May 13, 1952 E. C. CUNNINGHAM 2,596,130

MANUALLY OPERATED TELEMETRIC GUN CONTROL SYSTEM

Filed June 28, 1945 3 Sheets-Sheet 1

Fig. 1.

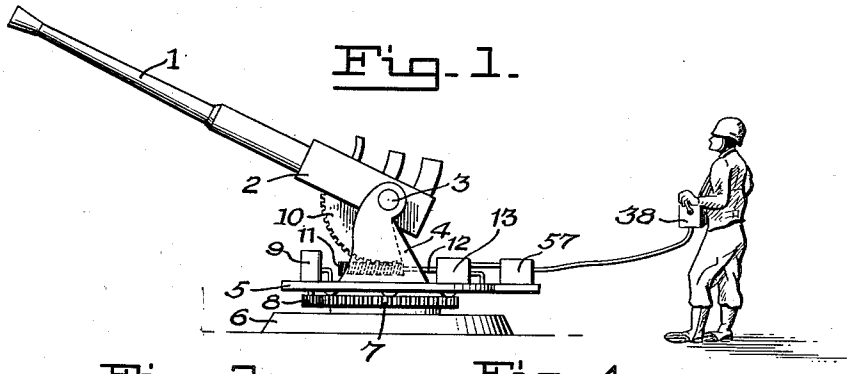


Fig. 2.

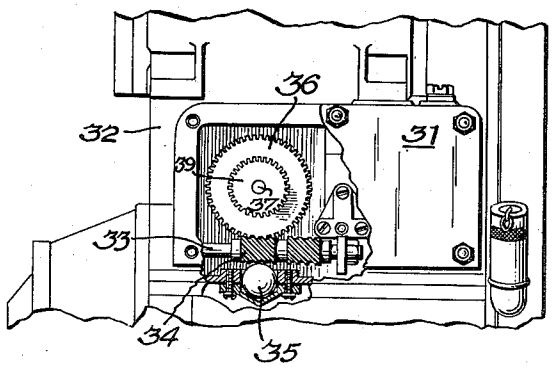


Fig. 4.

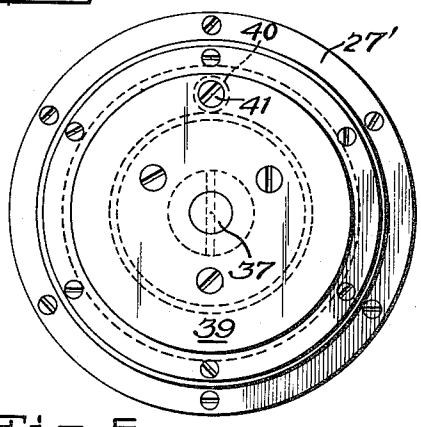


Fig. 5.

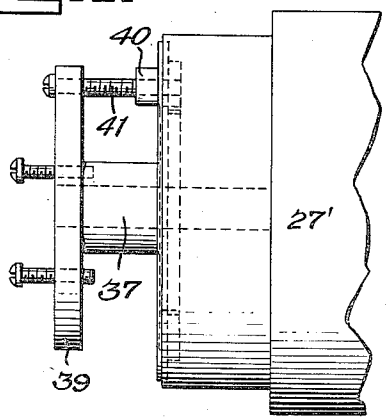
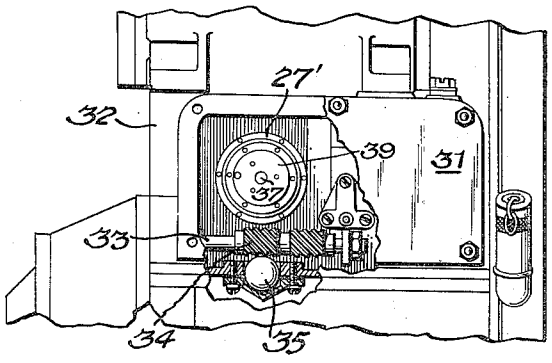


Fig. 3.



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May 13, 1952 E. C. CUNNINGHAM 2,596,130

MANUALLY OPERATED TELEMETRIC GUN CONTROL SYSTEM

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Fig. 6.

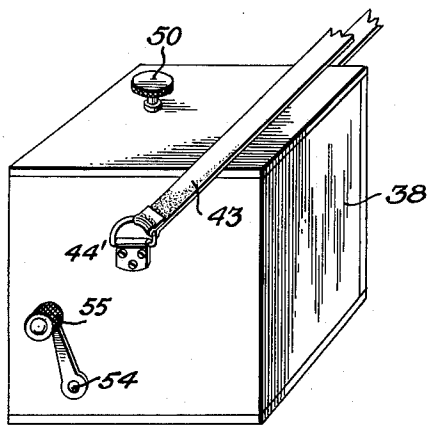


Fig. 7.

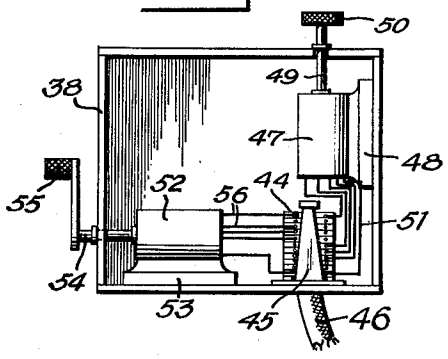


Fig. 8.

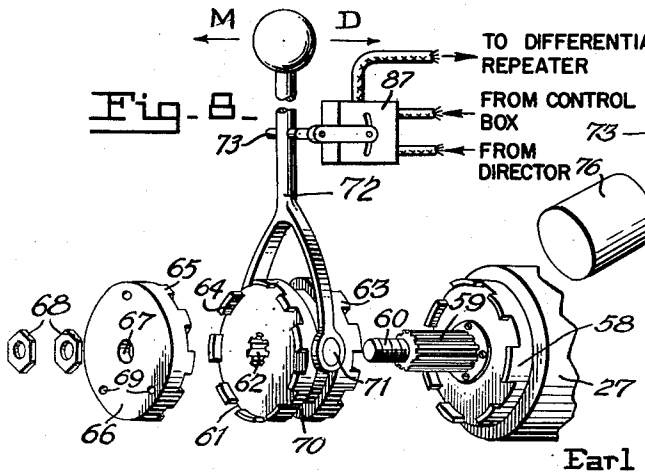
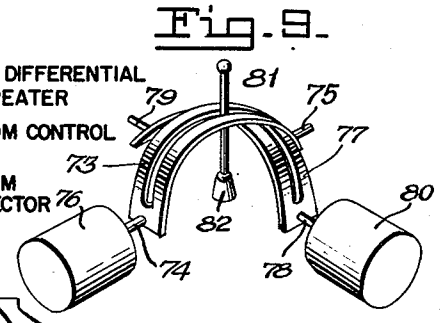


Fig. 9.



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MANUALLY OPERATED TELEMETRIC GUN CONTROL SYSTEM

Filed June 28, 1945 3 Sheets-Sheet 3

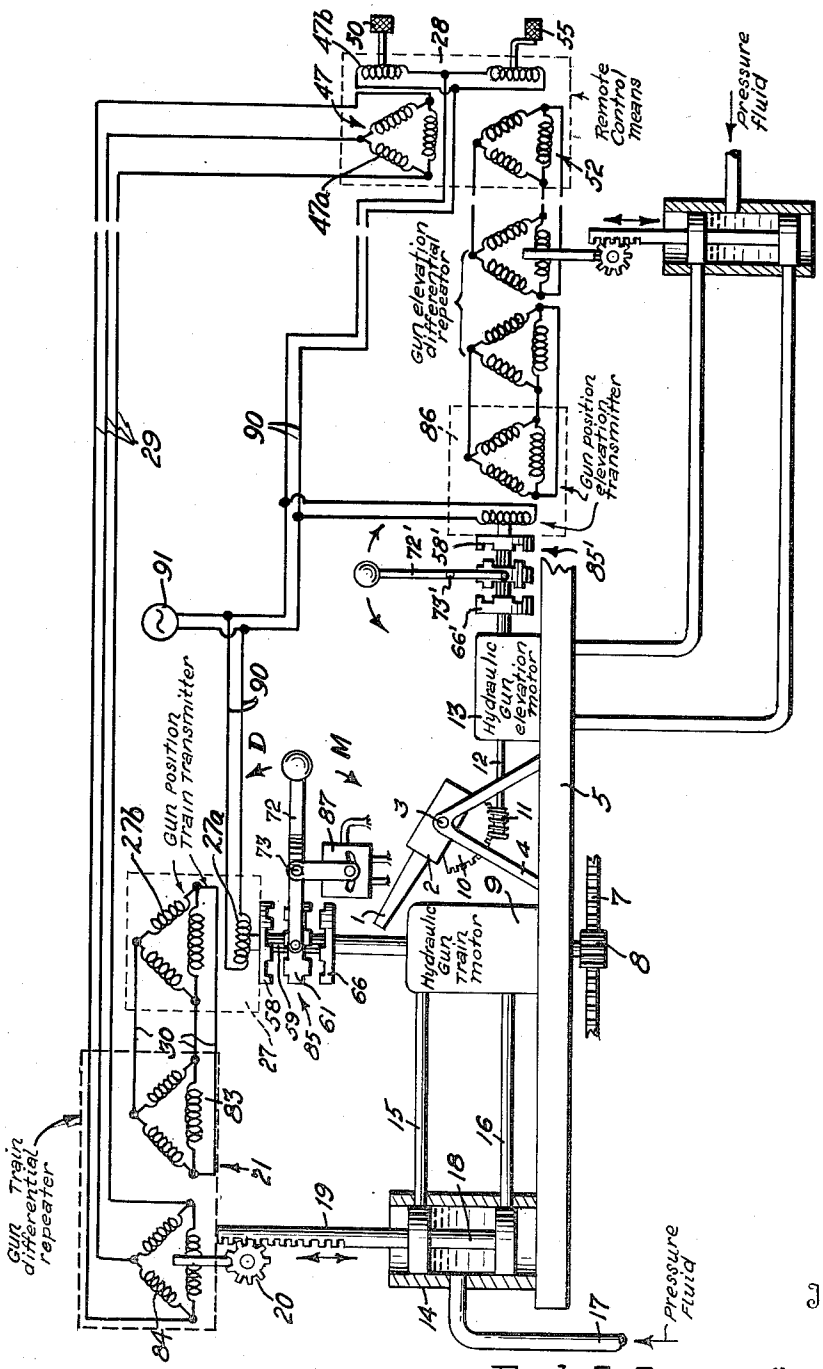

Fig. 10.

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UNITED STATES PATENT OFFICE

2,596,130

MANUALLY OPERATED TELEMETRIC GUN CONTROL SYSTEM

Earl C. Cunningham, Waco, Tex.

Application June 28, 1945, Serial No. 602,140

7 Claims. (Cl. 89—41)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This invention relates to manual control mechanisms to control the rate of angular movement in train and elevation, of a power operated gun. In certain types of gun units now in use, such as the 40-mm. fire unit, the gun itself is trained and elevated by hydraulically operated motors directly connected to the train and elevation mechanisms. The rate of operation of each motor is controlled by the amount of displacement of a piston-type pilot valve connected to control a source of high pressure oil through reversing connections to the motor. When the valve is in central position, no oil flows to the motor from the high pressure source and no movement of the gun takes place. As the piston of the valve is moved in one direction or the other, flow of high pressure oil is permitted from a corresponding end of the main valve, to thereby rotate the motor, exhaust taking place to the sump, by way of the other end of the main valve. Thus the direction of rotation of the motor depends upon the direction of displacement of the pilot valve; and the rate of rotation is proportional to valve displacement. It will be understood that two motors are used, one to train the gun and one to elevate it, and that each is controlled by a corresponding hydraulic valve. The description will be confined to the train control since both operate upon the same principles.

Confining the description, then, to the mechanism for controlling movement of the gun in train, control of the hydraulic gun train motor is effected by a gun train differential repeater having a stator delta-connected to the stator of a gun position train transmitter, and a rotor delta-connected to the stator of remote control train transmitter. Movement of the hydraulic motor control valve is effected by a mechanical connection with the rotor of the aforesaid gun train differential repeater. The rotor of the remote control transmitter, and the rotor of the gun position transmitter, are connected in parallel with a single phase source. The rotor of the gun position train transmitter is connected to be driven from the corresponding hydraulic gun train motor and at a reduced rate such as 18 to 1, so that said rotor is turned 18 complete revolutions for each 360° angular movement of the resultant gun in train.

When the aforesaid parts are at rest, the fields induced by the rotor and stator of the differential repeater, are in alignment and no torque is applied to the rotor. Hence the hydraulic motor control valve is in cut-off position so that no pressure fluid is flowing to the motor. Upon rotation of the remote-control train transmitter

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rotor, the direction of the induced field in the stator rotates proportionately and this rotation causes a corresponding rotation of the field induced by the rotor coils of the gun train differential repeater. Inasmuch as the gun is not moving, the field induced in the stator of the gun position train transmitter is at rest as well as the field controlled thereby in the stator of the gun train differential repeater. Therefore, because of the interaction between the two differential repeater fields, the rotor thereof turns to effect a corresponding movement of the control valve. The connections are such that the resulting movement of the hydraulic gun train motor, acts to turn the rotor of the gun position train transmitter in the proper direction until the field induced in its stator and repeated in the stator of the differential repeater, is again in alignment with the field induced in the rotor of the gun train differential repeater, so that the rotor torque of the differential repeater drops to zero. Thereupon, the control valve returns to cut-off position under the urge of a centralizing spring and all movement ceases. Thus the gun angularly moves at all times in a direction determined by the direction of rotation of the transmitter rotor at the remote director, while the rate of angular movement is proportional to the rate of rotation of said rotor. In short, the rotor of the gun position transmitter follows the rotor of the remote control transmitter, so that the two actually rotate in synchronism.

From the foregoing description, it will be apparent that, if the rotor of the gun position train transmitter is disconnected and locked in position so that it is not moved in response to operation of the hydraulic gun train motor, the rotor of the gun train differential repeater will be responsive solely to displacement of the transmitter rotor at the remote control. As the hydraulic gun train motor will ordinarily be connected to the rotor of the gun position train transmitter in, say, an 18 to 1 ratio, the transmitter at the remote control must rotate 18 times for each 360° rotation of the gun in train. By the disconnection and locking of the rotor of the gun position train transmitter, however, the rate of train of the gun is made proportional to the displacement of the remote control transmitter rotor, and a sensitive and rapid response of the gun is provided with relatively small displacements of the remote control rotor.

At times it has been found desirable in combat either because the remote automatic director is out of action or for other reasons, to provide for manual control by a single observer located at a point somewhat remote from the gun whereby the observer may direct the gun by observation of the tracers alone.

It is an object of my invention to modify the

controls just described, whereby manual control may be substituted for the director quickly and without in any way impairing the re-conversion to automatic control when desired.

It is a further object of my invention to provide a manually operated control box that uses standard parts and that gives sensitive and rapid manual rate control of the gun in elevation and azimuth.

Another object is to provide an efficient and accurate manual control in case the automatic director is out of action.

A further object is to provide a mechanism enabling instantaneous change from director or automatic control of a power-operated gun, to manual control thereof.

Another object is to provide a single manual control lever for controlling movement of the gun about both axes of movement and so correlated with said axes that movement of said lever simulates movement of the gun itself.

A still further object is to provide a manual control as explained in the preceding paragraph that enables the observer to take the position that is most favorable for each tactical situation encountered.

Other objects and advantages will become apparent as the description proceeds.

In the drawings:

Fig. 1 is a diagrammatic view showing the general arrangement of a gun with my invention applied thereto;

Fig. 2 shows the transmitter and oil gear unit at the gun as used with automatic director control, it being understood that two units are used with each gun, one for control in train and the other in elevation;

Fig. 3 shows the construction of Fig. 2 after the necessary changes have been made to adapt the same to manual control in accordance with the invention;

Fig. 4 is an enlarged detail showing a preferred manner of locking the armature of the gun position transmitter, whereby direct manual control of the differential repeater is effected;

Fig. 5 is a side elevation of Fig. 4;

Fig. 6 is an exterior view of the control box constructed in accordance with the invention;

Fig. 7 is an elevation of the control box with one side removed to show the interior construction;

Fig. 8 is an exploded perspective view of a modification whereby shifting of a lever acts instantaneously to disconnect the oil gear and lock the transmitter rotor;

Fig. 9 is a view showing a modification wherein a single "joy stick" control is employed for the elevation and train transmitters, and

Figure 10 is a schematic view of the electrical and hydraulic controls including remote control means.

At Fig. 1 I have shown, more or less schematically, a gun 1 having a cradle 2 with trunnions 3. These trunnions are mounted in bearings in supports 4 fixed to a rotatable platform 5 that is journaled on a fixed base 6 for rotation about a vertical axis. A ring gear 7 is fixed to base 6 and is in mesh with a pinion 8 mounted upon the shaft of hydraulic train motor 9 which, in turn, is fixed to platform 5. A gear sector 10 is fixed to cradle 2 concentric of the axis of trunnions 3. A worm 11 is journaled upon platform 5 and meshes with said sector. Worm 11 is fixed to the shaft 12 of a hydraulic elevating motor 13. Each motor 9 and 13 may incorporate control

valves, together with well known adjusting and actuating means therefor for controlling the flow thereto of high pressure fluid.

One such mechanism is shown in Fig. 10, where the cylinder 14 of a control valve has its ends connected by passageways 15 and 16 to motor 9, and its center connected by pipe 17 to a source of high pressure fluid. A spool or piston 18 has its ends slidably fitting cylinder 14 so that, in the position shown, flow of fluid to the motor is prevented. The motor may be rotated in one direction or the other by a corresponding direction of movement of piston 18. The piston is actuated by means of a rack 19 secured thereto and in mesh with a pinion 20 upon the rotor shaft of a differential repeater motor 21. This motor has 3-phase, delta- or Y-connected stator or field coils 83 and rotor or armature coils 84 so related that the rotor 84 will be urged to place the resultant field induced in its coils, in alignment with the resultant field induced in the coils of stator 83. Thus, when any relative rotation between these fields occurs, valve 18 will be moved upwardly or downwardly, as the case may be, to effect a corresponding rotation of motor 9 and training movement of the gun.

As shown upon Figure 10, motor 9 has its shaft connected, as by a manually operable clutch 85, subsequently described, with the rotor shaft of gun position train transmitter 27, comprising a rotor 27a and a stator 27b, and carried by platform 5. By this construction, as the gun is moved in train in response to displacement of valve 18 from central position, the rotor of transmitter 27 is turned in step therewith, for example, in an 18 to 1 ratio. Three-phase connections are indicated at 29, between a transmitter 47 and repeater 21, and at 30, between repeater 21 and transmitter 27. Thus, when the rotor of the train transmitter 47 at the remote control means or director is turned, a relative rotation of the rotor and stator fields in the differential repeater 21 is effected, resulting in a displacement of valve piston 18 and a rotation of motor 9 to train the gun in the proper direction. At the same time, the rotor of transmitter 27 is turned to correspondingly rotate the field induced in its stator coils. The reproduced field in the stator 83 of gun train differential repeater 21 is correspondingly turned and the connections are such that this field follows the field rotation induced in its rotor 84 by rotation of the remote transmitter 47. Thus, when the two fields in the repeater 21 are again matched, the torque exerted thereby reduces to zero and the valve resumes its centralized, or cut-off position, under the influence of restoring springs, not shown.

Fig. 2 shows an actual construction employed in the oil gear of an antiaircraft gun, with cover plate 31 broken away. The numeral 32 identifies a framework carried by the gun carriage or platform mechanically coupled with one hydraulic motor such as 9, carries a worm 34, in mesh with gear 36 fixed to the rotor shaft 37 of gun train transmitter 27. Transmitter 27 is electrically connected as shown upon Fig. 10.

At times, it is necessary or desirable to temporarily dispense with the director and to provide for manual control of the gun whereby the same is trained and elevated in response to the observation of the tracers. In such cases, it is not sufficient merely to substitute a pair of hand-operated transmitters corresponding to the transmitters in the director. In the first place, these transmitters, because of the geared down

connection between the gun and the gun position transmitters, must rotate at a relatively high rate for a given angular rate of movement of the gun so that, were these director transmitters operated manually, rough tracking would result. In the second place, the transmitter shafts in the director not only control the rate of movement of the gun by their rate of displacement, but their actual displacement or rotation from a given position is proportional to a corresponding angular movement of the gun.

On the other hand, for manual control, it is extremely desirable to increase the rate of response of the gun for a given relatively small angular displacement of the respective control transmitters, and to make said rate proportional to the displacement of the respective transmitters instead of proportional to their rates of displacement. This is because the latter arrangement permits the operator to sense the deflections necessary to bring the tracer stream onto the target much more quickly and accurately in that, with practice, he can get the sense or feeling that he is directly moving the gun itself.

In the preferred form of the invention, means are provided to rapidly disconnect the gun position train transmitter **27** and gun position elevation transmitter **86** from the hydraulic motors **9** and **13**, respectively, and, at the same time, lock the rotors of the aforesaid transmitters. Referring to Figs. 8 and 10, gun position train transmitter **27** has clutch teeth **58** fixed to its casing concentric of its splined shaft **59**. The shaft has a reduced threaded end **60**. A clutch element **61** has a splined bore **62** slidably fitting shaft **59** and is provided with clutch teeth **63** on one side to engage with teeth **58**, and teeth **64** on its other side to engage the teeth **65** of a disc **66**. This disc has a central bore **67** to fit the reduced end **60** of shaft **59** so that when lock nuts **68** are in place, the disc may freely rotate upon the shaft when free of clutch element **61**. As shown upon Fig. 10, the shaft of hydraulic motor **9** is mechanically coupled in any suitable manner, with disc **66**.

Clutch element **61** is formed with a peripheral channel **70** whose side walls are engaged by rollers, not shown, mounted on stub shafts **71** of a forked lever **72**. This lever is fulcrumed by a pin **73**. When the lever is shifted in the direction of arrow D, Fig. 8, teeth **64** and **65** are brought into engagement and disc **66** and the shaft of motor **9** are locked to shaft **59** whereby the gun is adapted for control by a remote director or computer. When lever **72** is thrown in the direction of arrow M, Fig. 8, teeth **64** and **65** are separated and teeth **58** and **63** are engaged. Thereby the disc **66** is freed from shaft **59** and the shaft as well as the rotor fixed thereto, are locked, to adapt the gun for remote manual control. If desired, a double-throw switch **87**, may be mounted for actuation in response to lever **72**, so that change from one type of remote control to the other may be effected instantaneously merely by shifting lever **72**. The parts are so dimensioned that one pair of clutch teeth are fully separated before the other pair can begin to engage.

The hydraulic gun elevation motor **13** is similarly connected with its transmitter **86** by a clutch whose parts are identified upon Fig. 10 by the same numeral, primed, as are used to identify corresponding parts for the motor **9**. Hence it is unnecessary to describe these parts in detail.

A control box **38** is provided that may conveniently be substantially cubical and about ten inches on a side. The box has a strap **43** and hangers **44'**, by which it may be suspended from the neck of the operator. As shown at Fig. 7, a standard receptacle **44** is mounted with the box and is adapted to receive a plug **45** on the end of cable **46**, whereby all connections may be simultaneously made by the simple operation of securing the plug in its receptacle. This receptacle **44** may be identical with the one used in the director and may be similarly wired to the transmitters so that the change from director to manual control may be made simply by removing plug **45** from the director and inserting it in the receptacle in box **38**. This is, of course, merely a matter of convenience, as the connections from gun to box **38** may be made in any way desired.

A train transmitter **47** comprising stator **47*a*** and rotor **47*b*** has a base **48** secured to the right-hand wall of the box **38**, as viewed in Fig. 7. The shaft **49** of the rotor of transmitter **47**, extends upwardly through the top of the box and terminates in a knob or handle **50**. Electrical connections **51** are provided between the transmitter and receptacle **44**. An elevation transmitter **52** has its base **53** affixed to the bottom of box **38** and its rotor shaft **54** projects through the left hand wall of the box, as viewed in Fig. 7, and there carries a knob or handle **55**. Electrical connections **29** are provided between the transmitter and receptacle **44** to junction box **57** on platform **5**. The rotors of transmitters **27**, **86**, **47** and **52**, are all energized in synchronism by a source of single phase A. C. **91**, and connections **90**, Figure 10.

The operation will now be clear from the foregoing description. When the rotor of the gun position transmitters are locked, rotation of train transmitter knob **50**, for example, causes a corresponding rotation of the induced field in its stator and effects a corresponding rotation of the field induced in the armature of gun train differential repeater **21**. Since the gun position transmitter rotors are locked, the field induced in the stator of each differential repeater motor is fixed. As a result, when knob **50** is turned, armature **84** is displaced in a corresponding amount and direction. Since the displacement of the valve **18** of the hydraulic train motor **9** is proportional to the armature displacement, the gun is trained in a direction and at a rate corresponding to the direction and amount of displacement of said knob. It will be understood that movements of knobs **50** and **55** is so related to the resulting gun movements that, when knob **50** is turned to the right, the gun moves to the right, and when knob **55** is elevated, the gun moves to increase its elevation. Thus, the two movements are effectively correlated and, with practice the operator comes to intuitively turn the controls in the proper direction and amount to quickly cause the trajectory of the tracers to intersect the target.

While I have shown the form of my invention now preferred by me, because it unitizes the remote control system to place responsibility in a single person, this is not absolutely necessary. If desired, the controls may be separated, one man being assigned to operate the azimuth knob, and another to operate the elevation knob. It has been found that a man with as much training as he normally receives on the director, is able to manipulate the controls instinctively to high precision control of the gun and at a rate

faster than is possible either with the director or previous systems of manual control.

Furthermore, within the limits of the length of cable 46 connecting box 38 and the gun platform, the operator may take the most advantageous position for viewing the tracers and the target at a point remote from the smoke and jar. There is no "dead area" as in the case of director control, so that the field of fire is literally, 360° of azimuth with my invention. In addition, by the use of my invention, the gun crew can be reduced by at least two men as the director trackers are then no longer needed; and the cost of a single installation would be insignificant, in comparison to the many thousands of dollars cost of a single director. By having the power plant and junction box upon the gun truck (not shown), the gun may be fired in traveling position without dismounting from the truck so that only a negligible time need elapse between stopping the truck and the order to open fire.

Where a simplified construction is desired, it is possible to realize the benefits of the invention without the two clutches 85 and 85'. Thus, referring to Figs. 2 through 5, the numeral 27' identifies a gun position train transmitter which is essentially similar to instrument 27 except that it has a plain shaft 37 to which a disc 39 is attached. A gear 35 is attached to disc 39 and is driven by a pinion 34 fixed to shaft 33 which, in turn, is mechanically coupled with motor 9. When the parts are as shown at Fig. 2, the gun is adapted for automatic or computer control. When direct manual control is desired, gear 36 is removed and disc 39 and shaft 37 are locked by a screw 41, Figs. 4 and 5, inserted through a hole in disc 39 and threaded into a tapped hole a lug 40 of the transmitter casing. The hydraulic gun train motor is thus disconnected from its transmitter and the rotor of the latter is locked, as in the preferred form. In this way the two clutches may be omitted although, of course, a longer time is required to effect change from one type of control to the other.

In Fig. 9, I have shown a "joy stick" control that may be substituted for the control shown at Figs. 6 and 7. This consists of a first slotted bail or yoke 73 journaled upon trunnions 74 and 75 forming a diameter of said bail. One trunnion 74 is connected to the rotor of a transmitter 76 that may control movement of gun in train. A second slotted bail 77 has trunnions 78 and 79 extending on a diameter of said bail. The axes of the two pairs of trunnions are mutually perpendicular and the rotor of an elevation transmitter 80, is secured to trunnion 78. Bail 77 is slightly less in diameter than bail 73, so that the two may rotate without any interference. A universally pivotable lever 81 is universally mounted at 82 and extends through the opening defined by the overlapping slots in bails 73 and 77. The parts may be so mounted on a base, that, when in position on the person controlling the gun, the axis of trunnions 74—75 will be vertical while that of trunnions 78 and 79 will be horizontal. Thus, lever 81 has axes of movement similar to those of the gun and, by grasping the lever and moving it in the direction in which it is desired to move the gun the operator comes to intuitively move the lever in the proper direction. In fact, he obtains the "feel" that he is actually moving the gun itself.

Thus I have provided a mechanism that may either replace or be instantaneously substituted for director control of a gun, to manually control the rate and direction of movement of the gun in a smooth precise and rapid manner. By my invention, the flexibility and effectiveness of a weapon equipped therewith are greatly increased and the gun may be used under conditions of fire where director control is impractical or impossible.

While I have shown my invention in connection with a 40-mm. fire unit, it will be understood that it is merely to comply with the requirements of the patent statutes and is not to be construed in a limiting sense. The control is readily adapted to use with any power-controlled weapon capable of being independently aimed. Therefore, I do not wish to be limited to the precise details of construction shown, but reserve all such modifications, alterations, and substitutions of equivalents as fall within the scope of the sub-joined claims.

Having fully disclosed the invention, what I claim as new, and desire to secure by Letters Patent is:

1. In a gun control system, a gun position transmitter having a fixed frame and a splined shaft, a first series of clutch teeth on said frame, a disc having a second series of clutch teeth and journaled on said shaft, means rotating said disc by and in proportion to angular movement of the gun about a predetermined axis, a clutch element splined to said shaft and having oppositely facing series of clutch teeth to engage said first and second clutch teeth, respectively, and means manually operable to shift said element axially of said shaft to thereby selectively clutch said disc to said shaft or alternatively to lock said shaft to said frame.

2. In a control system for a gun having a reversible hydraulic motor connected to rotate the gun about a predetermined axis, control means for said motor comprising a valve, a repeater having stationary field coils and an armature, a driving connection between said repeater armature and said valve, a first transmitter having its field coils connected to the field coils of said repeater so that the fields induced thereby rotate in synchronism, a second transmitter having its field coils connected with the armature of said repeater so that the fields induced thereby rotate in synchronism, means connecting the armatures of said transmitters for synchronous energization by a source of alternating current, manually operable means connected to rotate the armature of said second transmitter, and means operable to selectively connect the armature of said first transmitter to be operated by and in accordance with the operation of said motor, or to lock said armature against movement relatively to its field coils while simultaneously disconnecting the same from said motor.

3. In a control system for a gun angularly movable about first and second mutually normal axes, first and second hydraulic motors each connected to move said gun about a corresponding axis, a control valve for starting and reversing each motor, first and second telemetric repeaters, each having its armature connected to operate a respective control valve, a support, first and second manual transmitters on said support, manually operable means connected to turn the rotors of said transmitters, first and second gun transmitters each having its rotor adapted to be turned in response to movement of

said gun about a corresponding axis, means electrically connecting the stators of said gun transmitters with the stators of said first and second repeaters, respectively, whereby the fields induced thereby rotate synchronously, means electrically connecting the stators of said first and second manual transmitters with the armatures of said first and second repeaters, respectively, whereby their fields rotate synchronously, means energizing the rotors of said transmitters in phase, and means selectively operable to connect the rotor of each said gun transmitter to be turned by and in proportion to the angular movement of said gun about a corresponding axis, or to disconnect said rotors from said gun and lock the same in fixed relation with its respective stator.

4. In a manual control for a power-operated gun, a hydraulic elevation motor, a gun elevation transmitter having rotor and stator coils, a differential repeater having relatively rotatable field and armature coils, one of said coils being electrically connected with the stator coils of said elevation transmitter, a remote transmitter having a manually-rotatable rotor coil, electrical connections between the stator coils of said remote transmitter and the other of the said coils of said repeater, means electrically connecting the rotors of said transmitters for energization in phase, a control valve for said motor connected to be actuated by rotation of said repeater armature and means operable at will to selectively connect the rotor of said gun elevation transmitter to be rotated by and in accordance with rotation of said elevation motor, or to disconnect said rotor from said motor and lock said rotor.

5. In a selective manual or remote director control for a power-operated gun, a reversible motor connected with the gun to angularly move the same, a gun transmitter having a rotor and a stator, a differential repeater having relatively rotatable field and armature coils, one of said coils being electrically connected with the stator coils of said gun transmitter, a remote transmitter having stator coils and a rotor coil, manually operable means connected with the rotor coil of said remote transmitter to rotate the same, electrical connections between the stator coils of said remote transmitter and the other of the coils of said differential repeater, means electrically connecting the rotors of said transmitters for synchronous energization from a common source of A. C., a control including a part movable to control the direction and rate of movement of said reversible motor, a driving connection between said other coil of said differential repeater and said part, and means selectively operable to connect the rotor of said gun transmitter to be driven by said reversible motor synchronously therewith, or to lock said rotor in fixed relation with its stator and independent of said reversible motor.

6. In a control system for a gun having a motor connected to angularly move said gun about a predetermined axis, a first transmitter having stator and rotor coils, a second transmitter having stator and rotor coils, manually operable means connected with the rotor coil of said second transmitter to rotate the same, a differential repeater having relatively rotatable field and armature coils, the armature coils of said differential repeater being electrically connected

with corresponding coils of the stator of said second transmitter, the field coils of said differential repeater being electrically connected with corresponding field coils of said first transmitter, control means operable to control the direction and speed of operation of said motor, a driving connection between said control means and the armature of said differential repeater, and clutch means manually operable from a first position coupling the rotor of said first transmitter with said motor for synchronous rotation therewith, to a second position disconnecting said motor and rotor while positively locking the rotor in fixed relation with its stator.

7. In a system for training a gun about a normally vertical axis, a hydraulic motor adapted to be connected to train the gun, a valve for controlling the direction and rate of movement of said motor, a differential repeater having polyphase field and armature windings, a driving connection between the armature of said repeater and said valve, first and second transmitters each having polyphase distributed stator windings and a single phase rotor winding, means manually operable to rotate the rotor of said second transmitter, electrical connections between the windings of the armature of said differential repeater and the stator windings of said second transmitter, electrical connections between the field windings of said differential repeater and the stator windings of said first transmitter, circuit means for synchronously energizing the rotor windings of said first and second transmitters from a source of A. C., and clutch means operable selectively from a first position positively connecting the rotor of said first transmitter for operation by said hydraulic motor to a second position disconnecting said motor and rotor and locking said rotor in fixed relation with its stator windings.

EARL C. CUNNINGHAM.

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