Aug. 12, 1947. J. F. JOY 2,425,329

GUN POSITIONING SYSTEM

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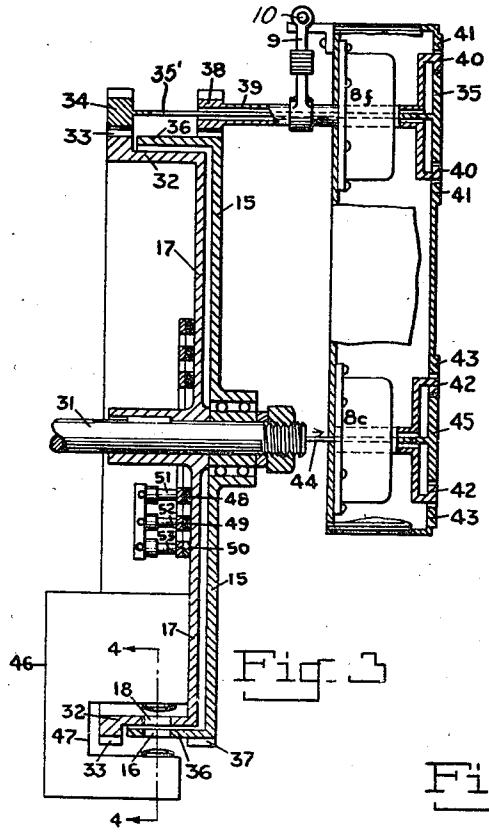


Fig. 3

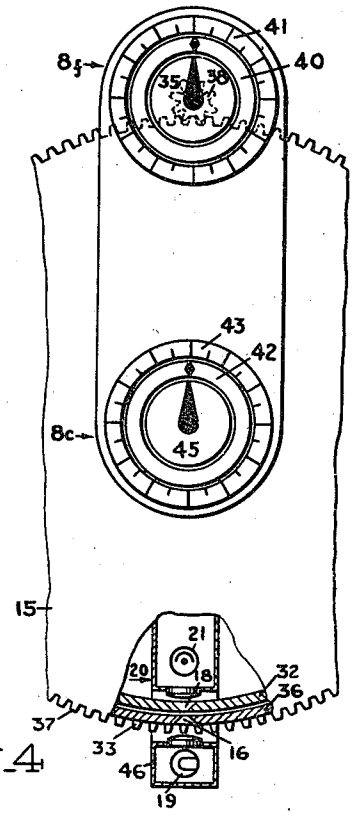
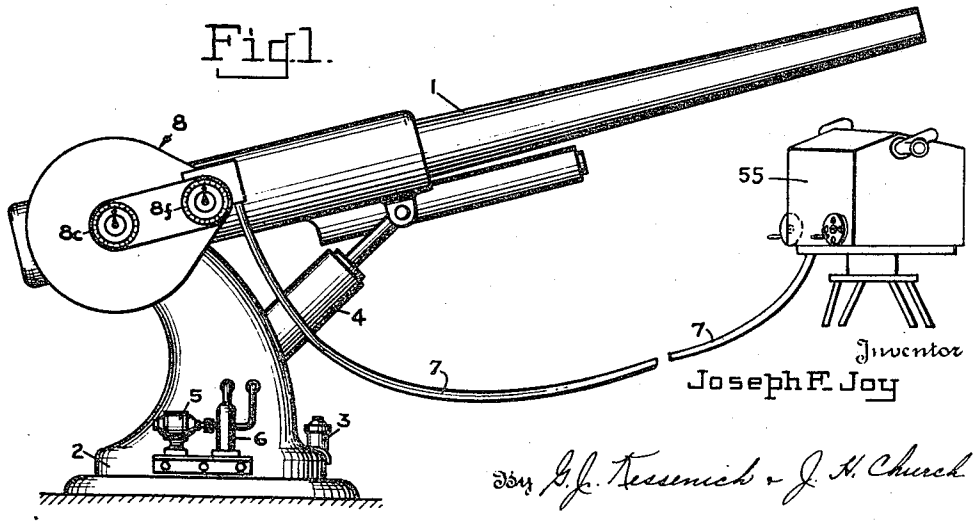


Fig. 4

Fig. 1.



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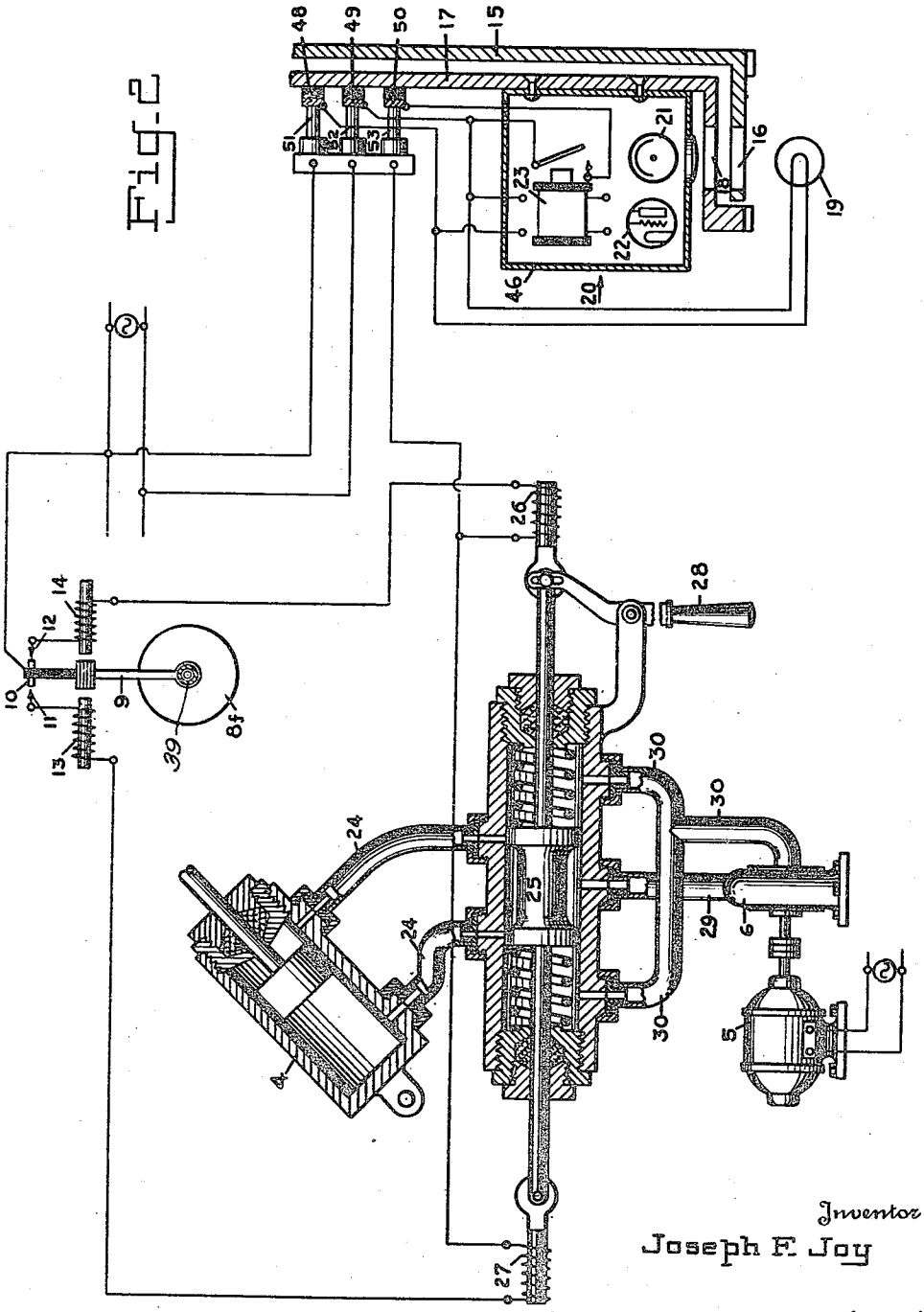
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Fig-2



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GUN POSITIONING SYSTEM

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4 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 the positioning of a heavy mass by means of a remotely located control instrument. More specifically this invention deals with a hydraulic system of gun training and pointing and with the electrical control equipment associated therewith.

The repeater controlled hydraulic gun positioning systems of the prior art have been distinguished chiefly for the complexity of their control equipment with all the attendant nuisances of complexity such as expense, difficulty of maintenance, and erratic operation.

It is therefore an object of this invention to provide means of simple and reliable construction for positively and accurately training or pointing a gun under the control of a remotely located fire control device.

The specific nature of the invention as well as other objects and advantages thereof will clearly appear from the description of a preferred embodiment as shown in the accompanying drawing in which:

Fig. 1 is a side elevational view of a gun equipped with hydraulic training and pointing equipment according to my invention.

Fig. 2 is a schematic view showing the electric and hydraulic circuits involved in the pointing or elevation control.

Fig. 3 is a side elevational view, partly in section, of the repeater motors and positioning control associated therewith.

Fig. 4 is an end elevation of the positioning disks and repeater motors, partially in section to show the positioning apertures therein.

Referring to the drawing by characters of reference there is shown in Fig. 1 a gun 1 mounted for elevation and traverse on a base 2. A hydraulic training motor 3 is provided on the base 2 and operates traversing gear to move the gun in azimuth in a known manner. A hydraulic elevating cylinder 4 is provided to move the gun in elevation. An electric motor 5 or other prime mover is provided to drive a variable displacement, constant pressure hydraulic pump 6. Repeater motors 8f and 8c are provided to control the operation of the hydraulic elevating gear, these being mounted as a unit on a case 8 which encloses cooperative positioning and follow-up discs to be described. This case 8 may be fixed on the traversible mount portion on which the gun is trunnioned. A similar set of repeaters (not

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shown) are provided to control the traversing gear, in response to impulses received through the control cable 7, from a data computing and transmitting station, as for instance, a director 55, of prior known construction, shown formally in Figure 1, which conventionally includes sighting and tracking means and mechanism, so as to develop and transmit the data necessary for training a given gun on the target observed at the station.

Fig. 2 shows schematically the system employed for the control of elevation. It must be understood, however, that except for obvious modifications the system is identical with that used to position the gun in azimuth. The control equipment includes a "fine" repeater motor 8f on the shaft 39 of which is mounted the rotation contactor comprising a contact arm 9 in light frictional engagement with the shaft for rotation therewith through a limited arc. A contact 10 is provided on the extremity of the arm 9 for establishing a circuit through either the contact 11 or 12 depending upon the direction of rotation of the repeater motor. Series coils 13 and 14 energizing hold-in electromagnets may be employed to maintain the contact as long as current flows in either line. The contacts 11 and 12 and also the holding coils 13—14 may be conventionally mounted, say, by brackets on the case of the adjacent repeater of Figure 3, or other framing fixed on the gun cradle. These features being well understood and optional are not illustrated in detail. It is the function of the rotation contactor to selectively make a circuit through the hydraulic valve operator corresponding to the direction of rotation of the repeater shaft, which corresponds with the rotation of the transmitter at the fire control station. Operating in conjunction with the repeater is a positioning disc 15 provided with an aperture 16 for the passage of a light beam. Follow-up disc 17 having a similar aperture 18 is arranged on an extension of the gun trunnion with the gun proper. In the position in which the apertures of the discs match, the gun is in the position called for by the equipment at the fire control station. A light source 19 and photoelectric amplifier 20 (Fig. 4) are carried by the disc 17 in alignment with the aperture and so arranged that unless the aperture 16 in the disc 15 coincides with aperture 18 the light beam will be unable to reach the photoelectric cell 21. The amplifier 20 preferably employs a triode thermionic gaseous tube 22 of the Thyratron type and is so arranged as to cause the

relay 23 to be closed whenever the light beam is interrupted.

The hydraulic system comprises an elevating cylinder 4 adapted to move the gun in elevation and having ports at either end of the cylinder communicating by means of duct tubes 24 with a sensitive hydraulic control valve 25 of the balanced piston type. The piston of the valve must be designed to provide greater lap on the outlet sides, than on the intake to obtain earlier cut-off of outlet than intake ports to insure the complete filling of the cylinder and the elimination of voids or cavities in the fluid such as might give rise to errors in gun alinement. The valve 25 is spring loaded to cause it to normally maintain the neutral position in which it is shown. Electric valve operators 26 and 27 of solenoidal or other convenient type are applied at either end of the control valve and a lever 28 is coupled to the valve to allow for manual actuation. Fluid is supplied to the valve under constant pressure through the line 29 from the pump 6 while the return circuit is completed through the line 30 connected with each end of the valve.

Fig. 3 shows one arrangement of positioning disks and repeater motors which may be conveniently employed to control the gun, and which may in emergency function in the same way as a conventional "follow-the-pointer" system. The follow-up disk 17 is mounted on the gun trunnion shaft 31 and keyed thereto. The disk is provided with a flanged rim 32 and it is in this rim that the positioning aperture 18 is formed. The rim 32 is further provided with gear teeth 33 on its outer periphery adapted to drive a pinion 34 which through an extended shaft 35′ operates the gun trunnion "fine" index 35. Rotatably mounted on an extension of the trunnion shaft 31 is the positioning disk 15 which is provided with a flanged rim 36 having therein the positioning aperture 16 and is further provided with gear teeth 37 adapted to be driven by a pinion 38 on the shaft 39 of the "fine" repeater 8f. Conveniently the shaft 39 will be made hollow and through it will extend the shaft 35′ of the trunnion index. An electrically controlled rotary annular fine index 40 may be provided on the hollow shaft 39 of the repeater 8f and both indices 35 and 40 may register against a stationary "fine" scale 41. As previously pointed out the rotation contactor arm 9 is mounted on the "fine" repeater shaft 39 for selectively closing the circuit to the proper valve operator depending upon the direction of rotation of the shaft 39.

In view of the limited load handling capacity of repeater motors of the "Selsyn" type the frictional drag imposed by the rotation contactor should be barely sufficient to shift the arm, contact being maintained by the hold-in electromagnets 13 or 14, and the disk 15 should be extremely light in weight and mounted on precision bearings. A "coarse" repeater 8c similar to the repeater 8f is provided with an annular rotary electrically controlled index 42 registering against a stationary scale 43. An extension shaft 44 reaches from the trunnion through the hollow shaft of the repeater 8c and carries on its outer end the trunnion "coarse" index 45.

It is apparent that in case of any failure in the control relays or electric valve operators the system may still function as a "follow-the-pointer" system, it only being necessary to actuate the hydraulic valves manually in such fashion as to match the trunnion indexes with the electrical indexes.

Preferably the rates between the "coarse" and "fine" indexes will be 16 to 1 to agree with the ratios existing in present fire control equipment in which the "coarse" transmitter makes one revolution for each 6400 mils of data transmitted while the "fine" transmitter makes one revolution for each 400 mils of data transmitted.

The light source 19 and photoelectric cell 21 with their associated relay equipment are preferably mounted in a single housing 46, secured to the disk 17 and provided with a slot 47 in which the rims of the disks may be received in such a position as to allow the light beam from the lamp 19 to impinge upon the photoelectric cell 21 when the apertures are in alignment. Insulated slip rings 48, 49, and 50 are provided on the inner face of the disk and operate against brushes 51, 52 and 53 which are supported from a stationary part of the mount to enable the controlling current to be maintained through the relay circuit as the disk rotates.

It will be realized that a similar result may be achieved by modification of elevation or azimuth data receivers of the conventional "follow-the-pointer" type used with virtually all electrical data transmission systems to provide means by which the "fine" receiver motor may, through reduction gearing of proper ratio, operate a positioning disk similar to the disk 15. The mechanical indexes would then be coupled to the gun trunnion in the usual manner and the electrical and mechanical indexes might be matched in the ordinary manner for manual operation.

To summarize the operation of the system let it be assumed that the gun has been properly leveled and oriented with respect to the fire control device 55. If the fire control device is then elevated in tracking a target this will result in a similar rotation of the repeater motor 8f. Such rotation will swing the rotation contactor arm 9 to a position in which the contact 10 engages one of the contacts 11 or 12 opposed to it. For illustration it may be assumed that the circuit was completed through the contact 11. At the same time that this contact was established the rotation of the disk 15 moved the aperture 16 out of line with the aperture 18, breaking the light beam and allowing the relay 23 to close. Under these conditions current will flow through the valve operator 27 allowing oil from the pump 6 to flow through the left one of the lines 24 to the lower end of the elevating cylinder 4 and elevating the gun. Elevation of the gun results in rotation of the follow-up disk 17 and when the light beam again passes through the apertures the photoelectric relay circuit will operate to open the circuit through the valve operator allowing the valve to close and locking the gun in aligned position. When the current in the circuit is interrupted the series energized hold-in magnet will release the rotation contact arm 9.

While the control elements specifically described have been utilized to control the gun in elevation it will be realized that a substantially identical system may be employed to control the gun in azimuth. For traversing the gun a hydraulic motor 3 driving the top carriage in any convenient manner may be utilized. Obviously the mechanical index and the follow-up disk of the training control system must be arranged to be driven by the movement of the top carriage in azimuth.

It will be understood that the showing of the device made herein is somewhat diagrammatic and that refinements may occur to those skilled

in the art in adapting the invention to any particular gun mount. It is intended therefore that the invention shall only be limited as indicated by the scope of the claims appended hereto.

It will be observed from Figure 3 that as the receiver of 8f drives the positioning disc 15 by means of a small gear 38, this disc rotates at a greatly reduced rate compared to that of the receiver motor. Also, as operation of the motor device 4 can not move the gun and disc 17 angularly faster than disc 15 moves, the gun and gear 33 are similarly driven in relation to the receiver motor 8f. However, a contrary effect is manifest at index 35, since the relation between gears 33 and 34 is that of a speed increasing gear so that the member 35 will be rotated to the same extent as the one 40 when the apertures 16—18 are brought to register after operation of the receiver to displace the apertures.

As is known in fire control devices including a coarse data receiver and a fine receiver, the fine receiver rotates at a rate which is a multiple of the rate of the coarse receiver, and the gearing between the receiver 8f and disc 15 between the disc 17 and index 35, and the connection between the index 45 and trunnion and disc 17 will cause an approximately corresponding ratio between the indexes 35 and 45, as a necessary result of the gearing shown. This will result in movement of the index 45 being nearly synchronous with that of the coarse receiver 8c, a slight lag being manifest due to the fact that on receipt of a change of data there will at first be a slight delay in matching of the gun, disc 17 and index 45 on one hand with the coarse receiver motor 8c and index 42 on the other, and a resultant angular lag of the index 35 relative to the index 40, due to the fact that a slight displacement of the apertures 16 and 18 is necessary before the motor device 4 operates.

The lag is only a matter of milliseconds, however, and is quickly recovered or made up at the termination of a signal. The signals customarily include "dead time" components which will allow for the time interval between the calculated position of the target and the firing of the gun at any instant, so that on firing during the reception of data the lag will not produce inaccuracy in gun pointing, being included as the "dead time" component of the data transmitted.

The indexes 40 and 42 operated by the receivers 8f and 8c may be termed electrical indexes since they are directly responsive to movements of the receiver motors. The indexes 35 and 45 however are mechanically connected to the gun, and so are invariably operated therefrom. This positive mechanical coupling is necessary in order to avoid any possibility of incorrect registering of the actual position of the gun in relation to the data transmitted. Other coupling of the gun and indexes 35 and 45, such as electrical, for instance are subject to many possibilities of disturbance and vagaries which render them unsuitable.

I claim:

1. Automatic gun positioning apparatus comprising, in combination with a gun and a remote sighting device therefor, a hydraulic motor operatively connected to said gun, a reversing valve for said motor normally spring biased to neutral position, electric valve operators to operate the valve for each direction of movement, a data receiver adapted to receive indications from said sighting device, a rotation contactor on said data receiver adapted to select one of said valve operators corresponding to the direction of rotation of said receiver, a positioning disk rotated by said receiver, a follow-up disk rotated by said gun and axially opposed to said positioning disk, apertures through each of said disks in opposed relation when said disks are in synchronous relation, means to project light through said openings when in opposed relation, and light sensitive means to receive light projected through said apertures, said light sensitive means being adapted to complete an electric circuit through said rotation contactor to one of said valve operators when said apertures are displaced and to interrupt said circuit when said apertures are in opposed relation.

2. In an automatic gun positioning system, a hydraulic motor, a reversing valve therefor, a pair of electric valve operators each constructed, arranged and adapted to condition said valve for a different direction of action of said motor, a data receiver motor constructed to receive indications from a remote sighting device, a rotation contactor operatively connected to said data receiver to be shifted from one position to another to correspond with the direction of rotation of said data receiver, and means in each of said positions to establish an electric circuit to the corresponding electric valve operator.

3. In an automatic positioning system for a gun, an electrical coarse data receiver and rotary index synchronous therewith, an electrical fine data receiver, a positioning disk, means by which said positioning disk is driven by the fine receiver at the same relative speed as the coarse receiver, a follow-up disk adapted to be driven from the gun, a mechanical rotary index connected in 1 to 1 ratio with the follow-up disk and adapted to be matched with the electrical index for initial synchronization, and means controlled by said fine receiver and said positioning disk for positioning said gun and the associated follow-up disk.

4. Means for positioning an object in accordance with signals from a remotely located control device, said positioning means comprising a data receiver motor constructed and adapted to rotate in response to signals from a remotely located control device, a positioning disc rotated by said receiver motor, a follow-up disc connected to the object to be rotated by the object, said follow-up disc being coaxial with and opposed to said positioning disc, an aperture being formed in each of said discs, said apertures being arranged so as to align with each other in one relative position of said discs, motor means connected to said object to move the same, and means responsive to relative displacement of said apertures to initiate the action of said motor means, said motor means constructed, arranged and adapted on realignment of said apertures to stop the action of said motor means and including a light source fixed in relation to said object adapted to throw a light beam through said apertures when the apertures are aligned therewith, and light responsive relay means carried by one of said discs and adapted to receive light passing through said apertures, said means responsive to relative displacement of said apertures including a contact arm rotatable by said receiver motor to either side of a neutral position depending upon the direction of rotation of said receiver motor, contacts at each side of said arm and circuits to motor governing devices therefrom, the contact arm being adapted to selectively com-

plete an electric circuit governing the direction of action of said motor means.

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