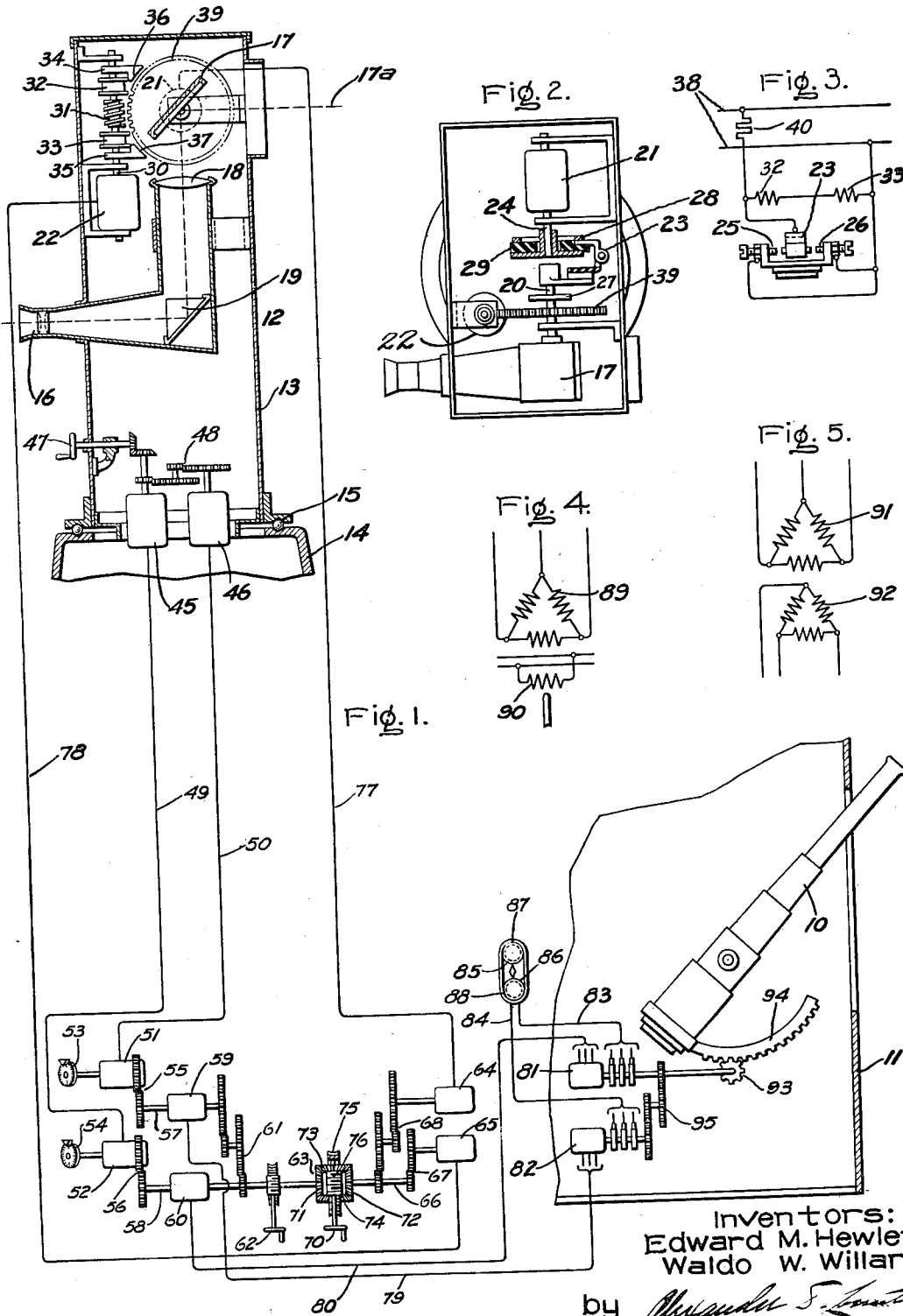


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SYSTEM OF GUNFIRE CONTROL

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UNITED STATES PATENT OFFICE.

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SYSTEM OF GUNFIRE CONTROL.

Application filed November 29, 1924. Serial No. 752,969.

Our invention relates to systems of gun fire control, and has for its object improved means for controlling the position of a gun from a remotely situated directing instrument.

More particularly our invention relates to gun fire control systems in which the gun is directed by means of a remote sighting device usually situated in a more advantageous position for observing the target, such as aloft. In such systems the angular movements of the sighting device in being brought to bear on the target are transmitted to the gun and are utilized in directing the gun on the target. Usually corrections peculiar to the gun, such as corrections for curvature of the trajectory, trunnion tilt, etc., are introduced in these transmitted movements of the sighting device. When the ship is rolling and pitching, which is usually the case, these corrections are in a state of continual change, which means that the gun must be continually adjusted if it is to meet these varying conditions. With the large caliber guns now in use it is difficult to make adjustments, especially to make them quickly, due to the great inertia of the gun, and it is therefore desirable to make only the fewest possible adjustments.

In carrying out our invention we provide means whereby corrections, instead of being applied directly to the gun directing apparatus, are first applied to the sighting device and may then be introduced in the gun directing apparatus by readjustment of the sighting device if necessary.

For a more complete understanding of our invention reference should be had to the accompanying drawing in which Fig. 1 is a somewhat diagrammatic view partially in section of a system of gun fire control embodying our invention including a single line diagram of the electrical connections; Fig. 2 is a plan view partially in section of the directing apparatus; Fig. 3 is a detailed view; while Figs. 4 and 5 are diagrammatic views showing the instruments used in transmitting angular motion.

Referring to the drawing, in carrying out our invention in one form we control the gun 10, suitably mounted in the turret 11, by means of a remote sighting instrument or director 12 situated aloft or in some suitable

position from which the target may be viewed to advantage. The system shown is applied to the adjustment of the gun in elevation. It is contemplated, however, that a similar system may be used for controlling the gun in train.

The director 12 comprises a suitable casing 13 which is mounted on a support 14 so as to be freely rotatable on bearings 15 in a normally horizontal train plane. The sighting means proper may be somewhat similar to that used in a periscope, suitable cross-hairs being provided. The target is observed through an eye-piece 16, the reflected light from the target falling first upon an adjustable mirror 17 which directs it downward through a lens 18 onto a reflecting prism 19. The prism 19 in turn directs the light to the eye of the observer. This path of the light from the target to the eye of the observer is indicated by dotted line 17^a. Adjustment of the sighting device in elevation is made by adjusting the angular position of mirror 17 in the altitude plane, or in other words about an axis parallel with the train plane. As shown, in Fig. 2 the mirror 17 is mounted on a shaft 20 which is rotatable about an axis parallel to the train plane.

The mirror 17 is adjusted by means of two receivers or reproducers of angular motion 21 and 22 which operate in low and high speed ratios respectively. As shown, the reproducer 21 operates in a 1:1 driving ratio with the adjustment to be given mirror, i. e., in a 1:2 driving ratio with the angle to be applied to the line of sight for it will be observed that movement of the mirror on shaft 20 results in a deflection of the line of sight equal to twice the angle through which the mirror is moved. The reproducer 21 is mechanically connected directly to the mirror. This mechanical driving connection comprises a contact arm 23 secured to and insulated from the driving shaft 24 of the reproducer 21 and moving between two contacts 25 and 26 (Fig. 3) which are secured to the shaft 20 and insulated from each other and from the shaft 20. When the reproducer 21 turns, the contact arm engages one or the other of the contacts depending upon the direction of rotation thus driving the mirror.

In addition to their function of forming a mechanical driving connection, the contact arm and contacts control an electric circuit, as will be described hereinafter. Electrical connections may be established by suitable brushes bearing on collector rings 27 and 28 mounted on shafts 20 and 24 respectively in insulated relations therewith. The ring 28 and contact arm 23 are electrically connected together and mounted on a disc 29 of insulating material which is secured to shaft 24. The contacts 25 and 26 are electrically connected to ring 27.

As previously stated the reproducer 22 operates in any suitable high speed driving ratio, such as 72:1, with the adjustment to be given the mirror, i. e., 36:1 with the line of sight. Obviously, both reproducers, due to their independent action, cannot be connected to the mirror at the same time. A releasible driving connection is therefore provided between the reproducer 22 and the mirror, which connection is broken while the reproducer 21 is adjusting the mirror and is established upon the completion of the adjustment by reproducer 21 so that the high speed reproducer 22 can then make the accurate adjustment. It will be understood that the high speed reproducer is provided for greater accuracy of adjustment, the low speed reproducer being also necessary to prevent errors due to the high speed reproducer getting out of step one or more complete revolutions. This may occur, for example, when the reproducers are switched onto transmitters having different angular positions.

A magnetic driving connection controlled by the low speed reproducer is provided between the high speed reproducer 22 and the mirror. The driving shaft 30 of the reproducer 22 is made of soft iron and is provided with a soft iron worm 31 secured thereto which is slightly spaced from but in otherwise operating relation with a soft iron worm gear 39 secured to shaft 20. In other words the worm is displaced in the plane of the worm gear in a direction at right angles to its own axis so that its threads or teeth do not engage with the teeth of the worm gear. Encircling the shaft 30 on opposite ends of the worm are two stationary magnet coils 32 and 33 and embracing the magnet coils are stationary members 34 and 35 which complete the magnet circuits for the coils through the shaft 30 and the worm and worm gear. The members 34 and 35 preferably closely encircle the shaft 30 and their opposite ends are provided with pole faces 36 and 37 which are spaced near the periphery of the worm gear. The coils 32 and 33 are oppositely connected to a suitable source of direct current supply 38. As thus connected the magnetic fluxes set up by the coils will be in

opposite directions along the shaft 30 and through the threads of the worm across the air gap to the teeth of the worm gear where the fluxes will divide and return on each side through the worm gear and the members 34 and 35. The threads of the worm and the teeth of the adjacent portion of the worm gear thus form magnet poles of opposite polarity when the coils are energized and therefore attract each other. Upon rotation of the worm by the reproducer 22 the teeth of the worm gear will follow the threads of the worm due to this magnetic attraction, and the worm gear will be driven substantially the same as it would be driven if the worm and worm gear were in mechanical engagement.

In order to control this magnetic connection by means of the reproducer 21, a short circuit is established around the coils 32 and 33 so that they are not energized when the contact arm 23 is in engagement with either one of the contact arms 25 and 26. As indicated diagrammatically in Fig. 3, the contact arm may be electrically connected to one side of the coils 32 and 33 while the contacts 25 and 26 may be connected to the other side of the coils so that the coils are short circuited when the contact arm is in engagement with either one of the contacts. A resistor 40 is connected to the supply source 38 in series with the coils so as to prevent a short circuit of the supply source when the contact arm engages either one of the contacts. It will thus be observed that when contact arm 23 is in engagement with either one of the contacts the driving connection for the reproducer 22 is broken to permit the mirror to be adjusted by the coarse reproducer 21. When the coarse reproducer has completed its adjustment, the contact will be broken, due to the inertia of the mirror causing it to overrun, and the magnetic driving connection thus established by the energization of the coils whereupon the adjacent teeth of the worm gear will snap to the positions opposite to the threads of the worm to complete the accurate adjustment. If desired a spring may be provided to bias the contact arm to a position midway between the two contacts. This system used in driving the mirror by means of the two reproducers is described and claimed in a copending application of Edwin J. Murphy and Leonard P. Hutt, Serial No. 742,732, filed October 9, 1924, assigned to the same assignee as this invention.

Under normal conditions of operation the high speed reproducer will drive the mirror, the lag being insufficient to cause the low speed reproducer to take control. In certain cases, however, for example when the reproducers are switched onto transmitters having considerably different angular positions, the low speed reproducer will be

called upon to make the rough adjustment. The permissible lag between the worm and worm gear must be less than one half the pitch of the worm when the high speed reproducer is connected, and for greater lags the low speed reproducer must first make the rough adjustment. This amount of lag before the low speed reproducer drives the mirror can be regulated by adjusting contacts 25 and 26.

Conveniently located in the casing 13 are mounted two devices 45 and 46 for transmitting angular motion in high and low speed ratios respectively. The ratios of the two transmitters 45 and 46 to the angle transmitters are the same as that of the two reproducers 22 and 21 respectively to the angle to be applied to the line of sight. These transmitters are operated by means of a gun directing member shown as a hand wheel 47 which may be connected in a 1:1 ratio to the high speed transmitter 45 and through a 72:1 reducing gear train 48 to the low speed transmitter 46.

The transmitters 45 and 46 are electrically connected through sets of conductors 49 and 50 to reproducing devices 51 and 52 located in a remote central station or plotting room where corrections may be introduced. The rotors of the reproducers 51 and 52 drive indicating dials 53 and 54 respectively. The stators of the reproducers 51 and 52 are rotatably mounted and mechanically connected through gears 55 and 56 in 1:1 driving ratios to the rotor shafts 57 and 58 of two transmitting devices 59 and 60. A 72:1 speed ratio gear train 61 mechanically connects the shafts 57 and 58 so that shaft 58 operates at 72 times the speed of shaft 57. By means of an operating member shown as a hand wheel 62 provided with a worm and worm gear driving connection with the shaft 58, the stators 51 and 52 may be rotated to turn the dials 53 and 54 back to zero position, the rotors of the reproducers 51 and 52 and hence the dials being turned with their stators due to the magnetic connection between them. At the same time it will be observed that the rotors of transmitters 59 and 60 secured to shafts 57 and 58 are turned a like amount.

Rotation of the shaft 58 is also transmitted through a differential gear mechanism 63 to transmitting devices 64 and 65. The transmitting device 65 is connected to shaft 66 driven from shaft 58 through the differential gear 63 by means of a reducing gearing 67 having a 2:1 speed ratio whereby the transmitter 65 is driven at one half the speed of shaft 66. The transmitter 64 is connected to shaft 66 through a 36:1 speed ratio, reducing gear train 68. It will thus be observed that the transmitting devices 64 and 65 are driven by hand wheel 62 in 1:36 and 1:2 speed ratios respectively with relation

to shaft 58. Corrections may be introduced by turning hand wheel 70, which cooperates with the differential gear driving mechanism, in a well known manner.

The differential gear may, for example, comprise bevel gears 71 and 72 secured to the shafts 58 and 66 respectively and planetary bevel gears 73 and 74 cooperating therewith and carried by a ring worm gear 75 with which meshes worm 76 driven by the hand wheel 70. Since shaft 58 is held by the worm and worm gear driving connections associated with hand wheel 62, it is not turned by hand wheel 70.

The transmitters 64 and 65 are electrically connected through sets of conductors 77 and 78 to reproducers 21 and 22 respectively, and the transmitters 59 and 60 are connected through sets of conductors 79 and 80 to differential devices 81 and 82 in the turret. These differential devices are in turn connected through sets of conductors 83 and 84 to reproducing devices 85 and 86, indicated by dotted circles, which drive indicating dials 87 and 88, respectively, located in the turret.

Although any suitable systems may be used for transmitting angular movements, preferably alternating current systems are used in which the transmitting and reproducing devices are similar in construction and are each provided with a polycircuit armature winding and a single circuit field winding. For example, as shown diagrammatically in Fig. 4, the transmitting and reproducing devices may each be provided with a polycircuit armature winding 89, which is physically similar to a three-phase bi-polar, delta connected armature winding, and with a single circuit field winding 90. The transmitters and reproducers are connected together by means of three conductors connecting like points of their armature windings. It will be understood that the various single line conductors shown in the drawing as connecting these instruments represent a plurality of conductors. The field windings of each set of connected instruments are connected to a suitable source of alternating current supply. The field windings induce alternating electromotive forces in the circuits of their respective armature windings, the relative value of the electromotive forces in the respective circuits of the armature windings depending on the angular relation of the field winding therewith. When the rotors of the transmitter and reproducer are in angular agreement the electromotive forces induced in the various circuits of the armature windings are equal and opposite and therefore no current is produced. When the transmitter is turned and held in the new position, however, this voltage balance no longer exists so that currents are caused to flow and a

torque is thereby exerted upon the rotor of the reproducer, which torque turns it to a position in which the voltages again balance when the rotors will again be in angular agreement.

The electrical differential devices 81 and 82 are similar in construction. As shown in Fig. 5, each comprises two 3-circuit, bipolar, cooperating armature windings 91 and 92, one of which is rotatably mounted. When the two windings are in corresponding angular positions the electromotive forces impressed on one of the windings by the transmitter will be induced without change in relation value in the other winding so that the angular movements being transmitted through them will not be affected, but when the two windings are angularly displaced this displacement causes the electromotive force output of the differential device to be different from the impressed electromotive force so that the angular displacement is added to or subtracted from the movement of the transmitter depending on the direction of the displacement. This differential device is described and claimed in our copending application Serial No. 501,007, filed September 15, 1921.

The rotor of differential 81 is connected to the gun, for example, by means of a pinion 93 secured to it and meshing with an elevation gear sector 94 secured to the gun, so as to be driven in a high speed 72:1 ratio with the movement of the gun in elevation. The rotor of differential 82 is connected through the 72:1 speed ratio gear train 95 with the rotor of differential 81 so as to be driven in a low speed 1:1 ratio with the gun.

In the operation of our invention the operator of the director 12 transmits the desired gun elevation by means of the gun directing hand wheel 47, judging this elevation by observing whether the target appears too high or too low in his field of view. This movement of hand wheel 47 is applied to transmitting devices 45 and 46 and is reproduced in the central station on dials 53 and 54 by means of the reproducers 51 and 52. The operator in the central station upon noting this movement of the dials, turns the operating member or hand wheel 62 in a direction and by an amount to bring the dials 53 and 54 back to zero. In turning hand wheel 62, the central station operator applies this movement to transmitters 59 and 60 whereby it is transmitted through the differential devices 81 and 82 and applied to dials 87 and 88 in the turret by the reproducers 85 and 86. At the same time this movement is applied to transmitters 64 and 65 in their respective ratios by way of the differential device 63 and geared connections which cause the movement to be repeated by reproducers 21 and 22 and applied to the mirror 17,

whereby the line of sight is adjusted in accordance with the rotation of the gun directing hand wheel 47. Therefore, when the hand wheel 47 has been turned properly, the mirror 17 will be tilted until the desired target can be seen on the cross-hairs and the corresponding elevation will be transmitted to the gun.

When corrections such as for range, the elevation component of trunnion tilt, etc., are introduced by hand wheel 70, these corrections are applied through the agency of transmitters 64 and 65 and reproducers 21 and 22 to the mirror 17. The director operator upon observing this movement of the mirror may if he so desires turn hand wheel 47 in the proper direction to bring about a change in elevation of the gun and in so doing operates the dials 53 and 54 as previously described. The operator in the central station immediately turns the operating hand wheel 62 whereby this movement is applied to transmitters 59 and 60 and also to transmitters 64 and 65. This takes place until the mirror 17 has assumed its original angular position or any other suitable position chosen by the operator. During this operation, it will be seen that the necessary adjustment of gun elevation is applied by the director operator to transmitters 45 and 46 and thus indirectly to dials 87 and 88 in the turret, while preserving the correct angular relation of the line of sight to the bore of the gun previously established by turning hand wheel 70.

The gun pointer in the gun turret adjusts the gun in elevation in accordance with the amount and direction of the displacement of dials 87 and 88 from zero. The movements of the gun are applied to the rotating elements of the differential devices 81 and 82 in such direction that the displacement of the windings in each results in a shifting or change in relative values of the electromotive forces applied to the receiving devices 85 and 86 connected to dials 87 and 88 in such manner that the dials are turned back toward zero. When the dials have been brought back to zero position the gun pointer knows that the gun is in the position designated by the director operator and that the relation of the line of sight to the gun is modified by the corrections introduced by hand wheel 70.

For the purpose of simplicity the apparatus in the central station has been shown diagrammatically in its most elementary form. The application of the motion of the reproducers 51 and 52 to the transmitters 59, 60, 64 and 65 in their proper ratios may be effected automatically, for example, by providing an electric motor which is controlled by the reproducers 51 and 52 and operatively connected in a suitable driving ratio with the shaft 58.

While we have described our invention as embodied in concrete form and as operating in a specific manner in accordance with the provisions of the patent statutes, it should be understood that we do not limit our invention thereto, since various modifications thereof will suggest themselves to those skilled in the art without departing from the spirit of our invention, the scope of which is set forth in the annexed claims.

What we claim as new and desire to secure by Letters Patent of the United States, is:—

1. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, gun-directing means adjacent said sighting device operated independently of said sighting device, and control means for said sighting device operating independently of said gun directing means.

2. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, a position indicator adjacent said gun, means remote from said sighting device for operating said indicator, and means remote from said sighting device for adjusting said sighting device independently of said indicator.

3. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, directing means for said gun adjacent said sighting device operating independently of said sighting device, and control means for said sighting device remote from said sighting device.

4. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, directing means for said gun remote from said gun operating independently of said sighting device, and control means for said sighting device remote from said sighting device.

5. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, an indicator adjacent said gun arranged to show the desired angular adjustment for said gun in a predetermined plane, control means for said indicator adjacent said sighting device operating independently of said sighting device, and control means for said sighting device remote from said sighting device.

6. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, an indicator adjacent said gun arranged to show the desired angular adjustment for said gun in a predetermined plane, and means remote from said sighting device for actuating said sighting device and said indicator.

7. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, a position indicator adjacent said gun, means for operating said indicator to show the desired angular adjustment for said gun, and means remote from

said sighting device and gun for controlling the angular adjustment of said sighting device independently of said position indicator.

8. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, gun directing means adjacent said sighting device operating independently of said sighting device, and means remote from said gun directing means for applying the movements of said gun directing means to said sighting device.

9. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, gun directing means adjacent said sighting device operated independently of said sighting device, and means for applying the movements of said gun directing means to said sighting device.

10. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, control means for said sighting device remote from said sighting device and gun, gun directing means adjacent said sighting device operated independently thereof, and means for applying the movements of said gun directing means to said sighting device.

11. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, operating means for said sighting device remote from said sighting device, means adjacent said sighting device for determining the amount of movement to be applied to said operating means, and means for reproducing the movements of said operating means at said gun.

12. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, a gun-directing member adjacent said sighting device, means for reproducing the movements of said gun directing member in a remote control station, operating means in said control station for applying the reproduced movements of said directing member to said sighting device, and means for reproducing the movements of said operating means at said gun.

13. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, gun-directing means adjacent said sighting device operated independently of said sighting device, means for applying the movements of said gun-directing means to said sighting device, and auxiliary means for adjusting said sighting device to introduce corrections.

14. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, a position indicator adjacent said gun, means remote from said sighting device for operating said indicator to show the desired angular adjustment for said gun in a predetermined plane, means for applying the movements of said indicator to said sighting device in a similar

plane, and auxiliary means for adjusting said sighting device to introduce corrections.

15. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, operating means remote from said gun and said sighting device for controlling the angular position of said sighting device, motion transmitting means actuated by said operating means, motion reproducing means adjacent said gun connected to said transmitting means, and position indicating means driven by said reproducing means to indicate the angular adjustment for said gun.

16. A system of gun fire control comprising in combination with a gun, a sighting device remote from said gun, operating means for said sighting device remote from said sighting device and said gun, a member adjacent said sighting device actuated by the sighting device observer, means for transmitting the movements of said member to a point adjacent said sighting device operating means, means for applying the movements of said member to said sighting device operating means, an indicator at said gun and means for transmitting the movements of said sighting device operating means to said indicator.

17. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, a position indicator adjacent said gun, actuating means remote from said sighting device for driving said indicator to show the desired angular adjustment for said gun, operating means for said sighting device controlled by said actuating means, and auxiliary means for controlling said operating means to introduce corrections.

18. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, operating means remote from said gun and said sighting device for controlling the angular position of said sighting device, means adjacent said sighting device for determining the amount of movement to be applied to said operating means, motion transmitting means actuated by said operating means, motion reproducing means adjacent said gun connected to said transmitting means, and position indicating means driven by said reproducing means to indicate the angular adjustment for said gun.

19. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, a gun-directing member adjacent said sighting device, motion transmitting means actuated by said gun-directing member, motion reproducing means in a remote control station connected to said transmitting means, control means for said sighting device in said control station, operating means for applying the

movements of said reproducing means to said sighting device control means, motion transmitting means driven by said operating means, motion reproducing means adjacent said gun connected to said last mentioned transmitting means, and an indicating device driven by said last mentioned reproducing means.

20. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, a gun-directing member adjacent said sighting device, motion transmitting means actuated by said gun-directing member, motion reproducing means in a remote control station connected to said motion transmitting means, control means for said sighting device in said control station, operating means for applying the movements of said reproducing means to said sighting device control means, means for actuating said sighting device control means independently of said operating means to introduce corrections, motion transmitting means driven by said operating means, motion reproducing means adjacent said gun connected to said last mentioned transmitting means, and an indicating device driven by said last mentioned reproducing means.

21. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, a gun-directing member adjacent said sighting device, means for reproducing the movements of said gun directing member in a remote control station, motion transmitting means in said remote control station, operating means for applying the reproduced movements of said gun-directing member to said motion transmitting means, motion reproducing means adjacent said sighting device connected to said transmitting means, a driving connection between said last mentioned reproducing means and said sighting device whereby said sighting device is adjusted in accordance with the movements of said operating means, and means for reproducing the movements of said operating means at said gun.

22. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, a gun-directing member adjacent said sighting device, means for reproducing the movements of said gun directing member in a remote control station, motion transmitting means in said remote control station, operating means for applying the reproduced movements of said gun directing member to said motion transmitting means, motion reproducing means adjacent said sighting device connected to said transmitting means, a driving connection between said last mentioned reproducing means and said sighting device whereby said sighting device is adjusted in accordance with the

movements of said operating means, means for actuating said transmitting means independently of said operating means to introduce corrections, and means for reproducing the movements of said operating means at said gun.

23. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, a gun-directing member adjacent said sighting device, means for reproducing the movements of said gun-directing member in a remote control station, motion transmitting means in said control station, operating means for applying the reproduced movements of said gun-directing member to said motion transmitting means, motion reproducing means adjacent said sighting device connected to said transmitting means, a driving connection between said last mentioned reproducing means and said sighting device whereby said sighting device is adjusted in accordance with the movements of said operating means, motion transmitting means driven by said operating means, motion reproducing means adjacent said gun connected to said last mentioned transmitting means, and an indicator driven by said last mentioned reproducing means to show the adjustment to be given the gun.

24. A system of gun fire control comprising in combination with a gun, a sighting device remote therefrom, a gun-directing member adjacent said sighting device, motion transmitting means actuated by said gun directing member, motion reproducing means in a remote control station connected to said transmitting means, motion transmitting means in said control station, operating means for applying the movements of said reproducing means to said last mentioned transmitting means, motion reproducing means adjacent said sighting device connected to said last mentioned transmitting means, a driving connection between said last mentioned reproducing means and said sighting device whereby said sighting device is adjusted in accordance with the movements of said operating means, means for actuating said last mentioned transmitting

means independently of said operating means, auxiliary motion transmitting means driven by said operating means, motion reproducing means adjacent said gun connected to said last mentioned transmitting means and an indicator driven by the said last mentioned reproducing means to show the adjustment to be given the gun.

25. In a system of gun fire control, a sighting device, operating means for said sighting device remote therefrom, and manually actuated means adjacent said sighting device operated by the sighting device observer for determining the movement to be applied to said operating means, said manually actuated means being independent of said sighting device.

26. In a system of gun fire control, a sighting device, a remote control station, operating means in said control station, high and low speed motion transmitting means in said control station actuated by said operating means, high and low speed motion reproducing means adjacent said sighting device connected to said transmitting means, and a driving connection between said reproducing means and said sighting device whereby said sighting device is adjusted in accordance with the movements of said operating means.

27. In a system of gun fire control, a sighting device, a remote control station, operating means in said control station, motion transmitting means in said control station actuated by said operating means, motion reproducing means adjacent said sighting device connected to said transmitting means, a driving connection between said reproducing means and said sighting device whereby said sighting device is adjusted in accordance with the movements of said operating means, a directing member adjacent said sighting device, and means for reproducing the movements of said directing member in said control station.

In witness whereof, we have hereunto set our hands this 28th day of November, 1924.

EDWARD M. HEWLETT.

WALDO W. WILLARD.