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Apr. 24, 1923. 1,453,104

P. W. GRAY

APPARATUS FOR USE IN THE LAYING OR SIGHTING OF ORDNANCE

Filed Aug. 29, 1922 4 Sheets-Sheet 1

Fig. 1.

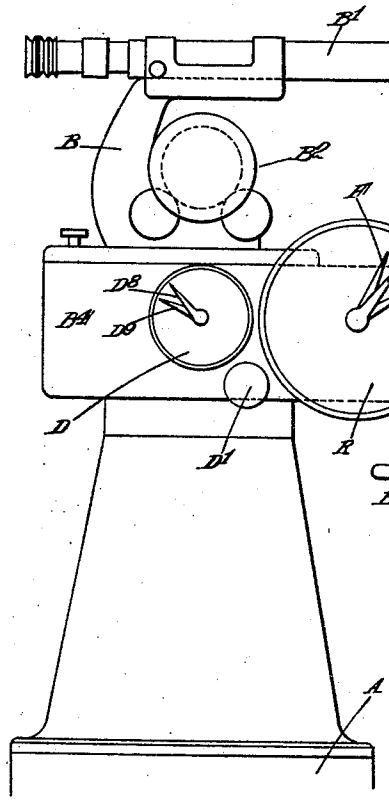


Fig. 2.

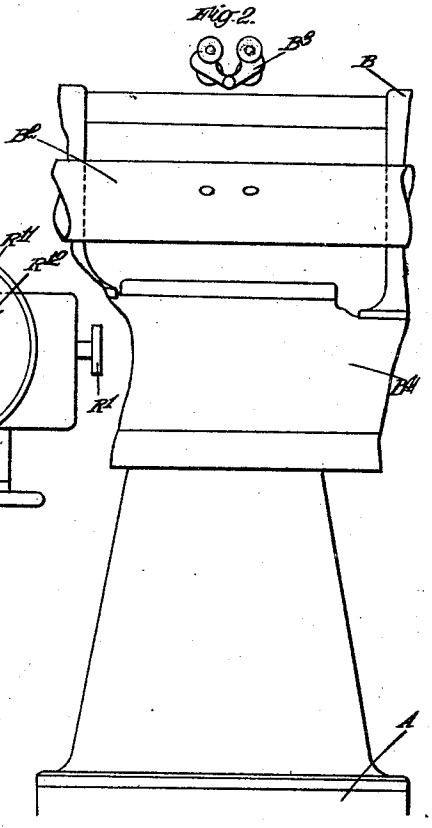


Fig. 3.

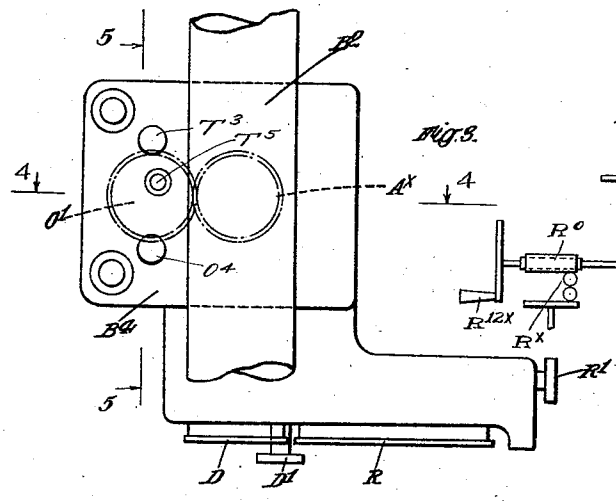
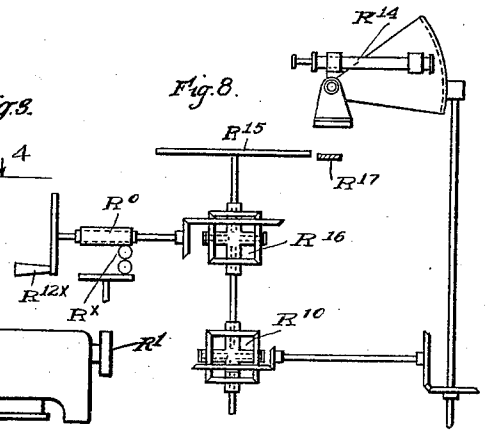


Fig. 8.



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Fig. 4.

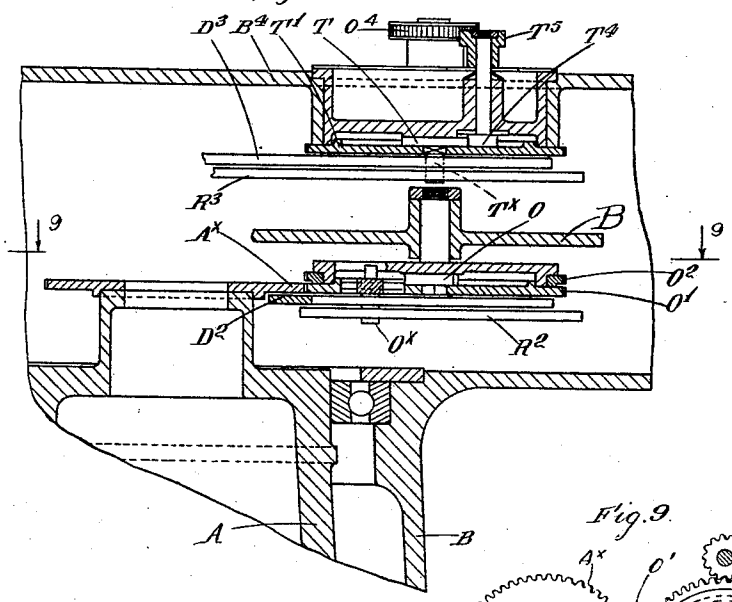


Fig. 9.

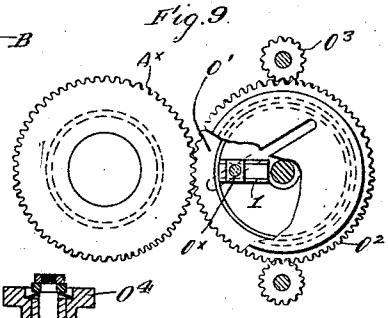
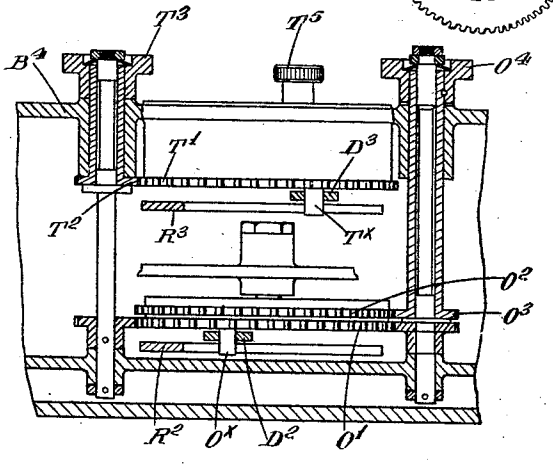


Fig. 5



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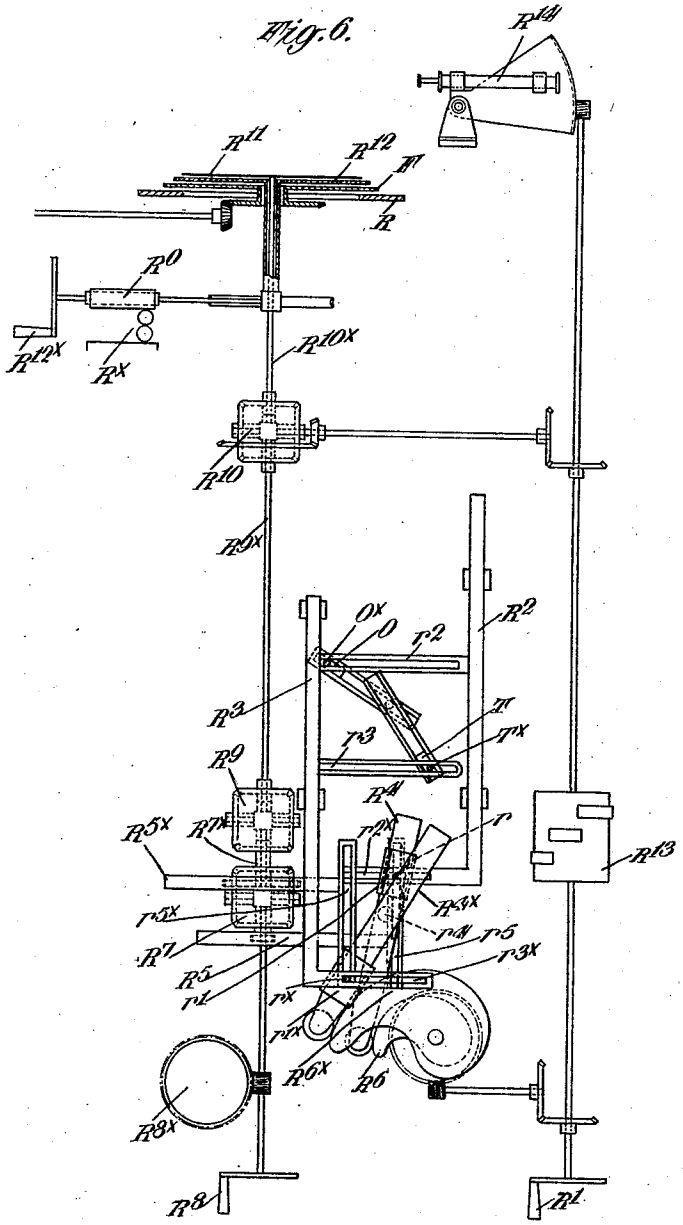
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APPARATUS FOR USE IN THE LAYING OR SIGHTING OF ORDNANCE

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Fig. 6.



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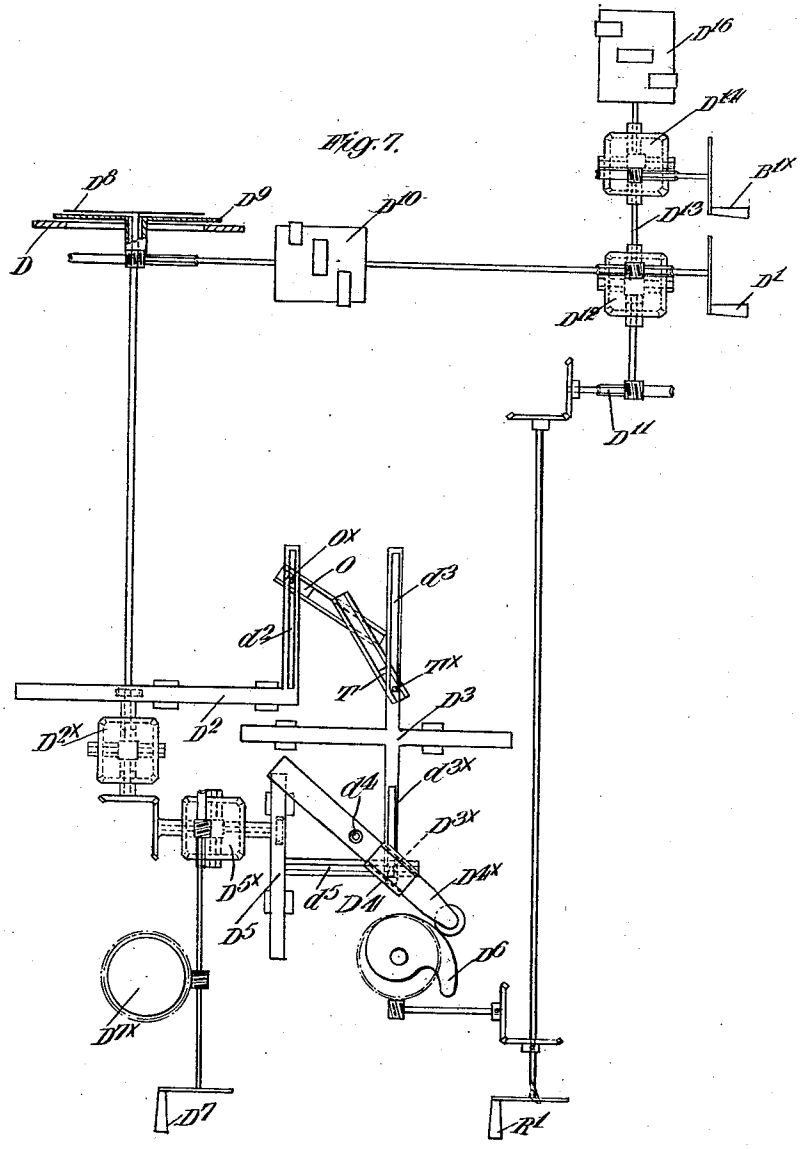
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APPARATUS FOR USE IN THE LAYING OR SIGHTING OF ORDNANCE

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Fig. 7.



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Patented Apr. 24, 1923. 1,453,104

UNITED STATES PATENT OFFICE.

PERCY WILLIS GRAY, OF WESTMINSTER, LONDON, ENGLAND, ASSIGNOR TO VICKERS LIMITED, OF WESTMINSTER, ENGLAND, A BRITISH COMPANY.

APPARATUS FOR USE IN THE LAYING OR SIGHTING OF ORDNANCE.

Application filed August 29, 1922. Serial No. 585,068.

To all whom it may concern:

Be it known that I, PERCY WILLIS GRAY, a subject of the King of Great Britain, residing at Vickers House, Broadway, Westminster, in the county of London, England, have invented certain new and useful Improvements in or Relating to Apparatus for Use in the Laying or Sighting of Ordnance, of which the following is a specification.

This invention relates to apparatus for use in the laying or sighting of ordnance, which apparatus includes a range clock or similar range keeping instrument having adjustable members (usually arms or bars) which, when set in accordance with the course and speed of the target or "enemy" ship and in accordance with the course and speed of "own" ship, will move the adjustable element of the variable speed mechanism of the clock in accordance with the rate of change of range of the target.

According to the present invention the aforesaid adjustable members are mounted on the training portion of a director sight from which gun training (or both gun training and elevating) instructions are transmitted to the gun or guns and means are provided whereby the training movement of the sight to keep it on the target automatically effects the setting of the member which is adjustable in accordance with "own" course and speed. I am able to dispense with the operator who, in the range clocks heretofore proposed, was required to effect the "own" course setting by keeping a separate sight (carried by the clock) on the target, and in this manner I am able to ensure that the director sight is being sighted on the same target as that for which the necessary data is being obtained for the setting of the adjustable members of the clock. I furthermore according to my invention provide in combination with the above-mentioned features, means for determining and for superimposing on the range given by the clock, a correction for change of range during the time of flight of the projectile (the total range being termed "predicted range") and also if desired for superimposing spotting corrections. I also according to my invention, provide means for deriving from the linear deflection obtained by the aforesaid adjustable members and from the range, the actual gun deflection it is necessary to set on the gun sight.

In order that the said invention may be clearly understood and readily carried into effect, the same will now be described more fully with reference to the accompanying drawings, in which:—

Figures 1, 2 and 3 are respectively a side elevation, a fragmental rear elevation and a fragmental plan of a director sighting apparatus the training portion of which carries a range clock constructed in accordance with this invention,

Figures 4 and 5 are vertical sections through the range clock taken on planes at right angles to each other, and showing the essential portions of the mechanism and

Figures 6 and 7 are views illustrating diagrammatically the operation of the range and deflection portions respectively of the clock.

Figure 8 is a view similar to the upper portion of Figure 6, showing a modified construction.

Fig. 9 is a horizontal section taken on line 9—9 of Fig. 4, with parts cut away to show the details of construction.

In the various figures similar reference letters are used to indicate similar parts.

Referring to Figures 1 to 3, A is the fixed pedestal of the director and B is the training carriage which has mounted thereon the director telescope B^1 (operated by a training handle B^{1x}), the range-finder B^2, spotting glasses B^3, a fall-of-shot clock (not shown) and, in carrying out the present invention, the complete range clock the casing of which is indicated at B^4. R is the range dial, R^1 is the range following handle, D is the deflection dial and D^1 is the deflection following handle. These dials and handles are carried by the range clock casing B^4.

Referring to Figures 4 and 5, O is the aforesaid adjustable member appertaining to "own" course and speed, which member is carried by the clock casing B^4 and, in accordance with this invention, is adjusted automatically to correspond with "own" course by the training movement of the carriage B in keeping the telescope B^1 on the target. In the example shown this movement of the member O is effected by the engagement of a gear wheel O^1 with a gear wheel A^x of equal diameter fixed to the non-training pedestal A. Two small idler pinions contacting with gear O′ are provided for the purpose of equalizing the

stress exerted on gear O′ by gear A^x. The adjustment of the said member O in accordance with "own" speed is effected in the usual manner through a toothed ring O^2, a pinion O^3 and an actuating head O^4. The gear wheel O^1 may be provided with a radial slot (see Fig. 9) having dove tail guides 1, adapted to support the pin O^x, which has dove tail slots therein engaging the guides 1. This pin O^x is loosely mounted in the radial slot. The upper end of the pin O^x projects into an eccentrically located slot in the gear O^2. The line connecting the pin O^x with the common axis of the gears O^1 and O^2 may be considered as a vector representing the velocity of "own" ship with respect to the target, the length of this line representing the speed of "own" ship, and its angular position the relative bearing of the ship with respect to the target. The adjustment for speed is made by turning the shaft connecting the spur gear O^3 and the head O^4, the training mechanism remaining stationary. When this shaft is turned, the pin O^x is forced by the camming action of the slot in O^2 to change its position in the radial slot in the gear O^1. The angular position of the line extending through O^x and the axis of O^1 is determined by the training movement of the sight, this adjustment being effected by virtue of the gear O^1 meshing with the stationary gear A^x.

If a horizontal line through the axis of A^x be taken as a reference line, the vector representing the relative velocity of "own" ship, will rotate through an angle of $2y$ degrees when the sight is rotated through an angle of y degrees. If, however, a second horizontal line through the axis of O′ is taken as a reference line in addition to the reference line through the axis of A^x, the vector will be turned through an angle of y degrees with respect to the second reference line, when the sight is turned through an angle of y degrees with respect to the first reference line. Thus, if the rotation of O′ and the sight be considered with respect to the respective axes of these members, it is apparent that they both rotate through the same angle; and so far as the operation of the mechanism is concerned, this conception of the angular displacement is proper, for as O′ revolves about A^x, all of the parts associated with O′ and the pin O^x revolve with O′. The angle representing the relative bearing of "own" ship, with respect to the target, is represented by the angular displacement of the vector with respect to the reference line through the axis of O′, this line being fixed with respect to the casing B^4.

By referring to Fig. 4 it may be noted that the gears O^1 and O^2 are in frictional contact with each other and the gear O^2 is therefore constrained to move with O^1 when the latter is actuated by the training movement of the sight. It is therefore evident that whenever gears O^1 and O^2 turn by virtue of the training movement of the sight, the spur gear O^3 must also turn. The head O^4 may fit tightly on its supporting shaft so that when this shaft turns, the head turns with it. The setting for "own" speed may be effected by rotating the shaft supporting the gear O^3 with respect to the head O^4 which may be held stationary during this operation.

T is the adjustable member appertaining to the course and speed of the target, which member is adjustable (in known manner) for the course of the target by a toothed wheel T^1, a pinion T^2 and an actuating head T^3, and for the speed of the target by a pinion T^4 and an actuating head T^5. The speed and course of the target may be determined in any usual manner, and then the heads T^4 and T^5 may be manually adjusted accordingly. The member O has a pin O^x engaging with a slot r^2 in a member R^2 (see also Figure 6) to move the latter in accordance with the rate of change of range due to "own" course and speed and with a slot d^2 in a member D^2 (see also Figure 7) to move the latter in accordance with the rate of change of deflection due to "own" course and speed. The members R^2 and D^2 are guided so that they can only move in paths at right angles to each other and at right angles to their slots r^2, d^2. The member T also has a pin T^x engaging with a slot r^3 in a member R^3 (see also Figure 6) to move the latter in accordance with the rate of change of range due to the course and speed of the target and with a slot d^3 in a member D^3 (see also Figure 7) to move the latter in accordance with the rate of change of deflection due to the course and speed of the target. The members R^3 and D^3 are guided so that they can only move in paths at right angles to each other and at right angles to their slots r^3, d^3. Furthermore the members R^3 D^3 move in paths parallel to those of the aforesaid members R^2 and D^2 respectively.

When the said adjustable members O and T are associated with the gun itself as aforesaid these members are carried by the gun mounting or other part moving with the sight in training and the range and deflection following handles operate through suitable mechanism upon the appropriate parts of the sight; these handles may also serve to transmit the range and deflection to receivers at the other guns.

Referring to Figure 7, the member D^2 operates upon a differential gear D^{2x} and the member D^3 has another slot d^{3x} (in line with the slot d^3) engaging with a pin D^{3x} on a slide D^4, this pin also engaging with a slot d^5 in a member D^5 which operates upon a

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differential gear D^{5x} and which is guided so that it can only move in a path at right angles to that of the member D^3. The said slide D^4 is carried by an arm D^{4x} which is pivoted at d^4 and has a roller bearing upon the surface of a cam D^6. The latter is rotated from the range following handle R' of Figure 1 and is so designed as to convert range into time of flight divided by range. The effect of this mechanism is therefore to cause the member D^5 to be displaced by an amount proportional to the deflection resulting from the movement of the target, taking into consideration the range and the time of flight of the shot. The differential gear D^{5x} is also under the control of a handle D^7 by which deflection spotting corrections can be effected; a spotting correction dial D^{7x} driven by the handle D^7 is provided. The differential gears D^{2x} and D^{5x} are interconnected as shown and the arrangement is such that a pointer D^8 is driven in accordance with the gun deflection depending upon the value of the various factors mentioned. This pointer moves about the axis of the aforesaid deflection dial D (see also Figure 1) and about the axis of a second pointer D^9. The latter pointer is maintained opposite the pointer D^8 by moving the handle D^1 and in so doing the gun deflection is transmitted to the gun sight by an electrical switch D^{10}.

A drift correcting device D^{11} driven by the handle R^1 is provided and this device operates upon a differential gear D^{12} also operated by the handle D^1. The shaft D^{13} leading from this differential gear operates upon a differential gear D^{14} which is also operated by the bearing or training handle B^{1x}. This latter differential gear is associated with a transmitting switch D^{16} so that the latter transmits angles of bearing corrected for deflection and drift.

Referring to Figure 6, the member R^2 has a second slot r^{2x} (parallel to the slot r^2) engaging with a pin r on a slide r' carried by an arm R^4 which is pivoted at r^4. The said pin r also engages in a slot r^5 in the member R^5 which is guided so that it can only move in a path at right angles to that of the member R^2. The said arm R^4 is operated upon by a cam R^6 which is so designed as to correct the range for "own" speed. The member R^3 similarly has a second slot r^{3x} (parallel to the slot r^3) engaging with a pin r^x on a slide r^{1x} carried by an arm R^{4x} which is pivoted at r^4. The said pin r^x also engages in a slot r^{5x} in a member R^{5x} which is guided so that it can only move in a path at right angles to that of the member R^3. The arm R^{4x} is operated upon by a cam R^{6x} which is so designed as to convert the range into time of flight of shot. The movements of the said members R^5, R^{5x} are added together by a differential gear R^7. The movement of the portion R^{7x} of the differential gear R^7 is therefore in accordance with the change of range due to the speed and course of "own" ship and of the target during the time of flight of shot. Any desired spotting or other corrections may be introduced by means of a handle R^8 which drives a graduated dial R^{8x} and the shaft of which passes through the differential gear R^7 (without having any operative connection therewith) and operates upon a further differential gear R^9. The movements of the shaft R^{9x} leading from the latter differential gear are added to the range movements of the handle R^1 by means of another differential gear R^{10} which imparts movement to a shaft R^{10x} in accordance with the sum of these factors. This latter shaft drives a pointer R^{11} which moves about the axis of the aforesaid range dial R and about the axis of a second pointer R^{12} driven by the range clock mechanism which is indicated diagrammatically at R^x. This mechanism may for example be similar to that described in English Patent No. 165565. The pointer R^{11} is maintained opposite the pointer R^{12} by operating the handle R^1 and in so doing the range is transmitted to the gun sights by a switch R^{13} and the director R^{14} sight is elevated. As the handle R^1 transmits angles proportional to the range, conversion or equalizing gear is necessary either between the said handle and the director R^{14} sight or between the said handle and the pointer R^{11}, for converting ranges into corresponding angles of elevation.

Another pointer F operated from the range-finder in accordance with the range may be provided contiguous to the pointers R^{11} and R^{12}. This pointer F is for the purpose of setting the pointer R^{12} opposite it to agree with the initial range of the target as found by the range-finder. The pointer R^{12} is adjusted by a handle R^{12x} the shaft of which is frictionally connected to the driven part R° of the range clock mechanism so as to enable the said shaft to be rotated relatively to the part R°.

Instead of the above described arrangement of two pointers R^{11} and R^{12} one of which is caused to follow the other, a single pointer R^{15} (Figure 8) operated through a differential gear R^{16} may be employed, it being the duty of the operator of the range following handle R^1 to so move this handle as to maintain the pointer opposite a fixed zero mark R^{17} and in so doing transmits the range as aforesaid. A similar arrangement may also be employed in connection with the deflection, a single pointer then replacing the aforesaid pointers D^8 and D^9.

The above described arrangement of pointers R^{11} and R^{12} (or the single pointer in the alternative mentioned above) can also be employed in conjunction with a gun sight

with which a range clock or keeper is associated.

It is to be understood that the term "range clock" herein employed is intended to include the range keeping portion of a combined range and bearing clock.

The herein described invention is particularly, although not exclusively, intended for use on destroyers and other comparatively light and fast vessels in which, owing to the speed at which they and the enemy ships manœuvre, the rate of change range and deflection are constantly and rapidly varying.

What I claim and desire to secure by Letters Patent of the United States is:—

1. In a device of the type described, the combination with the training portion of a sight, of means adapted to be adjusted in accordance with the course of "own" ship, said means being actuated by the training movement of the sight.

2. In a device of the type described, the combination with the training portion of a sight, of means mounted on the training portion and adapted to be adjusted in accordance with the course of "own" ship, said means being adapted to be moved relative to the support for the sight by the training mechanism of the sight.

3. In a device of the type described, the combination with the training portion of a sight, of means mounted on the training portion and geared to the fixed support for the sight, whereby the training movement of the sight actuates said means in accordance with the course of "own" ship.

4. In a device of the type described, the combination with the training portion of a sight, of a member adjustable in accordance with the course and speed of "own" ship, said member comprising means adapted to be set in accordance with the speed of "own" ship, and means adjustable in accordance with the course of "own" ship, said adjustable means being actuated by the training movements of the sight.

5. In a device of the type described, the combination with the training portion of a sight, of a member adjustable in accordance with the course and speed of the target or "enemy" ship, and a second member adjustable in accordance with the course and speed of "own" ship, said second member comprising means adapted to be set in accordance with the speed of "own" ship, and means adjustable in accordance with the course of "own" ship, said adjustable means being actuated by the training movements of the sight.

6. In a device of the type described, the combination with the training portion of a sight, of a member adjustable in accordance with the course and speed of the target or "enemy" ship, and a second member adjustable in accordance with the course and speed of "own" ship, said second member comprising means adapted to be set in accordance with the speed of "own" ship and means adjustable in accordance with the course of "own" ship, said adjustable means being actuated by the training movement of the sight, means actuated by said members to move in accordance with the rate of change of range and additional means actuated by said members to move in accordance with the rate of change of deflection.

7. In a device of the type described, the combination with the training portion of a sight, of a member adjustable in accordance with the course and speed of the target or "enemy" ship, and a second member adjustable in accordance with the course and speed of "own" ship, said second member comprising means adapted to be set in accordance with the speed of "own" ship and means adjustable in accordance with the course of "own" ship, said adjustable means being actuated by the training movement of the sight, means actuated by said members to move in accordance with the rate of change of range, additional means actuated by said members to move in accordance with the rate of change of deflection, and means actuated by a range following handle for introducing a change in the movements of the means actuated by said members whereby a correction for the time of flight of the shot is made, and the corrected deflection and range may be transmitted to the gun.

8. A range clock or similar range keeping instrument as in claim 1, provided with means for deriving from the linear deflection obtained by the adjustable members of the clock and from the range, the actual gun deflection it is necessary to set on the gun sight and means for applying this gun deflection to the gun.

9. In a device of the type described, the combination of an elevating mechanism, a range keeping instrument, a sight associated with said instrument, a pointer for indicating the gun deflection, said pointer being driven by said instrument, and a second pointer contiguous to the first pointer, said elevating mechanism including means for driving the second pointer, and means for transmitting the gun deflection to the gun.

10. In a device of the type described, the combination of an elevating mechanism, a range keeping instrument, a sight associated with said instrument, and a pointer operated by said instrument, said pointer also being under the influence of the elevating mechanism.

PERCY WILLIS GRAY.