

June 23, 1931.

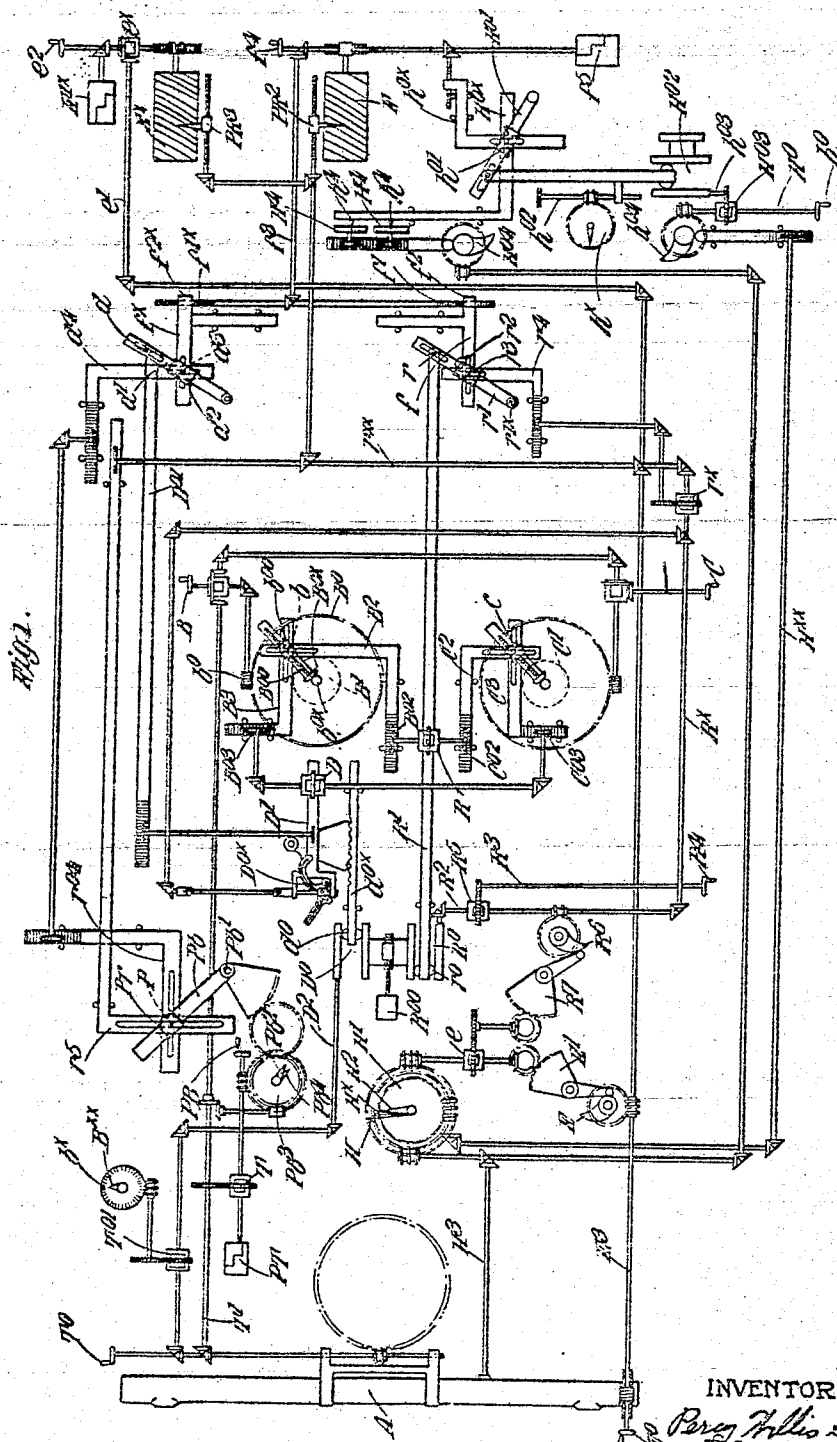
P. W. GRAY

1,811,688

APPARATUS FOR USE IN THE LAYING OF ANTI-AIRCRAFT GUNS

Filed Nov. 28, 1922

2 Sheets-Sheet 1



INVENTOR

Percy Willis Gray

Roni, Davis, Harris & Edwards
ATTORNEYS

61.5

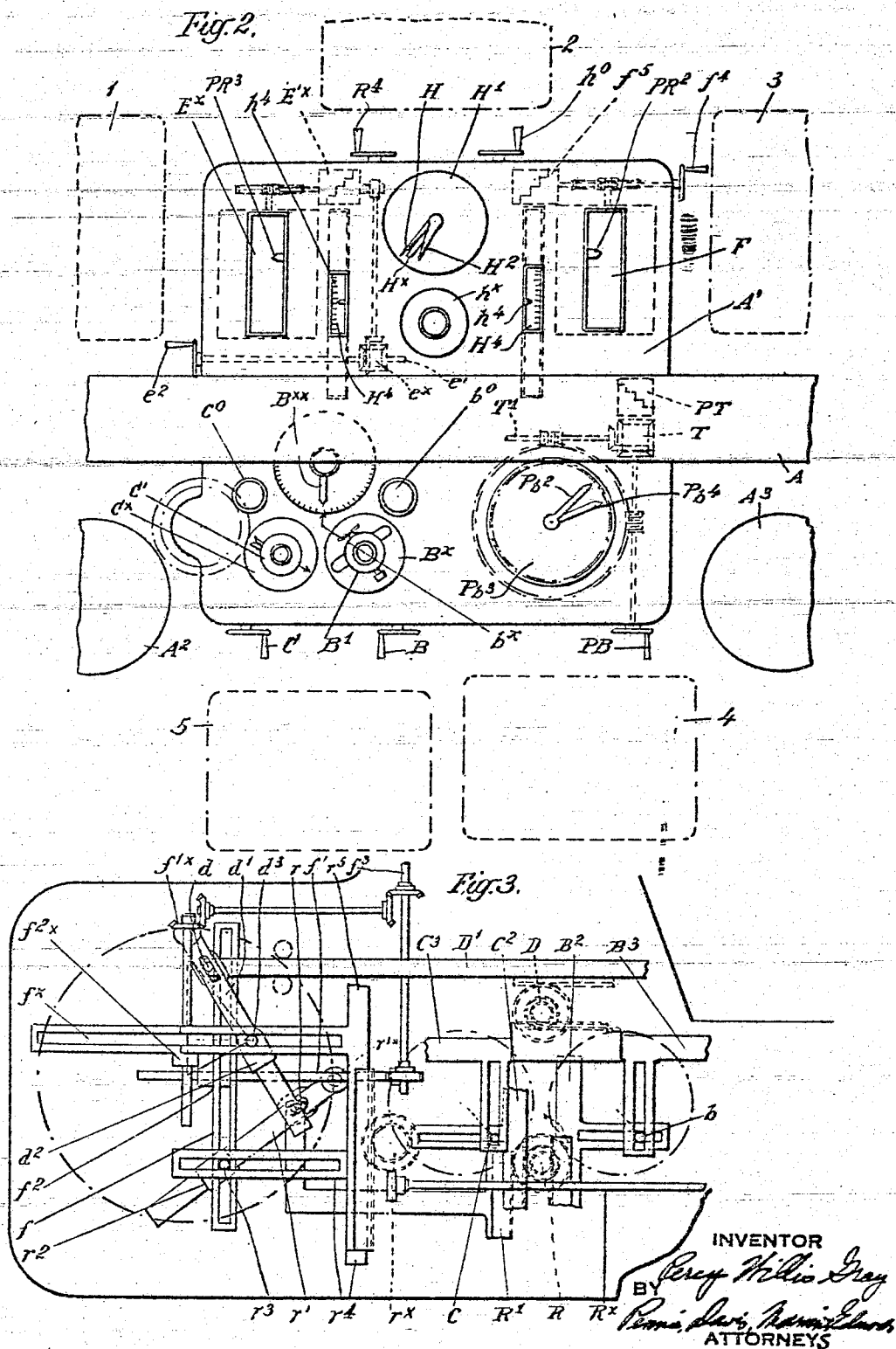
June 23, 1931.

P. W. GRAY

1,811,688

APPARATUS FOR USE IN THE LAYING OF ANTIAIRCRAFT GUNS

Filed Nov. 28, 1922 2 Sheets-Sheet 2



615

Patented June 23, 1931

1,811,688

UNITED STATES PATENT OFFICE

PERCY WILLIS GRAY, OF WESTMINSTER, LONDON, ENGLAND, ASSIGNOR TO VICKERS
LIMITED, OF WESTMINSTER, LONDON, ENGLAND

APPARATUS FOR USE IN THE LAYING OF ANTIAIRCRAFT GUNS

Application filed November 28, 1922, Serial No. 603,338, and in Great Britain December 22, 1921.

This invention relates to apparatus for use in the laying of anti-aircraft guns and is particularly devised to obviate the errors which occur with known apparatus in determining or predicting the future position of an aerial target travelling at a changing height. For example in the case of a target travelling along the line of sight of the apparatus it will be apparent that the angle of sight remains unchanged so that with apparatus whose operation is based on the rate of change of this angle, as has heretofore been the case, a false reading or prediction will be obtained of the future position of the target after the lapse of a given interval of time; in fact in the example referred to such apparatus would indicate that the target is stationary. Another example is that of a target travelling along an ascending or descending course (other than a course at ninety degrees to the line of sight) such that the angle of sight remains constant at all positions of the target though the latter is not travelling along the line of sight as in the previous example. In this case the target will be observed to change its angle of bearing at a certain rate and apparatus as heretofore proposed and used would, since there is no change in the angle of sight, operate on the false assumption that the target is travelling along the arc of a circle struck from a point situated vertically above the apparatus at a height equal to the assumed constant height of the target. It will therefore be seen that in this example also there will be obtained a false reading or prediction of the future position of the target after the lapse of a given interval of time. The two examples given are extreme cases but similar errors occur in all instances where the target is not travelling at a constant height.

The primary object of the invention is to provide an apparatus which avoids the errors referred to above.

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

Figure 1 is a view showing diagrammatically

a form of apparatus in accordance with this invention, it being understood that to facilitate the illustration the various parts are shown in positions which they would not occupy in actual practice.

Figure 2 is a plan showing a constructional form of the apparatus mounted on or combined with an anti-aircraft rangefinder, and

Figure 3 is a plan showing certain portions of the mechanism hereinafter referred to.

A is the rangefinder combined with a casing A¹ (Figure 2) carrying the mechanism to be hereinafter described. This casing and the rangefinder are mounted on a carriage which is capable of being trained and which has two seats A², A³ for the training operator and the elevating operator of the rangefinder. The numerals 1, 2, 3, 4 and 5 in Figure 2 represent the positions occupied by the elevation correcting operator, the height following operator, the time of flight setting operator, the predicted bearing following operator and the rate setting operator respectively. The duties performed by these operators will be apparent from the ensuing description of the mechanism.

b is a crank pin which is adjusted in accordance with the estimated course and speed of the target in the horizontal plane, the adjustment for course being effected by a handle B which operates a worm b⁰ meshing with a worm wheel B⁰ carrying a course dial B^x (Figure 2) and having a radial guide for receiving a block b⁰⁰ carrying the pin b. The adjustment for speed is effected by the angular displacement of a disc B¹ by means of a milled head or knob carried thereby, this disc carrying a bevel pinion b^{0x} meshing with a bevel pinion B^{0x} on a screw B⁰⁰ engaging with the block b⁰⁰; thus rotation of the disc B¹ adjusts the pin b radially in its guide. The said pin engages in slots formed at right angles to each other in two members B², B³ which are constrained to move in paths at right angles to their slots. The member B² therefore receives a movement proportional to the rate of change of horizontal range and the member B³ receives a movement proportional to the rate of change of deflection on the assumption that the wind does not affect the speed and direc-

tion of travel of the target. Another crank pin c similarly adjustable by a handle C (operating a dial C^2) and a disc C^1 in accordance with the direction and velocity of the wind operates two further slotted members C^2 , C^3 of which the former thus receives a movement proportional to the rate of change of horizontal range and the other a movement proportional to the rate of change of deflection on the assumption that the target is merely moving with and at the same velocity as the wind. These course and speed and wind devices are well known under the term "Dumaresq" and are designed to give movement in directions at right angles to each other to members in accordance with the respective rates as will be understood by a consideration of the principles of operation of a "Dumaresq". The movements of the two members B^2 , C^2 appertaining to the rates of change of horizontal range are mechanically added together by epicyclic gearing R to impart movement to another member R^1 in accordance with the resultant of these rates; similarly the movements of the two members B^3 , C^3 appertaining to the rates of change of deflection are added together by epicyclic gearing D to impart movement to another member D^1 in accordance with the resultant of these rates, that is to say in accordance with the rate of change of linear deflection. The members R^1 and D^1 moving in accordance with the said resultants serve to vary the position of the movable elements or balls r^0 and d^0 of the variable speed mechanism of range and bearing clocks R^0 , D^0 driven by a constant speed motor R^{00} by means of which change of horizontal range and change of bearing are continuously obtained and given to shafts R^2 and D^2 respectively. This is performed in respect to shaft R^2 by means of the frictional driving connection of its cylinder r^1 with the constant speed disc r^{01} of constant speed motor R^{00} through balls r^0 which are movable into an infinite number of radial positions on disc r^{01} by member R^1 to obtain proportional driving speeds for shaft R^2 in the manner described. Shaft D^2 is driven in the same way by the frictional driving connection of its attached cylinder d^1 with the constant disc d^{02} of speed motor R^{00} through balls d^0 which are adjustable radially on disc d^{02} by member d^{0x} . The member d^{0x} carrying the balls d^0 is preferably operated from the member D^1 through a device D^{0x} as described in specification of English Patent No. 164,398, the purpose of this device being to convert the rate of change of linear deflection given by the member D^1 as aforesaid into rate of change of angular deflection which is imparted to the member d^{0x} . This is necessary as the shaft D^2 is required to move in accordance with the change in the angle of bearing. The handles B , C and the discs B^1 , C^1 are adjusted by the aforesaid rate setting operator

occupying the position indicated by the numeral 5 in Figure 2.

The movements of the shaft R^2 and those of another shaft R^3 which is connected by gearing to a handle R^4 and is adjusted in accordance with the initial horizontal range, are added together by an epicyclic gear R^5 to displace a cam R^6 in accordance with the sum of these two movements, i. e. in accordance with the instantaneous range. This cam is so designed as to impart a movement to a toothed sector R^7 proportional to the logarithm of the instantaneous range. Another cam E designed to impart a movement to a toothed sector E^1 in accordance with the logarithm of the tangent of the angles of elevation of the rangefinder (which angles are the present angles of sight of the target) is operated by a shaft E^3 from the elevating handle E^0 of the rangefinder and the movements of the said sectors R^7 and E^1 are added together by an epicyclic gear e to operate a pointer H in accordance with the sum of the two movements. Since the tangent of the angle of elevation is the height of the target divided by the horizontal range, the height is the product of the tangent of said angle and the horizontal range, or stated logarithmically $\log \text{ height equals } \log \tan \text{ angle of elevation plus } \log \text{ horizontal range}$. The movements of the pointer H are thus in accordance with the logarithms of the height of the target which can be read by the position of the pointer H against graduations on a height dial H^1 . Although, as stated above, the initial horizontal range is set on the mechanism by means of the handle R^4 this range need not be indicated since it is converted into height before any indication is obtained. A second pointer H^2 operated by a shaft H^3 in accordance with the logarithms of the height as ascertained by the rangefinder is mounted co-axially with the other pointer H . Thus if the pointer H does not maintain coincidence with the pointer H^2 this is an indication that the settings of the aforesaid pins b and c require correction. Instead of this "follow-the-pointer" arrangement, a "balanced" pointer may be employed, this single pointer being under the conjoint influence of a part moved in a similar manner to the pointer H and of the shaft H^3 , through the intermediary of an epicyclic gear, the said single pointer remaining stationary opposite a fixed mark so long as the height derived as aforesaid from the range given by the range clock and from the angle of sight, corresponds to the height as ascertained by the rangefinder.

The setting of the aforesaid pins b and c can be furthermore checked from a comparison of the angles of training of the rangefinder obtained from the movements of the training handle T^0 and the angles of bearing obtained from the aforesaid bear-

ing clock D^0 for which purpose a "follow-the-pointer" or "balanced pointer" arrangement similar to that above described may be employed. In Figures 1 and 2 a balanced pointer B^{xx} under the conjoint influence (through a differential gear T^{01}) of the shaft D^2 of the bearing clock and of the training handle T^0 of the rangefinder is shown.

The aforesaid member R^1 moving proportionately to the total rate of change of range should preferably be corrected for the range effect of the wind on the shot. The correction for this wind effect is represented by the product of the wind velocity and a function of the time of flight of the shot; this function is obtained empirically and varies with guns of different caliber. To obtain this correction the epicyclic gear pinions B^{02} and C^{02} with which rack teeth on the members B^2 , C^2 engage, are made of slightly different diameters in a predetermined ratio corresponding to the aforesaid function. The aforesaid member D^1 moving proportionately to the total rate of change of linear deflection is also corrected for the deflection effect of the wind on the shot in a similar manner, the epicyclic gear pinions B^{03} and C^{03} which engage rack teeth on the members B^3 and C^3 being also made of slightly different diameters. It will, of course, be understood that if the aforesaid function is unity, the pinions B^{02} and C^{02} would be of the same diameter as would also the pinions B^{03} and C^{03} . The movements of the members R^1 and D^1 are arranged to be mechanically multiplied by the time of flight of the shot so as to produce the change of horizontal range and the change of deflection of the target during the time of flight of the shot. For this purpose the member R^1 has a pin r engaging in a slot in a bar r^1 which is pivoted at r^{1x} to a fixed part and on which is mounted a slider r^2 having a pin r^3 engaging in slots formed at right angles to each other in members f , r^4 which are constrained to move in directions at right angles to their slots. The member f is set at a distance from the pivot of the bar r^1 proportionate to the time of flight, by a screw-threaded shaft f^1 which engages in a nut f^2 formed on the member f and which is rotated by a shaft f^3 from a handle f^4 hereinafter referred to. The distance that the member r^4 is thus caused to assume from the axis of the pivoted arm r^1 thus represents the product of the rate of change of range and the time of flight of the shot, that is to say it represents the change of range that takes place during the time of flight of the shot. The movements of the said member r^4 and those of a shaft R^x moving in accordance with the instantaneous range (it may move with the aforesaid cam R^0 for example) are added together by an epicyclic gear indicated at r^x and the algebraic sum of these movements is imparted by the

said epicyclic gear to a shaft r^{xx} and thence to a slotted member r^5 . This member, which is constrained to move in a path at right angles to its slot, thus receives a movement equal to the algebraic sum of the instantaneous range and the change of range during the time of flight, that is to say in accordance with the future or predicted horizontal range.

The aforesaid member D^1 moving in accordance with the total rate of change of deflection corrected for the deflection effect of the wind on the shot, operates a member D^{01} which has a pin d engaging in a slot in a pivoted arm d^1 . This pivoted arm carries a slider d^2 having a pin d^3 which engages in a slot formed in a member d^4 and in a slot formed in a member f^x , these slots being arranged at right angles to each other and the members d^4 , f^x being constrained to move in directions at right angles to their slots. To prevent confusion the member d^4 has not been shown in Figure 3. The said member f^x is operated from the aforesaid time of flight of shot shaft f^3 by a screw-threaded shaft f^{1x} engaging with a nut portion f^{2x} of this member. It will thus be seen that the member d^4 will receive a displacement proportional to the product of the rate of change of linear deflection and the time of flight of the shot that is to say proportional to the linear deflection that takes place during the time of flight of the shot.

Engaging in the slots of the aforesaid member r^5 and d^4 (or, as shown in Figure 1 for convenience of representation, in the slot in the member r^5 and a slot in a member r^{04} moving with the member d^4) is a pin P the position of which thus determines the future or predicted position of the target when projected on to a horizontal plane. The said pin P is attached to a member P^r which is slidably mounted on a bar Pb pivoted by means of a spindle Pb^1 to a fixed part. The said bar is thus angularly displaced by the pin P in accordance with the angle of predicted or future bearing (i. e. the lateral angular deflection) of the target and actuates a pointer Pb^2 moving over a graduated dial Pb^3 . Arranged coaxially with the pointer Pb^2 is a "follower" pointer Pb^4 operated by a handle PB . The movements of this handle in causing the follower pointer Pb^4 to follow the movements of the pointer Pb^2 are added by an epicyclic gear indicated at T to the movements of a shaft T^1 operated by the handle T^0 in training the rangefinder and the sum of these movements is imparted by the said epicyclic gear to a transmitter switch PT by which the future angle of training or bearing with reference to a fixed line of reference is transmitted to the guns. The shaft T^1 also operates to drive the dial Pb^3 so as to indicate in conjunction with the pointer Pb^2 the angles transmitted by the switch PT .

The above-mentioned shaft r^{xx} moving in accordance with the predicted or future horizontal range operates to displace two pointers PR^2, PR^3 , which will be hereinafter referred to, in accordance with the predicted range. The movement of the aforesaid shaft f^3 in accordance with the time of flight of the shot is obtained in the following manner:—A drum F is engraved with curves so drawn that the angle of rotation of the drum is proportional to the time of flight of the shot corresponding to the height reading on the drum against the aforesaid pointer PR^2 moved in accordance with the predicted range. Thus by rotating the said drum by means of the aforesaid handle f^1 through the worm gearing shown in Figure 1 until the curve appertaining to the height as shown on the drum H^1 (hereinafter referred to) is opposite the pointer PR^2 , movement in accordance with the corresponding time of flight of the shot is imparted to the member f previously described. Movement of this member, as has already been shown, will displace the pointer PR^2 from its original position thus altering the height reading on the drum F which then has to be moved to keep the height in agreement with that indicated on the height drum H^1 . Thus each of the factors (i. e. time of flight of shot and predicted range) is corrected by the other until a balanced state is obtained when the "hitting horizontal range" and its corresponding time of flight are arrived at. The handle f^1 operates a transmitter switch f^5 for transmitting the time of flight of the shot to the gun or guns for the purpose of fuse setting, continuous fuse setting being preferably employed so that there is no time lag to be taken into account.

Two of the aforesaid height drums H^1 are provided and are operated by means of a cam H^{01} actuated from the shaft H^2 in accordance with the movements of the aforesaid logarithmic height pointer H^2 so as to permit evenly spaced graduations on these drums to be provided. The pointers h^1, h^2 appertaining to these drums are made adjustable in accordance with the change of height during the time of flight of the shot so that the drums H^1, H^2 indicate the future height of the target; for this purpose a multiplying mechanism is provided whereby the time of flight of the shot is multiplied by the rate of change of height set on a dial h^x , this mechanism comprising a slotted member h^{0x} displaced by the handle f^1 , a slotted member H^{0x} carrying the pointers h^1, h^2 and a pivoted bar H^{01} carrying a sliding block h^{01} having a pin engaging in the slots of the members h^{0x} and H^{0x} , this bar being operated from a shaft h^{02} appertaining to the dial h^x . Thus the pointers h^1, h^2 are displaced by the said mechanism in accordance with the product of the time of flight of the shot and

the rate of change of height. A height clock or keeper comprising a variable speed mechanism H^{02} driven by a constant speed motor is provided whereby the change of height corresponding to the rate of change of height set on the dial h^x is continuously obtained and imparted to a shaft h^{03} . The movement of this shaft is added by an epicyclic gear H^{03} to the movement of a shaft H^0 by a handle h^0 in accordance with initial height and a pointer H^1 is moved by mechanism including a shaft H^{0x} in accordance with the sum thus obtained after conversion by a cam h^{04} into logarithmic height. This pointer is mounted coaxially with the aforesaid pointers H, H^2 and the arrangement is such that if the rate of change of height is correctly set on the dial h^x the pointer H^1 will move in alignment with the follower pointer H . This arrangement thus constitutes a means of checking that the rate of change of height has been correctly set on the dial h^x .

The aforesaid predicted range pointer PR^3 moves over a drum E^x engraved with curves so drawn that the angle of rotation of the drum is proportional to the quadrant elevation or gun elevation angle corresponding to the height reading on the drum. This rotation of the drum may be effected through an epicyclic gear e^x the primary elements of which are driven one by a shaft e^1 operated from the shaft E^2 and the handle E^0 by the elevating operator of the rangefinder in elevating the latter and the other by a handle e^2 operated by the elevation correcting operator occupying the position indicated by the numeral 1 in Figure 2. The third element of the epicyclic gear as well as driving the drum E^x , also operates a transmitting switch E^1 by means of which the correct firing or quadrant elevation angle is transmitted to the gun or guns.

In operating the apparatus the rate setting operator occupying the position 5 in Figure 2 sets wind direction and estimated target course on the dial C^x and B^x by means of the handles C and B respectively, and then adjusts the dials C^1 and B^1 to correspond with the wind velocity and estimated target speed respectively. If the balanced bearing pointer B^{xx} is observed to be in motion, the rate setting operator occupying the position 5 first brings it opposite a fixed index b^x by means of a milled head attached to the pointer and then readjusts the target course and speed settings until the said pointer remains stationary against the fixed index.

The height following operator occupying the position 2 brings the follower pointer H by means of the handle R^1 into agreement with the height pointer H^2 operated by the range-taker. If the follower pointer H does not follow automatically the height pointer H^2 after being once brought into agreement with the latter, the height following operator

665
pushes one of two electric switch buttons by means of which one of two lamp indicators e^0 , b^0 Figure 2 is lit so as to inform the rate setting operator that an increase or decrease in the rate of change of range is necessary, on which information the rate setting operator readjusts the target course and speed settings whilst at the same time keeping the balanced bearing pointer B^x stationary against the fixed index b^x . Thus the correct rate of change of range and the correct rate of change of linear deflection are set on the apparatus.

If the height following operator sees the second follower pointer H^x (which is initially brought into agreement with the first follower pointer H by means of the handle h^0) gradually moving away from the latter, he so adjusts the rate of change of height setting by means of a milled head attached to the dial h^x , as to obtain a constant agreement of the said two follower pointers.

The time of flight setting operator occupying the position 3 now turns his handle f^4 until the predicted range pointer PR^2 reads on the drum F the same height as that indicated on the height drum H^4 during which operation the pointer PR^2 suffers a displacement on account of the fact that the setting of the time of flight of shot actuates the predicting mechanism by which the said pointer is operated. This operation will also cause a displacement of the height pointer h^4 by an amount equal to the change of height during the time of flight of shot, the indication now being the future height instead of the instantaneous height of the target. Thus a continuous alteration of the time of flight of shot setting is needed until a balanced state is arrived at when the time of flight of shot corresponds to the future height and range of target and is then continuously transmitted to the gun by the transmitter f^5 .

The elevation correcting operator occupying the position 1 now rotates his handle e^2 until the drum E^x reads against the pointer PR^2 the same height as that indicated on the height drum H^4 , thus transmitting quadrant elevation angle to the gun by means of the switch E^{1x} .

The lateral deflection or "predicted bearing" following operator occupying the position 4 keeps his follower pointer Pb^4 by means of the handle PB always in agreement with the pointer Pb^2 operated by the predicting mechanism, thus in conjunction with the training operator of the rangefinder transmitting the training angle to the gun by means of the switch PT .

The above described apparatus thus serves to transmit to the gun or guns the correct gun training angle by means of the switch PT , the correct time of flight of shot by means of the switch f^5 and the correct gun elevation angle by means of the switch E^{1x} .

The apparatus may comprise means for correcting the angle of bearing for drift. Tenuity corrections may be provided for by the use of different dials for gun elevation and for the time of flight of shot to suit different tenuity conditions.

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

1. Apparatus for use in the laying of anti-aircraft guns, comprising elements adjustable in accordance with the initial horizontal range of a target, elements adjustable in accordance with the initial angle of bearing of the target, elements adjustable in accordance with the speed of the target in the horizontal plane, elements adjustable in accordance with the course of the target in the horizontal plane, elements adjustable in accordance with the height of the target and means jointly controlled by all of said elements for predicting the future position of the target after the lapse of a given interval of time.

2. The combination with the elements claimed in claim 1, of mechanically operating elements coacting therewith and adjustable in accordance with the velocity and direction of the wind for correcting the future position of the target in accordance with wind conditions.

3. The combination with the elements claimed in claim 1, of means associated with the elements adjustable in accordance with the speed and course of the target and adjustable in accordance with the rate of change of horizontal range and means for correcting the movement of said means in accordance with the effect of the wind on the shot.

4. Apparatus for use in the laying of anti-aircraft guns, comprising elements adjustable in accordance with the initial horizontal range of a target, elements adjustable in accordance with the speed of the target in the horizontal plane, elements adjustable in accordance with the course of the target in the horizontal plane, means associated with the elements adjustable in accordance with the speed and course of the target and adjustable in accordance with the rate of change of horizontal range, means for correcting the movement of said means in accordance with the effect of the wind on the shot, means for multiplying the corrected rate of change of horizontal range by the time of flight of the shot, and a member movable by the last named means in accordance with the change of horizontal range.

5. Apparatus for use in the laying of anti-aircraft guns, comprising elements adjustable in accordance with the initial horizontal range of a target, elements adjustable in accordance with the speed of the target in the horizontal plane, elements adjustable in accordance with the course of the target in the horizontal plane, means associated with the elements adjustable in accordance with the

speed and course of the target and adjustable in accordance with the rate of change of horizontal range, means for correcting the movement of said means in accordance with the effect of the wind on the shot, means for multiplying the corrected rate of change of horizontal range by the time of flight of the shot, a member movable by the last named means in accordance with the change of horizontal range, a part movable in accordance with the instantaneous horizontal range, means for mechanically adding the displacement of the member to that of the part and a member movable in accordance with the sum of said displacements:

6. Apparatus as in claim 5, wherein means are associated with the member movable in accordance with the sum of the instantaneous horizontal range and the change of horizontal range for obtaining the predicted range.

7. Apparatus as in claim 5, wherein the displacement of the part is multiplied by the displacement of a member movable in accordance with the tangent of the angle of sight of the target and another member is displaced in accordance with the product in order to obtain the corresponding height of the target.

8. The combination with the elements claimed in claim 1, of means for determining the rate of change of the height of the target and for predicting the height after the lapse of a given interval of time.

9. The combination with the elements claimed in claim 1, of means associated with the elements adjustable in accordance with the initial angle of bearing of the target and adjustable in accordance with the rate of change of linear deflection corrected for the deflection effect of the wind on the shot.

10. Apparatus for use in the laying of anti-aircraft guns, comprising elements adjustable in accordance with the initial horizontal range of a target, elements adjustable in accordance with the initial angle of bearing of the target, elements adjustable in accordance with the speed of the target in the horizontal plane, elements adjustable in accordance with the course of the target in the horizontal plane, elements adjustable in accordance with the height of the target, means associated with the elements adjustable in accordance with the initial angle of bearing of the target and adjustable in accordance with the rate of change of linear deflection, means for correcting the movement of said means in accordance with the effect of the wind on the shot, means for multiplying the corrected rate of change of linear deflection by the time of flight of the shot, and a member movable by the last named means in accordance with the change of deflection.

11. The combination with the elements claimed in claim 10, of means associated with the member movable in accordance with the

change of deflection for obtaining the predicted angle of bearing.

12. Apparatus for use in laying anti-aircraft guns, comprising elements adjustable in accordance with the rate of change of target deflection, elements adjustable in accordance with the rate of change of range of the target, means for correcting the adjustment of the rate of change of range and deflection elements in accordance with wind direction and velocity, means for determining the time of flight of the shot, means for modifying the adjustment of the rate of change of deflection and range elements in accordance with the time of flight of the shot, elements adjustable in accordance with the rate of change of height of the target, means for combining the range and height of target values to obtain target elevation, and means for indicating target deflection and elevation as data for laying the guns.

13. Apparatus as in claim 12, including means for indicating the time of flight of the shot.

14. Apparatus for use in laying anti-aircraft guns, comprising a combined director sight and computing mechanism, said mechanism including a variable speed device having a part driven at constant speed, and another part at least partially adjustable by said sight, and means for indicating the values computed by said mechanism as data for laying the guns.

15. Apparatus for use in laying anti-aircraft guns, comprising a combined director sight and computing mechanism, means for adjusting said sight to follow a moving aerial target, said computing mechanism including a variable speed device having a part driven at constant speed and an adjustable part, connections between said means and adjustable part, and means for indicating the values computed by said mechanism as data for the laying of the guns.

16. Apparatus for use in laying anti-aircraft guns, comprising a director sight, means for moving the sight to keep it on the aerial target, computing mechanism at least partially operated in accordance with the movements of the sight, said computer including a variable speed device having a part driven at constant speed, and means for indicating the values computed thereby as data for laying the guns.

17. Apparatus for use in laying anti-aircraft guns comprising a combined director sight and computing mechanism movable to follow the aerial target, said computer including a variable speed device having a part driven at constant speed and a part at least partially controlled by movement of the sight and computing mechanism, and means for indicating the computed values as data for laying the guns.

18. Apparatus for use in laying anti-air-

61.5

1,811,688

7

craft guns, comprising a combined director sight and computing mechanism, means for adjusting said sight to follow a moving aerial target, said computing mechanism including a variable speed device having a part
5 driven at constant speed and an adjustable part, connections between said means and adjustable part, means for adjusting said part in accordance with values separately obtained,
10 and means for indicating the values computed by said mechanism as data for the laying of the guns.

19. Apparatus for use in laying anti-aircraft guns, the combination of a movable
15 director sight, a computing mechanism including means at least partially controlled by said sight for generating a linear quantity dependent upon the change in distance of the target from the director, an indicator having
20 a travelling member driven by said means, a second travelling member associated with said first member for comparison therewith, and means for driving said second member in accordance with a linear quantity obtained
25 for the observed distance of the target.

20. Apparatus for laying anti-aircraft guns, comprising a movable director sight, a computing mechanism, connections between
30 said sight and said mechanism for introducing the relative vertical and lateral positions of the aerial target, means in said computer for determining vertical and lateral deflections, means for combining the vertical and lateral positions with the respective vertical
35 and lateral deflections, and means for indicating these factors as data for laying the guns.

21. Apparatus for laying anti-aircraft guns, comprising a movable director sight, a
40 computing mechanism, connections between said sight and said mechanism for introducing the relative vertical and lateral positions of the aerial target, means in said computer for determining vertical and lateral deflections, means for combining the vertical and lateral positions with the respective vertical
45 and lateral deflections, means for modifying said factors in accordance with predetermined corrections, and means for indicating these factors as data for laying the guns.
50

22. Apparatus for use in laying anti-aircraft guns, comprising a sighting device, a
55 variable speed device having at least two parts, means for driving one part of said variable speed device at constant speed, connections between the sighting device and the other part of said variable speed device for adjusting the latter in accordance with movements of the sight, means in said connections
60 for varying the movements of the sight received by said last named part in accordance with changes in the range of the target and windage, and means driven by said variable speed device for indicating values as data
65 for laying the guns.

23. Apparatus for use in laying anti-aircraft guns, comprising a sight, a pair of variable speed devices each having at least two drivable parts, means for driving one of said parts of each of said devices at constant
70 speed, connections between the sight and the other part of one of said devices, whereby the latter is adjusted in accordance with the movements of the sight in elevation, connections between the sight and the other part of
75 the other of said devices whereby the latter is adjusted in accordance with movements of the sight in train, means in each connections for modifying the adjustment of the other parts of said devices in accordance with
80 predetermined corrections, means driven by the first named device for indicating corrected elevation as data for laying the guns in elevation, and means driven by the other of said devices for indicating corrected train
85 data for laying the guns in train.

PERCY WILLIS GRAY.

90

95

100

105

110

115

120

125

130