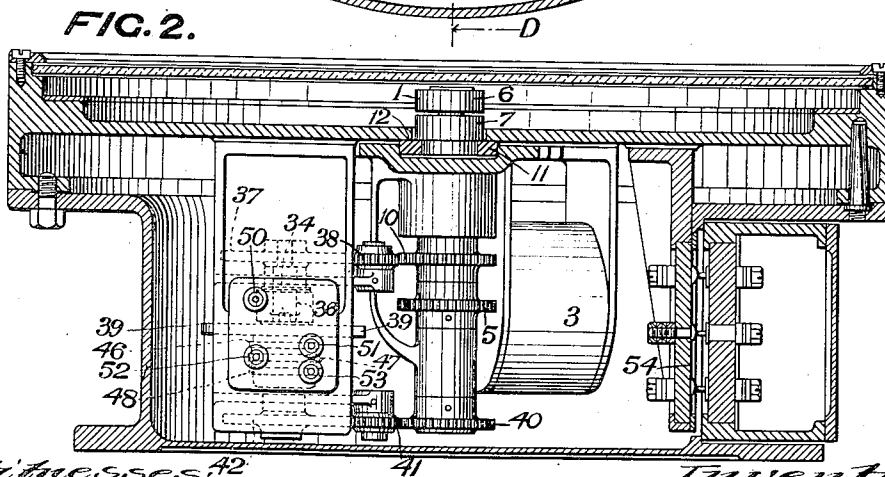
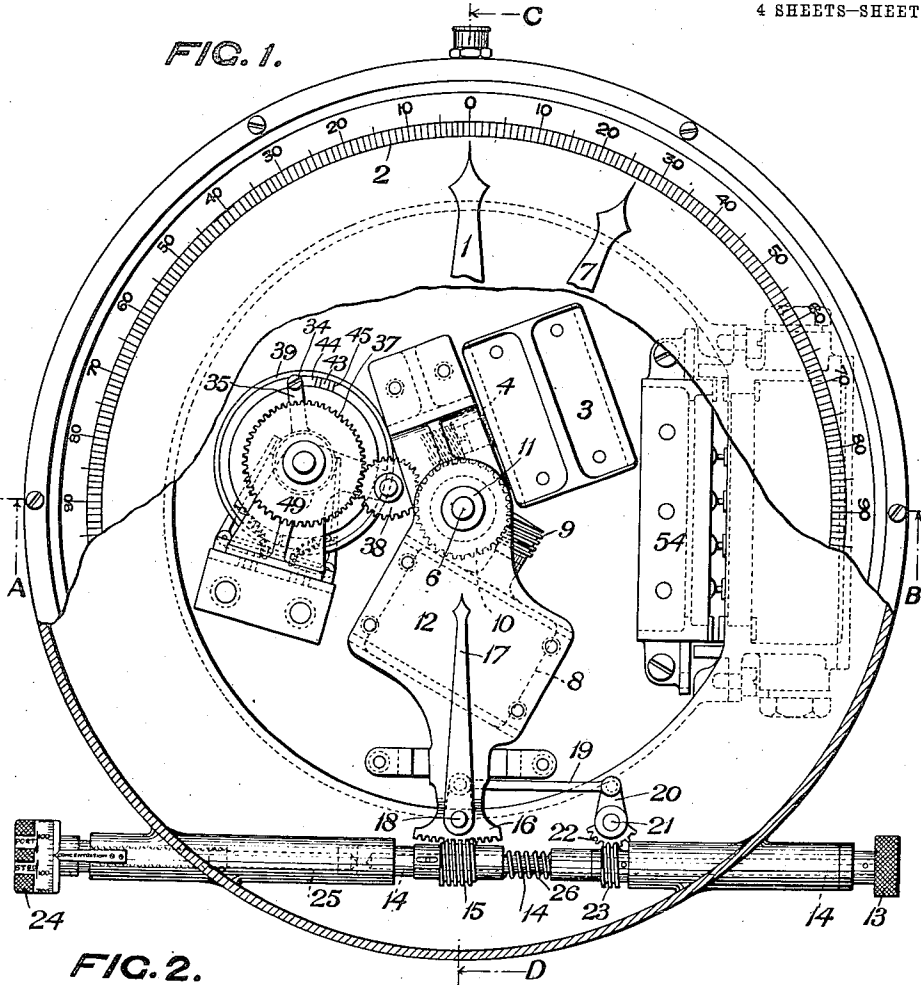


A. H. POLLEN & H. ISHERWOOD.
 NAVAL FIRE CONTROL APPARATUS.
 APPLICATION FILED JAN. 27, 1913.

1,077,965.

Patented Nov. 4, 1913.

4 SHEETS—SHEET 1.



Witnesses:
 M. E. McRae.
[Signature]

Inventors
 Arthur H. Pollen
 by Harold Isherwood
[Signature] Attorney

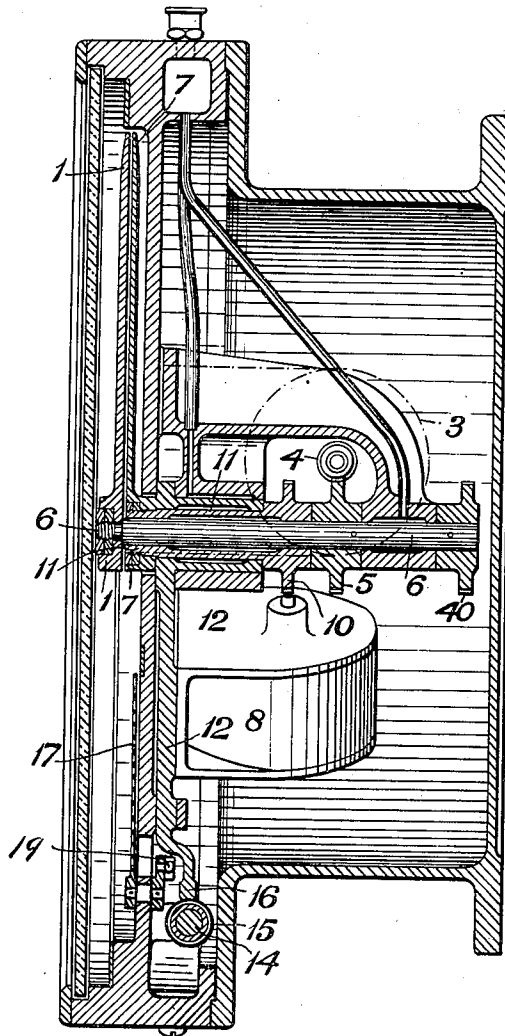
A. H. POLLEN & H. ISHERWOOD.
 NAVAL FIRE CONTROL APPARATUS.
 APPLICATION FILED JAN. 27, 1913.

1,077,965.

Patented Nov. 4, 1913.

4 SHEETS—SHEET 2.

FIG. 3.



Witnesses:

M. E. McRader.

[Signature]

Inventors

Arthur H. Pollen
 by Harold Isherwood

[Signature]

Attorney

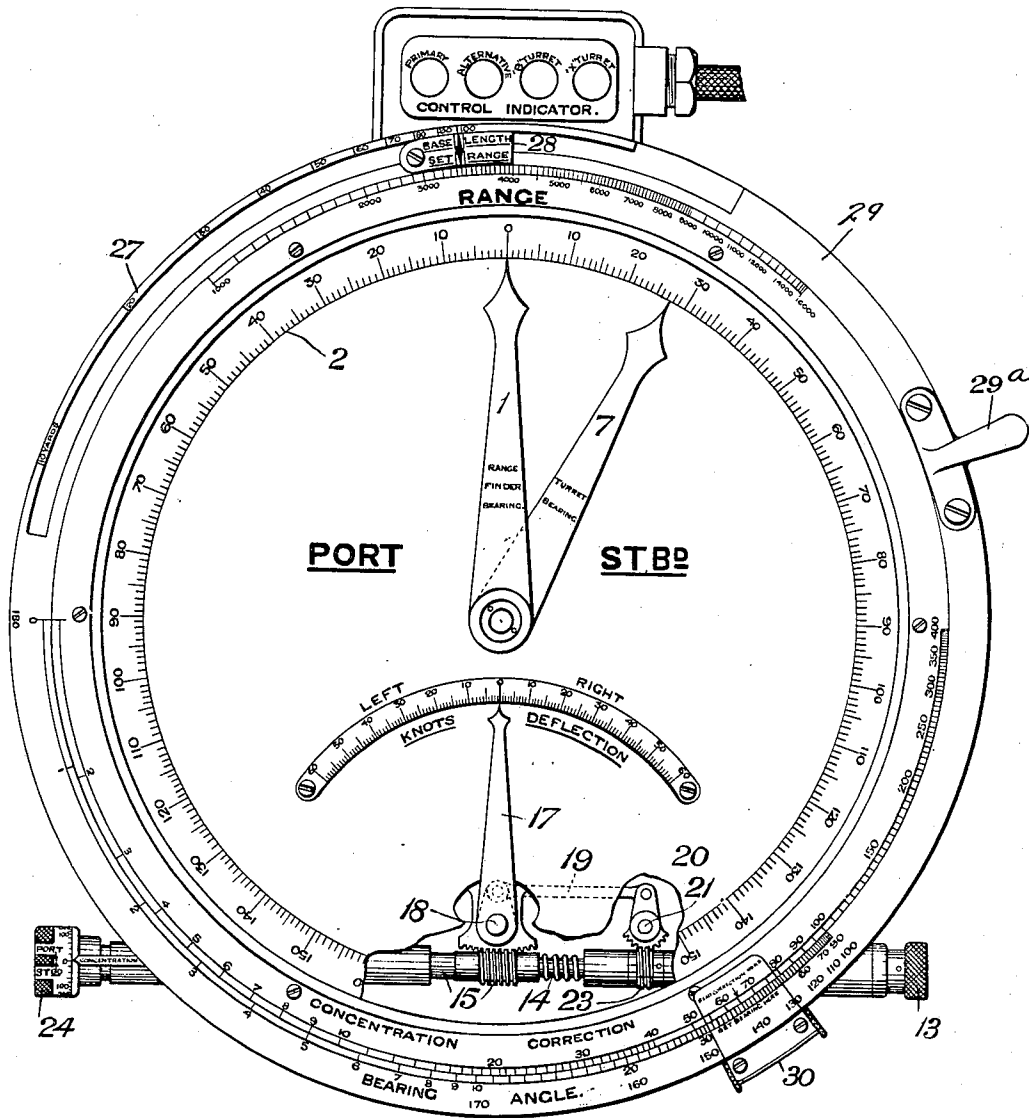
A. H. POLLEN & H. ISHERWOOD.
 NAVAL FIRE CONTROL APPARATUS.
 APPLICATION FILED JAN. 27, 1913.

1,077,965.

Patented Nov. 4, 1913.

4 SHEETS—SHEET 3.

FIG. 4.



Witnesses:

M. E. McRader.

[Signature]

Inventors
 Arthur H. Pollen
 by Harold Isherwood

[Signature]

Attorney

A. H. POLLEN & H. ISHERWOOD.
NAVAL FIRE CONTROL APPARATUS.
APPLICATION FILED JAN. 27, 1913.

1,077,965.

Patented Nov. 4, 1913.

4 SHEETS-SHEET 4.

FIG. 5.

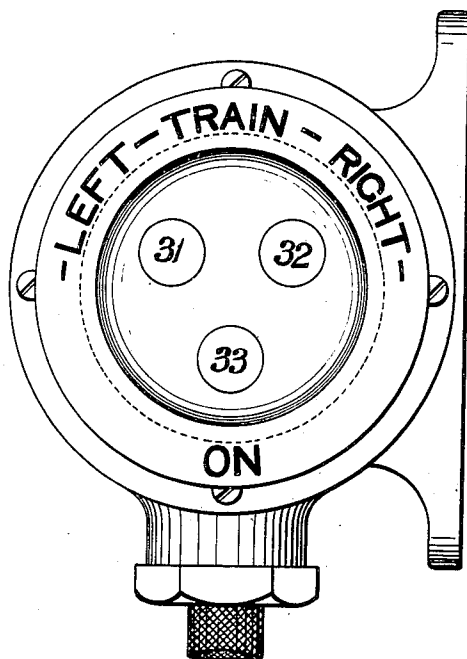
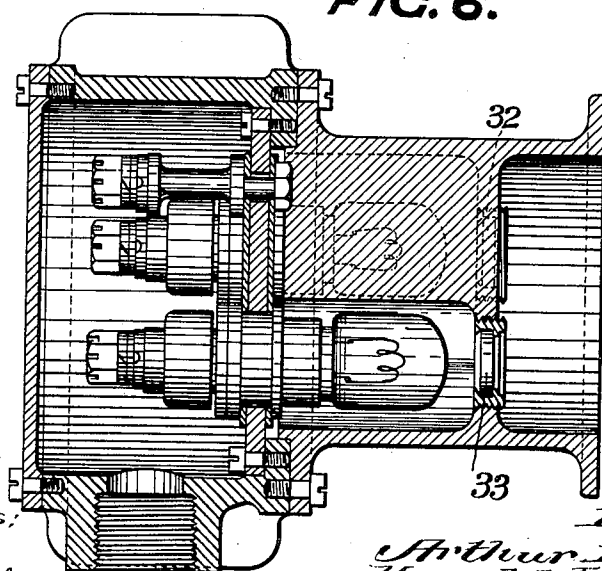


FIG. 6.



Witnesses:

M. E. McNamee.

[Signature]

Inventors

Arthur H. Pollen

by Harold Isherwood

[Signature]

Attorney

UNITED STATES PATENT OFFICE.

ARTHUR H. POLLEN, OF LONDON, AND HAROLD ISHERWOOD, OF YORK, ENGLAND.

NAVAL FIRE-CONTROL APPARATUS.

1,077,965.

Specification of Letters Patent.

Patented Nov. 4, 1913.

Application filed January 27, 1913. Serial No. 744,550.

To all whom it may concern:

Be it known that we, ARTHUR HUNGERFORD POLLEN and HAROLD ISHERWOOD, subjects of the King of Great Britain, residing at 14 Buckingham street, Strand, London, England, and Bishophill House, York, England, respectively, have invented certain new and useful Improvements in Naval Fire-Control Apparatus, of which the following is a specification.

This invention relates to improved means of fire control especially adapted for use on board ship, and has for its object to enable the selection of a target to be made and to insure that the target which is being observed by the rangefinder shall be the one at which the guns are firing.

Broadly the invention consists in the provision of a dial (or series of dials) provided with two pointers, called the red and blue pointers. The dial is graduated from naught to 180° to starboard and port, and the pointers which are pivoted concentrically read against such graduations, the red pointer reading the angle made by the line of sight of the range finder with the keel of the ship, and the blue pointer reading the angle made by the gun with the keel of the ship, to starboard or port as the case may be. Leaving out of consideration for the moment certain refinements which will hereinafter be described such as means for dealing with deflection and the concentration correction necessary to allow for the position of the turret itself on the ship, it will be seen that when the red and blue pointers coincide, the gun will be trained on the same target as is being observed by the rangefinder and not otherwise.

The mechanism we prefer to employ is as follows:—Geared to the shaft of the hand-wheel for training the range finder, we arrange an electrical transmitter of any suitable kind connected by a cable with a receiver in the gun turret adapted to transmit a motion identical with that of the rangefinder to the red pointer of an indicator as above described arranged in a convenient position in the turret. Such transmitting and receiving mechanism may be of the step-by-step kind and any suitable mechanism may be employed. A similar transmitter is arranged to be operated by the movement of the gun turret and is electrically connected to a receiver driving the blue pointer of the said indicator. By

taking care that the red and blue pointers of the indicator within the turret are coincident the trainer can insure that he is aiming at the right target, that is the target with reference to which information is being obtained at the range finder.

In order to take care of the fact that to hit the target, the gun does not in general point directly at it but points a certain angle to right or left thereof, known as the deflection angle, we employ the following device: Whereas the electrical receiving mechanism operating the red pointer is fixed relatively to the dial of the indicator, the receiving mechanism operating the blue pointer is carried on a plate capable of rotation about the axis of such pointer, and provided with means for rotating the same through any desired small angle being the angle of deflection or the angle between the axis of the telescopic sight on the gun and the axis of the gun in azimuth. In this manner it is possible to superpose on the motion transmitted to the blue pointer from the transmitter operated by the turret, a motion of the receiving mechanism itself equal to the deflection angle. The blue pointer will therefore no longer indicate the position of the turret but the position of the gun sight itself in azimuth.

In order to enable the trainer to know when the pointers are in coincidence we provide a tell-tale indicator placed in proximity to the gun sights so that it can be looked at by the trainer's idle eye. The indicator contains three colored lamps, white, red and green, which are controlled by the red and blue pointers.

The red pointer is geared to a contact disk adapted to be contacted by a brush geared to the blue pointer. The contact disk carries three contacts with an insulating space between them. When the pointers are coincident the brush rests on the central contact and the white lamp becomes energized. If the blue pointer is to the right of the red pointer the right hand contact will be energized, and the red lamp will burn, indicating to the trainer that the turret pointer is to the right of the range finder pointer and that he is to train the turret to the left which he does until the white lamp appears which indicates that the two pointers are coincident and that the sights of the gun are directed on the same object as is in the field of the rangefinder at that

instant. The white, and either the red or green lamp may be arranged to be alight together if the pointers are coincident, as more fully described hereafter. If the blue pointer is to the left of the red pointer the left hand contact will be energized and the green lamp will burn, indicating to the trainer that he is to train the turret to the right.

In order that the invention may be clearly understood we proceed to describe same with reference to the accompanying drawings in which:—

Figure 1 represents a plan view of the instrument with a portion of the dial broken away to show the operating mechanism. Fig. 2 is a sectional elevation on the line A B, Fig. 1. Fig. 3 is a sectional elevation on the line C D, Fig. 1. Fig. 4 is a plan showing the apparatus for calculating the concentration correction for different positions of the control station. Fig. 5 is a view of the dial of the tell-tale indicator which is fixed in proximity to the gun sights and indicates whether the gun is pointing to right or left of the target. Fig. 6 is a sectional view of the tell-tale indicator showing the arrangement of the incandescent lamps and screens.

Referring to Figs. 1 and 3, 1 is the red hand or pointer which, indicates on the dial 2 the bearing of the target which bearing is automatically transmitted thereto by means of the motor 3 acting through the worm 4 and worm wheel 5 fast on shaft 6 which carries the pointer 1. Similarly 7 is the blue pointer which indicates on the dial 2 the angle through which the turret has been rotated from the fore and aft line of the ship. The position of the turret is communicated to this pointer from the motor 8 through a worm 9 which drives the worm wheel 10 fast on the hollow shaft 11 on which is mounted the pointer 7. The motors 3 and 8 may be of any suitable design for reproducing motion at a distance, and may be of the step-by-step type. They are employed in conjunction with suitable transmitting gear driven by the range finder and the turret respectively or the rangefinder transmitter may be operated manually from the control station. Any suitable form of transmitting and receiving mechanism may be employed. It will be seen that since the red pointer 1 indicates the bearing of the target and the blue pointer 7 the angular direction of the turret relative to the keel of the ship, the trainer can by observing whether the red and blue pointers are coincident make sure that he is aiming at the right target.

The mechanism for setting the deflection angle is clearly shown in Figs. 1 and 3. The motor 8 which communicates a motion equal to that of the turret to the worm wheel 10 is mounted on a base plate 12 which is piv-

oted about the axis of the shafts 11 and 6 so that the motor 8 is capable of being bodily carried around the shaft 11 through a small angle. This motion is produced by means of the knurled head 13 operating through a shaft 14 and worm 15 to displace the toothed sector 16 which forms part of the base plate 12, through a small angle around the shaft 11. In this way the deflection angle can be superposed on the reading of the pointer 7, which now indicates approximately the position of the gun sight itself. The amount of deflection so set is indicated on a dial shown in Fig. 4 by the position of the pointer 17 which is pivoted at 18 and driven through a link 19 from a rocking lever 20 pivoted at 21 and whose position is controlled by the worm sector 22 which is driven by the worm 23 fast on the shaft 14 which carries the knurled head 13. There is still a small correction called the concentration correction which is designed to allow for the different positions of the various turrets on the ship itself relative to the control station. This correction is set up by means of the knurled head 24 mounted fast on the shaft 25 which is provided with a screw thread as shown so that a rotation of the head 24 will move the shaft 25 by a small amount lengthwise in one direction or the other. The member on which the worm 15 is formed is mounted on the squared shaft 14 so that it can slide but not rotate thereon. By means of the spring 26 the member 15 is kept pressed to the left so that it always contacts with the extremity of the screwed shaft 25. In this way rotation of the knurled head 24 moves the worm 15 bodily axially without rotating it and thus transmits motion to the pivoted base plate 12, while rotation of the knurled head 13 rotates the shaft 14 and therefore the worm 15 without displacing it axially and thus communicates in a well known manner a quite independent motion to the base plate 12 and therefore to the blue pointer 7. We provide as shown in Fig. 4 means for calculating what is the value of the concentration correction at any given range and bearing for any distance of the control station at the moment in use from the turret in question. The apparatus is designed on the principle of the circular slide rule and consists of a fixed scale 27 engraved on a movable ring 29 and representing the base-length or the horizontal distance between the range finder or control station and the turret in question, upon which scale this distance is set up by moving the cursor 28 which is carried in a groove in ring 29 to coincide with any particular reading. The range is then set by moving, by means of the handle 29^a, the ring 29 (see Fig. 4) and hence also the scale 27 and cursor 28 until the cursor reads against the required range on the fixed range scale;

a slider 30 is then shifted to the bearing angle that is the angle shown by the red pointer, which is read on a scale engraved on the same ring as the range scale.

5 The bearing slider 30 carries an arrow or pointer engraved thereon which will then read against the concentration correction scale which is divided into minutes, as shown. If the bearing that has been set up
10 is a starboard bearing, the concentration correction will be to starboard, and will in any case be set up by means of the knurled head 24. Practically, the concentration correction is the same for a bearing angle and its supplement, although the equality is not mathematically correct at very short range.

In cases where more than one control station exists we provide a control indicator showing by lamps from which station the
20 control is being effected, thereby enabling the operator to set correctly the base length above described. This control indicator is seen in Fig. 4, and consists of a casing containing four electric lamps: for example,
25 those marked "Primary" and "Alternative" being wired up to the primary and alternative control stations respectively, and the other two marked "B turret" and "X turret" being wired up to those turrets. Suitable
30 switch gear (not shown) is provided to enable the necessary connections to be made in accordance with which control station and which turret are in operation, as shown by the illumination of the corresponding
35 lamps.

We now proceed to describe the means adopted for indicating to the gun trainer whether his gun is pointing correctly or whether it is pointing to the right or left
40 of the selected target. Means are also described for indicating when the gun is very nearly pointing on the target. The apparatus called the tell-tale indicator contains three incandescent lamps showing respectively red, green and white lights on the
45 screens 31, 32 and 33 as shown in Figs. 5 and 6. The white lamp is arranged to be energized when the pointers 1 and 7 are anywhere within $\frac{1}{2}^\circ$ of coincidence. If the
50 pointers diverge more than $\frac{1}{2}^\circ$ but less than 10° the white lamp remains energized and either the red or green lamp is also energized according as the turret pointer 7 is to right or left of the rangefinder pointer 1.
55 If the pointers 1 and 7 diverge by more than 10° , the white lamp is extinguished and only the red or green lamp remains energized.

The mechanism by which the lamps are
60 energized is shown in Figs. 1 and 2 and consists of a contact 34 carried on an arm 35 mounted on a shaft 36 which is driven through the spur wheels 37 and 38 from the worm wheel 10. The contact 34 therefore
65 moves synchronously with the pointer 7 and

is thereby carried over a disk 39 similarly driven from the pointer 1 through the spur gears 40, 41 and 42. The disk 39 carries a ring on which are mounted contact pieces 43, 44 and 45 connected to slip rings 46, 47 and 48 on the axis of the disk 39. The contact
70 34 is connected with a slip-ring 49 carried on the shaft 36. Brushes 50, 51 and 52 and 53 bear on these slip rings and are brought out to a junction box 54 as shown in Figs. 1
75 and 2 from whence connection is made to the lamps in the tell-tale indicator with a common return which includes the source of E. M. F. for energizing the lamps. When the contact 34 makes contact with the contact piece 43, the white lamp is energized
80 whereas when contact is made with contact piece 44 or 45, the red or green lamps are caused to burn respectively. The apparatus is fixed in such a position relative to the gun
85 sight that while the trainer is looking down the telescopic sight with his one eye he can see the indicator with his idle eye.

It will be found convenient to arrange the instrument as above described in the con-
90 nning tower or control station and in certain cases at the rangefinder. In all cases each gun is fitted with the tell-tale indicator above described and in certain cases it is also advantageous to fit a complete instrument in
95 each turret.

With this apparatus when the officer in charge of the firing in the control station has selected a target he can then at once observe the manner in which the same is
100 picked up by the rangefinder and by the various guns on the ship.

We are aware that it is not in itself novel to superpose an additional motion on a rotating member by driving it with a motor
105 mounted so that the motor itself can be displaced around the axis, and that it is not in itself novel to superpose an additional motion on a member driven by a worm by displacing the worm axially, and we make no claim to such methods of obtaining additional motions *per se*.

What we claim is:—

1. In apparatus for controlling gun fire on board ship, mechanism for enabling selection of a target to be made and for insuring that the target observed shall be that at which the guns are firing, comprising a dial graduated to port and to starboard, a pointer mounted pivotally and reading on said dial
120 the bearing of said target, a second pointer mounted pivotally and reading on said dial the bearing of a gun turret, means controlled by a range finder whereby said target-bearing pointer has a motion identical with that
125 of the range finder, and means controlled by a gun turret whereby said turret-bearing pointer has a motion identical with that of the gun turret.

2. In apparatus for controlling gun fire on 130

board ship, mechanism for enabling the selection of a target to be made and for insuring that the target observed shall be that at which the guns are firing, comprising a dial graduated to port and to star-board, a pointer mounted pivotally and reading on said dial the bearing of said target, a second pointer mounted pivotally and reading on said dial the bearing of a gun turret, means controlled by a range finder whereby said target-bearing pointer has a motion identical with that of the range finder, means controlled by a gun turret whereby said turret-bearing pointer has a motion identical with that of the gun turret, and means for superposing on the motion of said turret-bearing pointer a motion equal to the angle between the axis of the telescopic sight on the gun and the axis of the gun in azimuth.

3. In apparatus for controlling gun fire on board ship, mechanism for enabling the selection of a target to be made and for insuring that the target observed shall be that at which the guns are firing, comprising a dial graduated to port and to star-board, a pointer mounted pivotally and reading on said dial the bearing of said target, a second pointer mounted pivotally and reading on said dial the bearing of a gun turret, means controlled by a range finder whereby said target-bearing pointer has a motion identical with that of the range finder, means controlled by a gun turret whereby said turret-bearing pointer has a motion identical with that of the gun turret, means for superposing on the motion of said turret-bearing pointer a motion equal to the angle between the axis of the telescopic sight on the gun and the axis of the gun in azimuth, and means for indicating when said pointers are coincident.

4. In apparatus for controlling gun fire on board ship, mechanism for enabling the selection of a target to be made and for insuring that the target observed shall be that at which the guns are firing, comprising a dial graduated to port and to star-board, a pointer mounted pivotally and reading on said dial the bearing of said target, a second pointer mounted pivotally and reading on said dial the bearing of a gun turret, means controlled by a range finder whereby said target-bearing pointer has a motion identical with that of the range finder, means controlled by a gun turret whereby said turret-bearing pointer has a motion identical with that of the gun turret, means for superposing on the motion of said turret-bearing pointer a motion equal to the angle between the axis of the telescopic sight on the gun and the axis of the gun in azimuth, means for indicating when said pointers are coincident, and means for correcting for the different positions of a plurality of gun turrets relatively to the fire control station.

5. In apparatus for controlling gun fire on board ship, mechanism for enabling the selection of a target to be made and for insuring that the target observed shall be that at which the guns are firing, comprising a dial graduated to port and to star-board, a pointer mounted pivotally and reading on said dial the bearing of said target, a second pointer mounted pivotally and reading on said dial the bearing of a gun turret, an electrical receiving mechanism controlled by a range finder for driving said target-bearing pointer a distance identical with the extent of training of the range finder, means controlled by a gun turret whereby said turret-bearing pointer has a motion identical with that of the gun turret, means for superposing on the motion of said turret-bearing pointer a motion equal to the angle between the axis of the telescopic sight on the gun and the axis of the gun in azimuth, means for indicating when said pointers are coincident, and means for correcting for the different positions of a plurality of gun turrets relatively to the fire control station.

6. In apparatus for controlling gun fire on board ship, mechanism for enabling the selection of a target to be made and for insuring that the target observed shall be that at which the guns are firing, comprising a dial graduated to port and to star-board, a pointer mounted pivotally and reading on said dial the bearing of said target, a second pointer mounted pivotally and reading on said dial the bearing on a gun turret, an electrical receiving mechanism controlled by a range finder and fixed relatively to said dial for driving said target-bearing pointer a distance identical with the extent of training of the range finder, means controlled by a gun turret whereby said turret bearing pointer has a motion identical with that of the gun turret, means for superposing on the motion of said turret-bearing pointer a motion equal to the angle between the axis of the telescopic sight on the gun and the axis of the gun in azimuth, means for indicating when said pointers are coincident and means for correcting for the different positions of a plurality of gun turrets relatively to the fire control station.

7. In apparatus for controlling gun fire on board ship, mechanism for enabling the selection of a target to be made and for insuring that the target observed shall be that at which the guns are firing, comprising a dial graduated to port and to starboard, a pointer mounted pivotally and reading on said dial the bearing of said target, a second pointer mounted pivotally and reading on said dial the bearing of a gun turret, an electrical receiving mechanism fixed relatively to said dial and controlled by a range finder for driving said target-bearing pointer a dis-

5 tance identical with the extent of training of the range finder, an electrical receiving mechanism controlled by a gun turret for imparting to said turret-bearing pointer a motion identical with that of the gun turret; means for superposing on the motion of said turret-bearing pointer a motion equal to the angle between the axis of the telescopic sight on the gun and the axis of the gun in azimuth, means for indicating when said pointers are coincident, and means for correcting for the different positions of a plurality of gun turrets relatively to the fire control station.

15 8. In apparatus for controlling gun fire on board ship, mechanism for enabling the selection of a target to be made and for insuring that the target observed shall be that at which the guns are firing, comprising a dial graduated to port and to starboard, a pointer mounted pivotally and reading on said dial the bearing of said target, a second pointer mounted pivotally and reading on said dial the bearing of a gun turret, an electrical receiving mechanism fixed relatively to said dial and controlled by a range finder for driving said target-bearing pointer a distance identical with the extent of training of the range finder, an electrical receiving mechanism controlled by a gun turret for imparting to said turret-bearing pointer a motion identical with that of the gun turret, and said turret-bearing receiving mechanism being capable of rotation relatively to the pivotal axis of said turret-bearing pointer, means for superposing in the motion of said turret-bearing pointer a motion equal to the angle between the axis of the telescopic sight on the gun and the axis of the gun in azimuth, means for indicating when said pointers are coincident, and means for correcting for the different positions of a plurality of gun turrets relatively to the fire control station.

45 9. In apparatus for controlling gun fire on board ship, mechanism for enabling the selection of a target to be made and for insuring that the target observed shall be that at which the guns are firing, comprising a dial graduated to port and to starboard, a pointer mounted pivotally and reading on said dial the bearing of said target, a second pointer mounted pivotally and reading on said dial the bearing of a gun turret, an electrical receiving mechanism fixed relatively to said dial and controlled by a range finder for driving said target bearing pointer a distance identical with the extent of training of the range finder, an electrical receiving mechanism controlled by a gun turret for imparting to said turret-bearing pointer a motion identical with that of the gun turret, said turret-bearing receiving mechanism being capable of rotation relatively to the pivotal axis of said

turret bearing pointer, a plate carrying said turret-bearing receiving mechanism, means for rotating said plate through any desired small angle so as to superpose on the motion of said turret bearing pointer a motion equal to the angle between the axis of the telescopic sight of the gun and the axis of the gun in azimuth, means for indicating when said pointers are coincident, and means for correcting for the different positions of a plurality of gun turrets relatively to the fire control station.

10. In apparatus for controlling gun fire on board ship, mechanism for enabling the selection of a target to be made and for insuring that the target observed shall be that at which the guns are firing, comprising a dial graduated to port and to starboard, a pointer mounted pivotally and reading on said dial the bearing of said target, a second pointer mounted pivotally and reading on said dial the bearing of a gun turret, an electrical receiving mechanism fixed relatively to said dial and controlled by a range finder for driving said target bearing pointer a distance identical with the extent of training of the range finder, an electrical receiving mechanism controlled by a gun turret for imparting to said turret-bearing pointer a motion identical with that of the gun turret, said turret-bearing receiving mechanism being capable of rotation relatively to the pivotal axis of said turret-bearing pointer, a plate carrying said turret-bearing receiving mechanism, means for rotating said plate through any desired small angle so as to superpose on the motion of said turret-bearing pointer a motion equal to the angle between the axis of the telescopic sight on the gun and the axis of the gun in azimuth, an electrically-operated lamp indicator for indicating the relative positions of said pointers, and means for correcting for the different positions of a plurality of gun turrets relatively to the fire control station.

11. In apparatus for controlling gun fire on board ship, mechanism for enabling the selection of a target to be made and for insuring that the target observed shall be that at which the guns are firing, comprising a dial graduated to port and to starboard, a pointer mounted pivotally and reading on said dial the bearing of said target, a second pointer mounted pivotally and reading on said dial the bearing of a gun turret, an electrical receiving mechanism fixed relatively to said dial and controlled by a range finder for driving said target bearing pointer a distance identical with the extent of training of the range finder, an electrical receiving mechanism controlled by a gun turret for imparting to said turret-bearing pointer a motion identical with that of the gun turret, said turret-bearing receiving mechanism being capable of rotation relatively to the

pivotal axis of said turret-bearing pointer, a plate carrying said turret-bearing receiving mechanism, means for rotating said plate through any desired small angle so as to superpose on the motion of said turret-bearing pointer a motion equal to the angle between the axis of the telescopic sight on the gun and the axis of the gun in azimuth, an indicator comprising different colored electric lamps, means connected with said pointers for energizing said lamps to indicate the relative positions of said pointers, and means for correcting for the different positions of a plurality of gun turrets relatively to the fire control station.

12. In apparatus for controlling gun fire on board ship, mechanism for enabling the selection of a target to be made and for insuring that the target observed shall be that at which the guns are firing, comprising a dial graduated to port and to starboard, a pointer mounted pivotally and reading on said dial the bearing of said target, a second pointer mounted pivotally and reading on said dial the bearing of a gun turret, an electrical receiving mechanism fixed relatively to said dial and controlled by a range finder for driving said target-bearing pointer a distance identical with the extent of training of the range finder, an electrical receiving mechanism controlled by a gun turret for imparting to said turret-bearing pointer

a motion identical with that of the gun turret, said turret-bearing receiving mechanism being capable of rotation relatively to the pivotal axis of said turret-bearing pointer, a plate carrying said turret-bearing receiving mechanism, a worm and worm wheel for rotating said plate through any desired small angle so as to superpose on the motion of said turret-bearing pointer a motion equal to the angle between the axis of the telescopic sight on the gun and the axis of the gun in azimuth, an indicator comprising different colored electric lamps, means connected with said pointers for energizing said lamps to indicate the relative positions of said pointers, and means for correcting for the different positions of a plurality of gun turrets relatively to the fire control station.

In witness whereof we have hereunto set our hands in the presence of two subscribing witnesses.

ARTHUR H. POLLEN.
HAROLD ISHERWOOD.

Witnesses to the signature of Arthur Hungerford Pollen:

ML. O'HARA,
B. R. ATTENBOROUGH.

Witnesses to the signature of Harold Isherwood:

J. E. BROWN,
S. MATTHEWS.