2 is shown a Wheatstone bridge having arcs and movable arms arranged in two members, *a b*. In Fig. 3 is shown a Wheatstone bridge in which arcs connect adjacent members, as *a c* and *b d*, and movable arms sweeping over said arcs are connected to the battery. Fig. 4 is a mathematical diagram illustrating the method of determining the angle ATC. Fig. 5 shows a disposition of the range-finder in connection with a dead-beat galvanometer; and Fig. 6, the same in connection with the slider. Similar letters of reference indicate like parts.

In Fig. 1, let *a b c d* represent the four members of an ordinary Wheatstone bridge, and *g* the transverse member, in which is connected the galvanometer *g'*. A battery *f* is also connected to the bridge in the usual way. In the members *c* and *d* are placed the fixed resistances *c'* and *d'*, and in the member *b* the variable resistance *b'* also, as usual. One wire from battery *f*, however, connects to the end of member *c*, and also to the pivot *l* of a swinging arm *i*. The extremity *k* of arm *i* moves over and maintains electrical contact with an arc *h* of conducting material, which has one extremity *j* connected, as shown, to the member *a* of the bridge. It is obvious that when the arm *i* is in the position shown in full lines in Fig. 1, then the current will traverse the whole arc *h*; and when said arm is in the position indicated by dotted lines (Fig. 1), then the arc *h* will be cut out, and the current will pass directly to member *a*. Now assume the arc *h* to be made of such material, and so proportioned that its electrical resistance to a current traversing it will be proportional to the length of arc included between the contact end *k* of arm *i* and the connecting-point *j* of member *a* with said arc. Therefore the resistance interposed in the member *a* of the bridge will be commensurate with the angle *j l k*; and if this resistance be known, the angle is also known. Let it now be assumed that the galvanometer *g'* and variable resistance *b'* be located at some point distant from the moving arm *i*, from which said arm is invisible or inaccessible. Clearly, then, an observer stationed at the galvanometer *g'* and resistance *b'* can, by noting the galvanometer and adjusting the resistance in the usual way, determine the resistance equilibrating any position of arm *i* along the arc *h*, and so discover the angle of adjustment of said arc; or, having adjusted the resistance *b'* at some given figure, the observer may, by simply noting the galvanometer or any other suitable indicating device, visual or audible, determine when the arm *i* is placed at a desired angle corresponding to the adjusted resistance, and this indicating device may obviously be at the place where the moving arm is located, so that the operator there may thus know when he has placed the arm at the predetermined point or at the distant station, so that the operator in charge of the resistance *b'* may know that the arm has been adjusted properly; or two indicating devices in the same circuit may give warning to both operators, as above, simultaneously.

Referring now to Fig. 2, it will be apparent, that, in lieu of the variable resistance *b'* in the member *b*, there is arranged an arc *h'* and swinging arm *i'*. The arc *h'* is connected at one end *j'* to the member *b*, and the swinging arm *i'* makes contact at one end *k'* with said arc, and to its pivot *l'* is connected the member *d*. The arrangement and construction of arc *h'* and arm *i'* are similar to those of arc *h* and arm *i*: consequently, when the arm *i* is set at a certain point on the arc *h*, the arm *i'* must be set at the corresponding point on the arc *h'*, in order that the resistance of the lengths of the arcs *h h'* respectively between the point *k* and point *h* and point *k'* and point *h'* may balance; hence, if the arm *k* be set at a certain angle, the observer at arm *k* may recognize that angle by noting the position of the arm *k* and the galvanometer, as before. It will be observed, however, that the effect of moving the arm *i* over arc *h* is practically to lengthen or shorten or to interpose more or less resistance in the member *a* of the bridge, and by