Dec. 9, 1924. 1,518,882

J. B. WALKER ET AL

FIRE CONTROL OF GUNS

Original Filed July 27, 1920 5 Sheets-Sheet 1

Fig. 1.

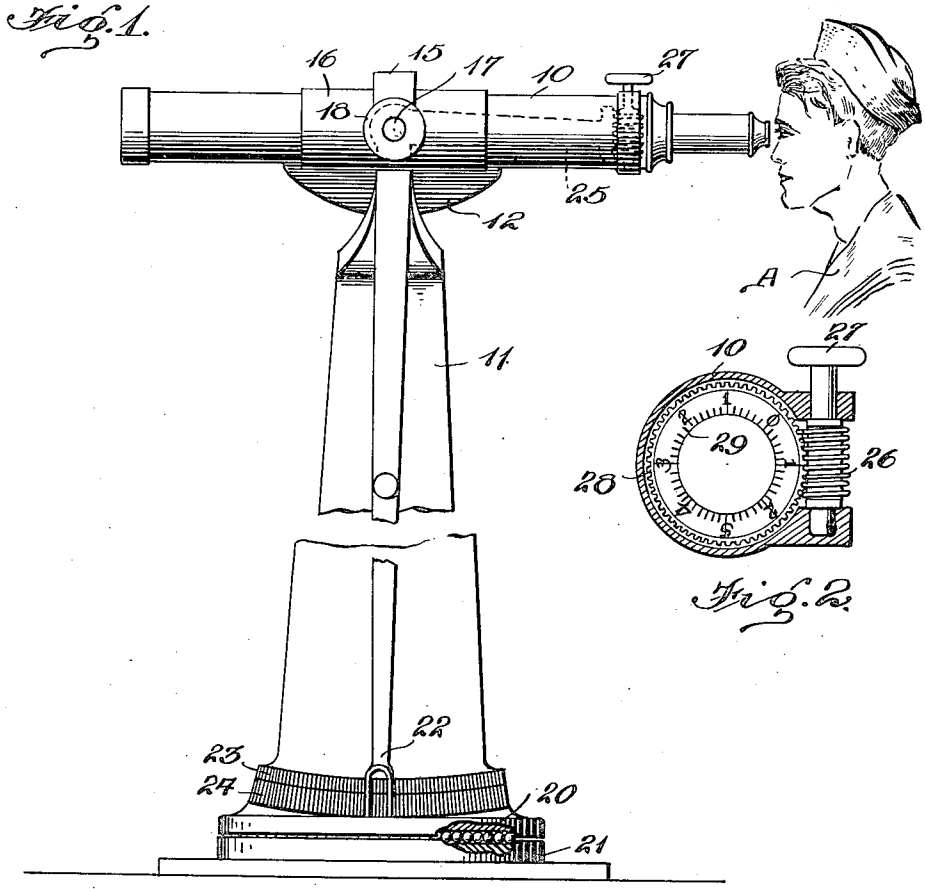
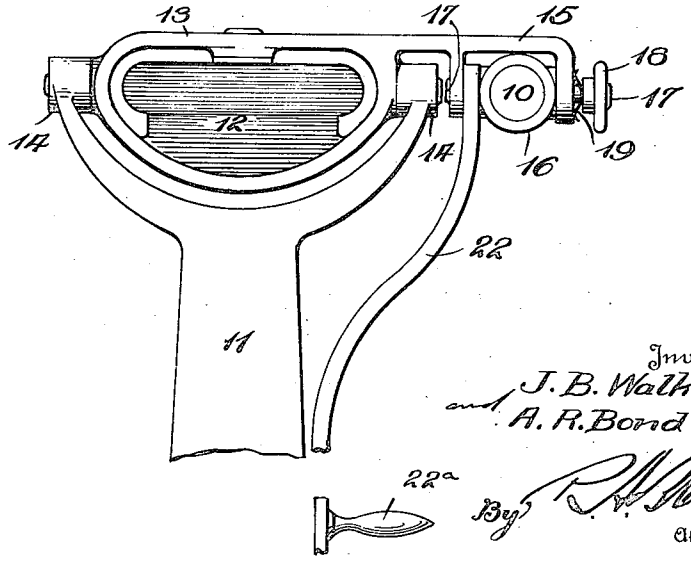


Fig. 2.

Fig. 3.



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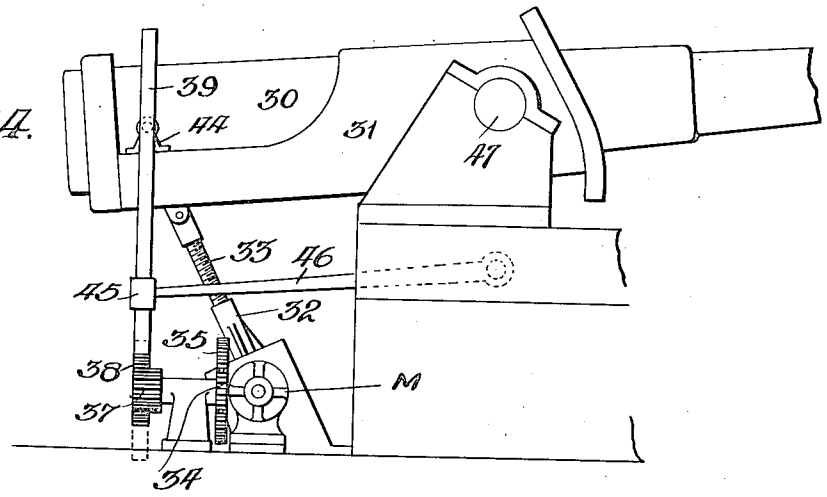
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FIRE CONTROL OF GUNS

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Fig. 4.



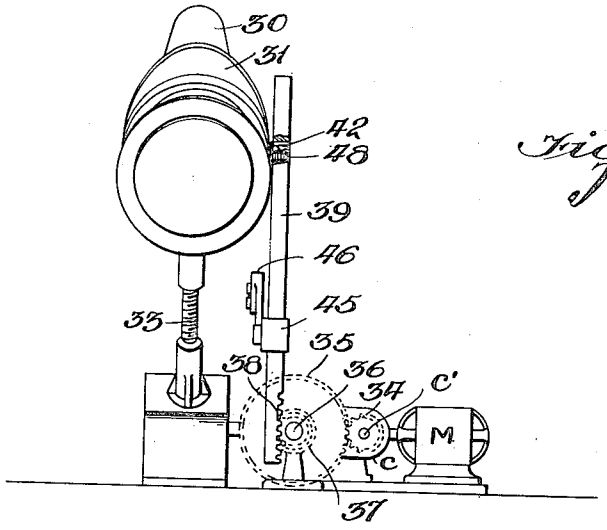


Fig. 5.

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FIRE CONTROL OF GUNS

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Fig. 6.

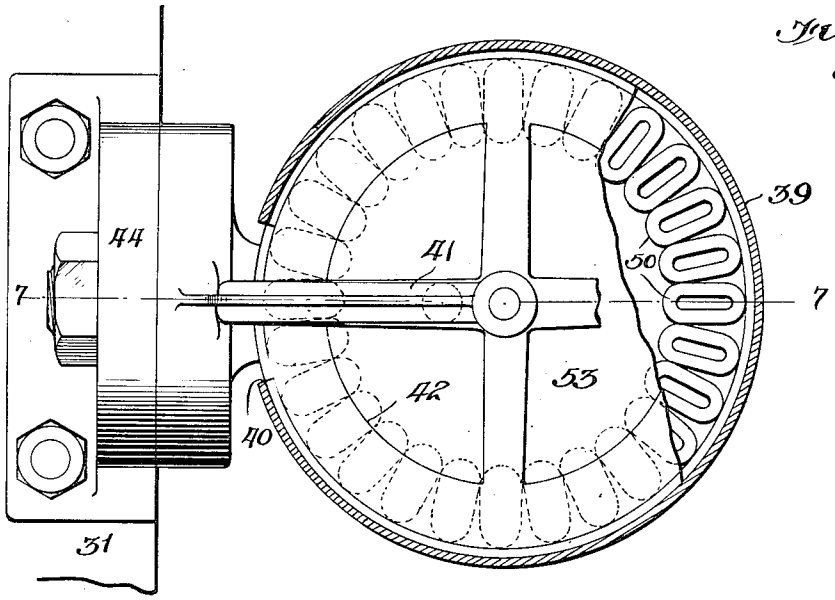
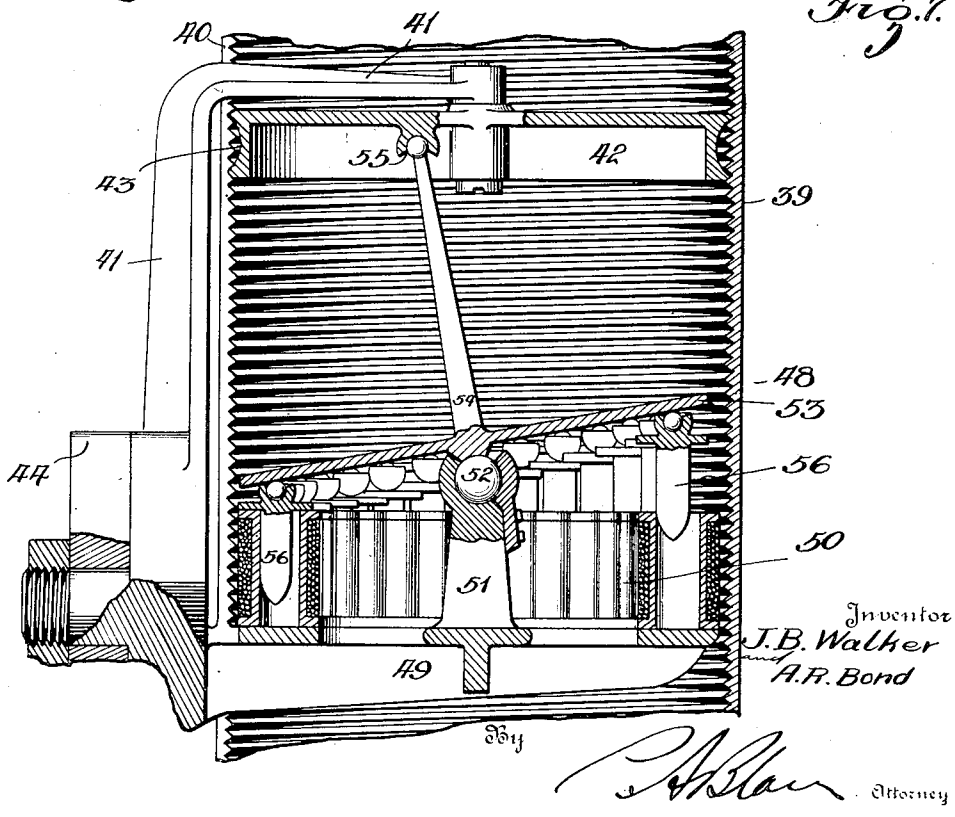


Fig. 7.



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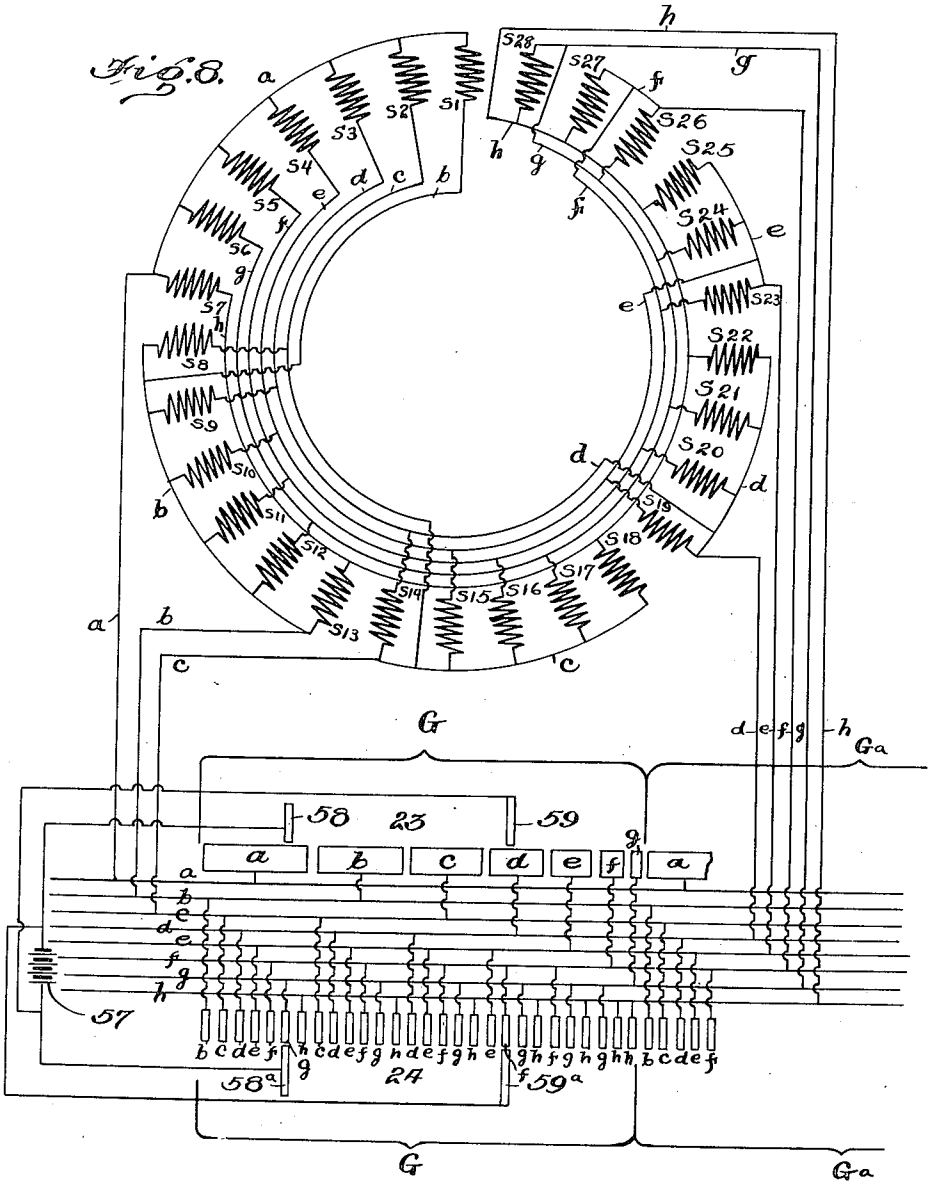
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FIRE CONTROL OF GUNS

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Fig. 8.



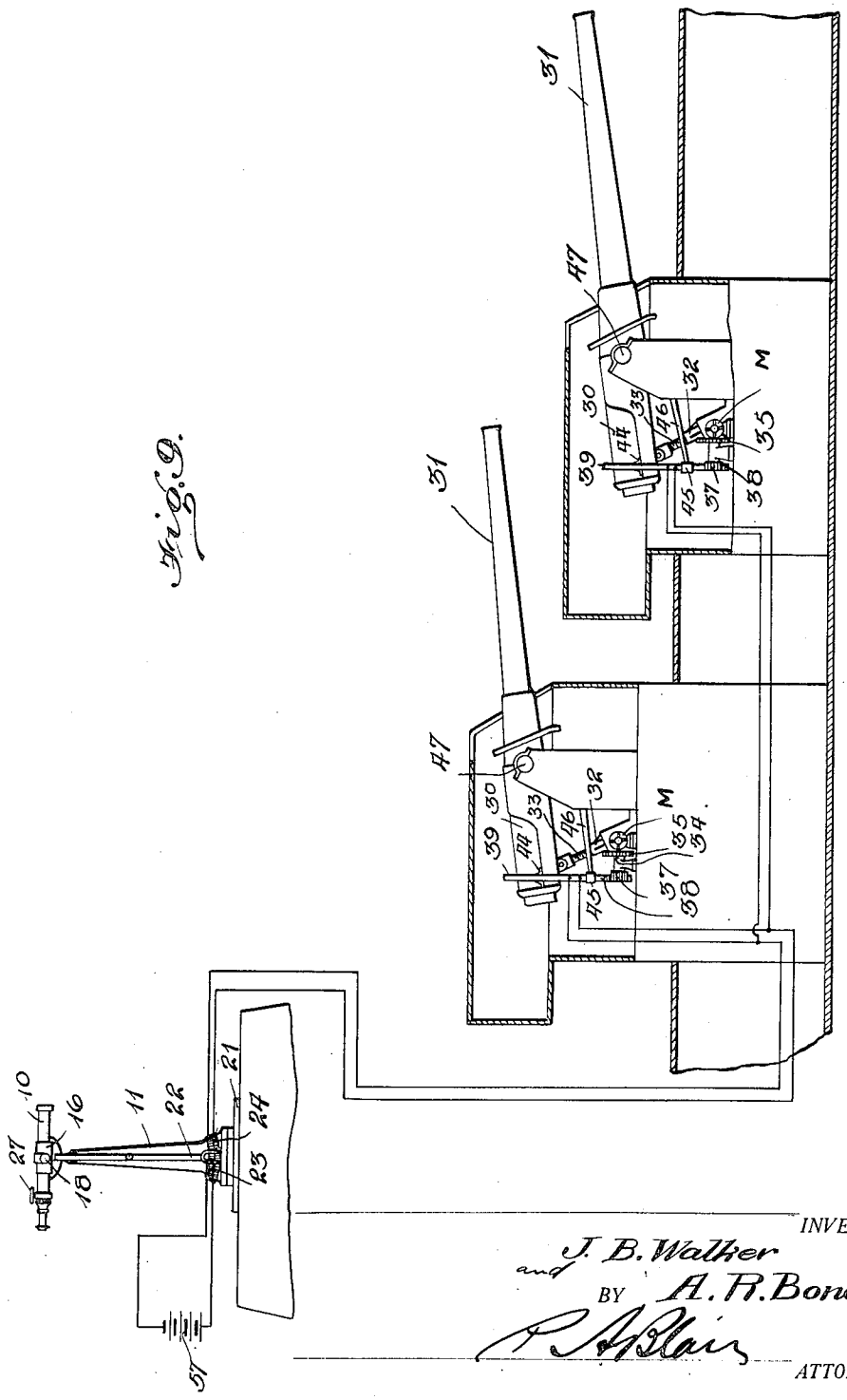
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J. B. WALKER ET AL

FIRE CONTROL OF GUNS

Original Filed July 27, 1920 5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE.

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FIRE CONTROL OF GUNS.

Application filed July 27, 1920, Serial No. 399,405. Renewed August 1, 1924.

To all whom it may concern:

Be it known that we, JOHN BERNARD WALKER and ALEXANDER RUSSELL BOND, citizens of the United States, residing at Brooklyn, New York, and Plainfield, New Jersey, respectively, have invented new and useful Improvements in Fire Control of Guns, of which the following is a specification.

This invention relates principally to batteries of guns of large calibre, such as form the primary armaments of warships and fortifications.

Of late years it has come to be realized that the most effective results are achieved when a whole battery is discharged at the same instant and when all of the hits are concentrated within a limited area of the enemy's ship or fortification. Under the present methods as carried out on warships, the range is found by instruments of precision, known as range-finders, and the range as thus found is transmitted to each gun, where the sights are set for the range, as given. The traversing of the guns, that is, their movement in the horizontal plane, is done by one man in each turret, who trains the turret by means of suitable turning gear, and endeavors to keep the vertical wire of his gun-sight telescope continually on the center of the enemy's ship. Similarly, the proper elevation of each gun is maintained by one man, the pointer, who elevates or depresses the gun, through hand-controlled mechanism, so as to compensate for the rolling of the ship, and maintains the horizontal wire of his gun-sight telescope always upon the water line of the enemy. When all the guns of the broadside are loaded and aimed, a signal to fire is sent to each gun from a central station, and each pointer, if he is on the target, presses a button and fires his gun.

Under these methods it is found that, due to the variation in the skill both of the pointers and trainers, there is usually a considerable dispersion of the shots, frequently amounting to several hundred yards, both in range and traverse, that is to say, in the vertical and the horizontal planes, some of the shots, say, falling beyond and others short of the target, and some falling, say, to right and others to left of the target.

These errors are corrected by the spotter, an observer who, from a platform at the top of the mast, guesses by the splash of the projectiles how much the mean point of impact is over or short, to right or left of the target. This dispersion coupled with the foreshortening due to the low elevation of the spotter's platform relative to the modern battle ranges of five to seven miles, renders the spotter's corrections of doubtful value.

It is the object of the present invention to eliminate the dispersion due to the individual aiming of the guns, by so interlocking the guns of a battery that the variation in elevation among them shall be reduced to a minimum, say one minute of arc, by providing distant control means whereby a plurality of guns can be pointed by one experienced operator, thus making it possible to eliminate, to a large extent, the personal equation, which has hitherto figured largely, owing to frequent errors in sightsetting, pointing, transmitting of ranges, orders, etc. Moreover, one object of this invention is to enable the guns to be correctly aimed and fired at any stage of the roll or pitch, and thus to save the valuable time now lost in the present standard system in which the guns can be correctly positioned during only a small part of the roll. Furthermore, this invention enables the master gun-pointer to change the lay of the guns with respect to the line of sight, or reference plane by greatly simplified means, thus saving much time and confusion in making spotting corrections, necessary changes in directorscope settings due to longer or shorter rolls, etc.

Reference is to be had to the accompanying drawings forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the views, and in which—

Figure 1 is a side elevation of a telescope equipped with means for electrically controlling the elevation and depression of one or more guns;

Figure 2 is a sectional view taken through the adjusting mechanism 27 shown in Figure 1.

Figure 3 is a front view of the upper portion of a pedestal on which the telescope shown in Figure 1 is mounted.

Figures 4 and 5 are side and end views respectively of a gun equipped with electrically controlled elevating mechanism;

Figure 6 is a plan view partly in section

of a motor used in connection with the electric control of the elevating mechanism of a gun;

Figure 7 is a section taken on line 7—7 of Figure 6,

Figure 8 is a wiring diagram of said means for electrically controlling the elevation of one or more guns;

Figure 9 is a diagrammatic view showing plurality of units.

Figures 1 to 8 inclusive show an electrical means of controlling the elevation and depression of one or more guns, said means consisting essentially of two principal elements. namely, a telescope carrying a contact lever adapted to sweep over and make electrical connection with a series of contacts as said telescope is swung up or down with respect to the ship on which it is carried, and a controller mounted on each of said guns, said controller being actuated by a motor under the control of said contact lever and operating a speed variator of a mechanism for elevating the gun. The telescope is shown at 10 in Figure 1 and is supported on a pedestal 11. In order to facilitate the keeping of the telescope fixed upon the target while the vessel on which the pedestal 11 is carried is rolling more or less, a gyroscope 12 is mounted in the upper end of the pedestal as indicated in Figure 3. The gyroscope wheel is preferably mounted to rotate in the horizontal plane, although it might be arranged to rotate in the vertical plane, without invalidating our invention. The axis of the gyroscope wheel is mounted in a frame member 13 which in turn is mounted to rotate on a horizontal axis in bearings 14 of the pedestal 11. The member 13 is provided with an extension bracket 15 in which is mounted the telescope 10, the latter being preferably in the plane of the gyroscope, as shown in Figure 3. The telescope 10 is fitted into a sleeve 16 provided with trunnions 17 which are journaled in bearings in the bracket 15. Threaded in one of the trunnions is a thumb-screw 18 adapted to be screwed against a spring 19, to press said spring against the bracket 15 and thus provide an adjustable frictional engagement between the telescope 10 and the bracket 15 which will retain the telescope 10 in any desired angular adjustment with respect to the bracket 15 and yet permit the telescope to be moved by hand to any desired angle in the vertical plane. In order to permit of angular movement of the telescope in the horizontal plane the pedestal 11 is mounted to swivel on a ball bearing 20 in the base plate 21.

Mounted on one of the trunnions 17 is a bell-crank lever, one arm 22 of which bears contact members adapted to make electrical connection with contacts in sectors 23 and 24. The other arm of said bell-crank lever terminates in a toothed sector 25 as shown by dotted lines in Figure 1. Said sector 25 is engaged by a worm 26 which may be turned by a thumb screw 27 to vary the angle between the longitudinal axis of the telescope 10 and the longitudinal axis of the arm 22. In order to provide for a very fine adjustment of said angle a worm wheel 28 is mounted within the telescope 10 in the focus of the eye-piece and with its teeth engaging the worm 26. Said worm wheel is provided with an annular index card 29 preferably of transparent material upon which is engraved a scale of degrees and minutes calibrated to show with respect to some fixed mark, such as a cross-hair, the variation from normal of said angle between the telescope and the arm 22.

It is the object of a pointer A to keep the telescope trained upon the target while the ship rolls under him, thereby producing a relative oscillatory movement between contact lever 22 and contact sectors 23 and 24.

Referring to Figures 4 and 5 we show a gun 30 mounted in sleeve 31 and adapted to be elevated or depressed by electric motor M driving through suitable gear, the nut 32 acting upon elevating screw 33. To vary the speed and stop and reverse the direction of rotation of nut 32, a variator C is provided which may be either a hydraulic speed gear or a rheostat acting upon the field of the motor M or any other device well known in the art. The control C′ of the variator C bears a pinion 34 engaging a spur gear 35, keyed to shaft 36 upon which in turn is keyed a pinion 37 engaging a rack 38. The upper portion of said rack consists of an internally threaded hollow shaft 39. Said shaft is slotted at 40 as shown in Figures 6 and 7 to admit a bracket 41 upon which is mounted, to turn, a threaded ring 42 engaging the threads formed on the inner surface of said shaft 39. In order to reduce friction the threaded face of the ring 42 is recessed as shown in Figure 7 at 43. The bracket 41 is pivoted upon a bracket 44 mounted on the gun sleeve 31. The ring 42 forms an upper bearing for said shaft 39, while a sleeve 45 pivoted to an arm 46 provides a lower bearing for the shaft 39. The arm 46 is pivoted vertically under the fulcrum 47 of the sleeve 31 so that as the gun 30 is oscillated the shaft will be maintained in vertical position on the principle of the parallel ruler. The threaded ring 42 is revolved by a gyratory motor 48. Figure 5, under control of the contact lever 22 (Figure 1). Said motor is shown in detail in Figures 6 and 7. The bracket 41 is formed with an arm 49 projecting through the slot 40 of the shaft 39, and at a suitable distance below the ring 42. Upon this arm are supported a plurality of solenoids 50 arranged in a circle concentric with the axis of the ring 42. At the center

of the said circle is a pedestal 51 formed with a socket bearing at its upper end to receive a ball 52 affixed to a disc 53. Rising perpendicularly from the center of said disc is an arm 54 which at its upper end is connected with the ring 42 to one side of the center of said ring by a ball and socket joint 55. Depending from the under surface of the disc 53 is a set of armatures 56 one for each solenoid. The armatures are connected to said disc by ball and socket joints as shown in Figure 7, so that they may hang vertically regardless of the inclination of the disc 53. The armatures are of such form as to fit freely into the solenoids and are of such length as not to be entirely withdrawn from the solenoids as they are elevated and depressed by the gyratory motion of the disc 53. It will be evident that if the solenoids 50 are successively energized they will successively attract their armatures causing the disc 53 to pursue a gyratory motion about the ball 52 as a center while the upper end of the arm 54 will describe a circle causing the ring 42 to revolve on its axis, thereby feeding the shaft 39 up or down, depending upon the direction of rotation. The armatures 56 are preferably polarized and while the solenoids are successively energized to attract the armatures on one side of the circle, those on the diametrically opposite side will be successively energized in the reverse direction repelling their armatures, thereby doubling the power of the motor. Preferably only two oppositely disposed solenoids are energized at a time so that when the sweep of energizing current about the ring of solenoids pauses the rotation of the disc 53 will also pause with the arm 54 inclined toward the attracting solenoid and away from the repelling solenoid.

Our method of connecting the solenoids 50 with the contacts in the sectors 23 and 24 (Figure 1) is shown in Figure 8. A large number of contacts is provided in each of the sectors 23 and 24, preferably one for each minute of arc. The contacts are grouped in sets, each set comprising as many pairs of contacts as there are solenoids in the motor. In our drawings we have shown a motor with twenty-eight solenoids and consequently the groups of contacts for this motor must be arranged in groups of twenty-eight pairs. To avoid running multiplicity of wires to the motor we use but eight wires in twenty-eight different combinations.

In Figure 8 these wires are designated *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, respectively, and the windings of the solenoids are respectively designated as S^1, S^2, S^3, S^4, S^5, S^6, S^7, S^8, S^9, S^{10}, S^{11}, S^{12}, S^{13}, S^{14}, S^{15}, S^{16}, S^{17}, S^{18}, S^{19}, S^{20}, S^{21}, S^{22}, S^{23}, S^{24}, S^{25}, S^{26}, S^{27}, S^{28}. As the contacts are virtually terminals of the wires, *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, they are assigned the corresponding letters in Figure 8. The combinations of contacts and wires used are as follows: *ab*, *ac*, *ad*, *ae*, *af*, *ag*, *ah*, *bc*, *bd*, *be*, *bf*, *bg*, *bh*, *cd*, *ce*, *cf*, *cg*, *ch*, *de*, *df*, *dg*, *dh*, *ef*, *eg*, *eh*, *fg*, *fh*, and *gh*. Through said combinations of wires current is conducted to and from the solenoid windings S^1, S^2, S^3, S^4, S^5, S^6, S^7, S^8, S^9, S^{10}, S^{11}, S^{12}, S^{13}, S^{14}, S^{15}, S^{16}, S^{17}, S^{18}, S^{19}, S^{20}, S^{21}, S^{22}, S^{23}, S^{24}, S^{25}, S^{26}, S^{27}, S^{28} respectively. Where there are several adjacent contacts to be connected to the same wire it is preferable to combine them into a single contact plate. In the segment 23, for instance, all the *a* contacts of a group are combined into a single contact plate, all the *b* contacts into another plate, etc. A complete group of contacts is enclosed within the brackets G, G and it will be understood that similar groups will be repeated throughout the segments 23 and 24. Current is supplied to the contacts from the battery or other source of supply 57 through the contacts 58, 58^a and 59, 59^a carried by the contact lever 22. It will be observed that the current admitted through the contacts 58, 58^a is of opposite polarity from that admitted through the contacts 59, 59^a, and that the spacing is such that the former pair of said contacts will always energize a solenoid diametrically opposite the solenoid energized by the latter pair of contacts.

In operation the pointer A keeps his telescope trained upon the target, moving it with respect to the gyroscope 12, if necessary, by means of the handle 22^a. If he finds that it is necessary to elevate the guns a certain number of degrees and minutes he operates the thumb screw 27 to move the contact lever through the same angular distance out of the perpendicular to the axis of the telescope, as indicated by the index card 29 at the focus of his eyepiece. As the contact lever is moved over the contact sectors 23 and 24 it successively energizes solenoids in the motors 48 on each of the guns causing the controller shafts 39 to be elevated through a corresponding distance. For the sake of clearness let us consider that the ship is not rolling and that the elevating mechanism is at rest. As the shaft 39 rises it turns the variator shaft C′, starting the elevating mechanism and causing it to elevate the gun. But as the gun is elevated, that is as the breech of the gun swings downward, it also carries the motor 48 and its controller shaft 39 downward, owing to their attachment to the sleeve 31, bringing the control shaft C′ back to normal or rest position and stopping the gun when its breech has been depressed as much as the shaft 39 has been elevated. The pitch of the thread in the hollow shaft 39 is such that the gun will be brought to rest when the gun has traveled through precisely the same angle as has the lever 22.

When the ship rolls there is a relative motion between the telescope and the pedestal 11 which causes the arm 22 to sweep over the contact sectors 23 and 24 and the shafts 39 on the guns to feed up and down correspondingly. As the shaft moves downward it operates each elevating mechanism through the variator C, elevating the breech of each gun. When the shaft is moved upward it reverses each elevating mechanism causing the breech of each gun to be depressed. It will be evident that the elevation of the guns or their depression produced by operating the thumb screw 27 will be superimposed on the oscillatory elevation and depression produced by the sweep of lever 22 over the contact sectors 23 and 24 as the ship rolls.

It will be observed that the control shaft C′ of the variator is turned by the differential motion between the shaft 39 and the gun. As said shaft 39 must always move first before the elevating mechanism can be thrown into action there must necessarily be a lag in the motion of the gun with respect to the telescope 10. The time interval of this lag may be varied by varying the gear ratio between the shaft rack 38 and the control shaft C′. If, for instance, it be desired to make the lag one-fourth of a second and if the control shaft must be turned through 360 degrees to bring the elevating mechanism to full speed, and if again the rack 38 will move through a distance Z in a quarter of a second when traveling at a rate that would call for full speed of the elevating mechanism, the gearing between said rack and said control shaft C′ must be such that a movement Z of the rack will produce one complete turn of the control shaft. The speed controlling mechanism must be such that the speeds will vary directly with the angular motion of the control lever. Then the elevating mechanism will duplicate the speed variations of the rack 38 but always with lag of one-quarter second. By altering the gearing between the rack and the variator the lag may be made more or less than one-quarter second, as desired. Now it is found in practice desirable to press the firing button of a gun a quarter of a second before the horizontal hair line of the pointers telescope comes into line with the target so as to allow for the time consumed in depressing the button. This necessary lag is utilized in our mechanism to throw the control lever and hence is automatically taken care of, making it unnecessary for the pointer to depend upon guesswork as to the amount of elevation or depression required to bring the gun to true aim a quarter of a second after the touching of the firing button.

What we claim is:

The combination with a plurality of guns and elevating mechanism operating on each of said guns, of a plurality of speed variators for controlling said elevating mechanism mounted on relatively fixed supports, shafts respectively mounted on said guns, a telescope, a contact lever connected thereto, series of contacts adapted to be engaged by said lever, motors controlled by said contact lever contacting with said series of contacts, said motors operating to move said shafts up or down with respect to said guns, and means for operating said variators by the movement of said shafts with respect to said fixed supports.

Signed at New York, New York, this 10th day of February, 1920.

JOHN BERNARD WALKER.
ALEXANDER RUSSELL BOND.