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TURRET CONTROL SYSTEM

Filed July 31, 1942

Fig. 1.

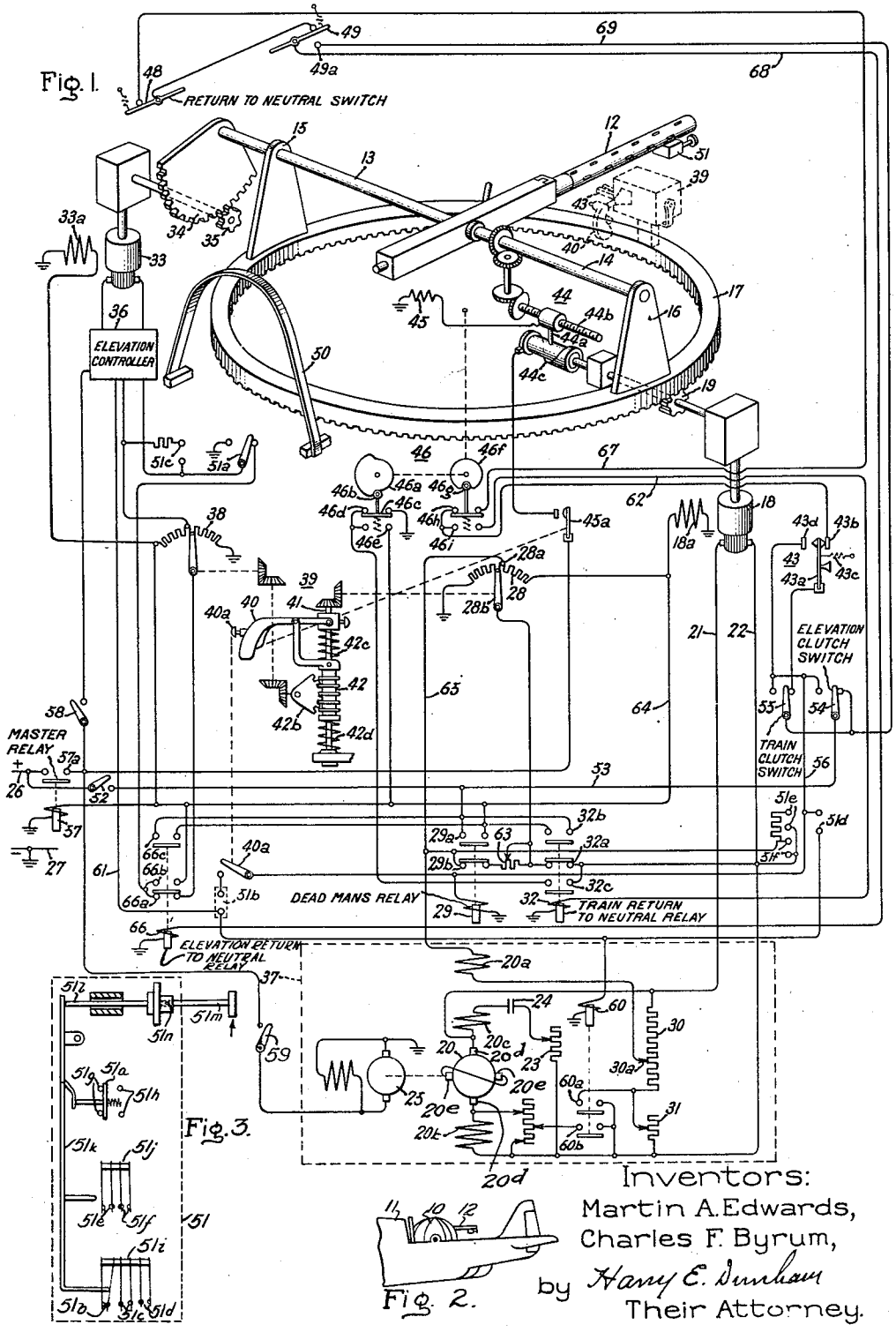


Fig. 3.

Fig. 2.

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TURRET CONTROL SYSTEM

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11 Claims. (Cl. 172—239)

1

This invention relates to control systems, more particularly to control systems for power driven gun turrets and the like, and it has for an object the provision of a simple, reliable, and improved control system of this character.

More particularly, the invention relates to control systems for gun turrets used on aircraft, and a more specific object of the invention is the provision of means for controlling the train and elevation driving means of the turret so that the gun is automatically controlled to clear the contour of any portion of the craft which may constitute an obstacle in the path of rotation of the gun.

Another object of the invention is the provision of means for always stowing the turret in the same position and to remove power from the turret when the turret is not in operation.

In carrying the invention into effect in one form thereof, means are provided for driving the turret both in train and in elevation. These driving means are under the control of a suitable manually operated master controlling device, which is provided with an auxiliary switching device that is moved to one operating position to effect the energization of the driving means and is biased to move to a second position in response to the release of pressure thereon. Means are provided which respond to the return of this switching device to its biased position for energizing the turret driving means to stow the turret in a predetermined neutral position in train and in elevation and then to remove power from the control. In another aspect of the invention, a contour limit is provided on the craft, and the turret is provided with a switching device which partakes of the movements of the turret in train and in elevation and engages the contour limit as the gun approaches a part of the fuselage. The control responds to the engagement of the switching device with the contour limit to control the driving means so that the gun clears the fuselage.

For a better and more complete understanding of the invention, reference should now be had to the following specification and to the accompanying drawing in which Fig. 1 is a simple, diagrammatical illustration of an embodiment of the invention, Fig. 2 is a diagrammatical sketch of an application of the invention and Fig. 3 is a mechanical diagrammatical sketch of a detail. This invention is an improvement of the invention of Martin A. Edwards and Kenneth K. Bowman disclosed in application Serial No. 420,792, "Turret control system," filed November 28, 1941, now Patent No. 2,356,152, dated August 22, 1944, and assigned to the same assignee as the assignee of the present invention.

2

Referring now to the drawing, a top gun turret 10 of a military aircraft 11 is provided with a machine gun 12 which it is desired to move both in train and in elevation. The machine gun 12 is provided with trunnions 13 and 14 which are journaled in trunnion cradles 15 and 16 to provide for elevation of the gun. The trunnion cradles 15 and 16 are fixedly mounted on a rotating ring 17 which is arranged to be rotated in train by suitable driving means illustrated as an electric motor 18. The rotating ring 17 may be geared to the motor 18 in any suitable manner. In the drawing, the ring is illustrated as being provided with gear teeth which mesh with a pinion gear 19 which is driven by motor 18. In actual practice the gun is usually fixedly mounted in the turret, and the turret itself mounted for rotation in elevation, as well as in train.

Current is supplied to the train motor 18 from a special armature reaction excited dynamoelectric machine 20 to the load brushes of which the armature of the motor 18 is connected by means of conductors 21 and 22. This armature reaction excited machine 20 is provided with a pair of load brushes 20*d* and with an additional pair of brushes 20*e* on an axis that is displaced 90 electrical degrees from the axis of the load brushes, and these additional brushes are short circuited as indicated in the drawing. The machine 20 is provided with a main control field winding 20*a* which is arranged so that its magnetic axis coincides with the axis of the load brushes. The flux along this axis causes a current to flow in the short circuit, and this short circuit current causes the armature to produce a flux along the short circuit axis which generates the voltage that appears across the load brushes of the machine. The important characteristics of the armature reaction excited dynamoelectric machine 20 are its exceptionally high speed of response, and its exceptionally high amplification factor, i. e., the ratio between the magnitude of the current flowing in the control field winding 20*a* and the current which flows in the output circuit of the machine.

The dynamoelectric machine 20 is provided with a compensating field winding 20*b* on the load axis of the machine which neutralizes the armature reaction of the machine which results from the armature current that flows in the output circuit of the machine. These compensating field wind-

ings neutralize the load armature reaction 100 per cent and provide an additional amount of compensation to compensate for the RI drop of the armature circuit. Consequently the main control field winding **20***a* is required only to produce the amount of flux necessary to cause current to flow in the short circuit. As a result, the magnitude of this control current is very small and this accounts for the high amplification factor of the machine. For the purpose of preventing surges and overshooting, the machine **20** is provided with an antihunt field winding **20***c* which is arranged on the load brush axis of the machine in such a manner as to act differentially with respect to the compensating field winding **20***b*, and it is connected across the load brushes of the machine through a portion of a resistor **23** and a capacitor **24**.

The dynamoelectric machine **20** is driven by any suitable driving means such as the direct current electric motor **25** which is supplied from a suitable direct current source such as represented by the two conductors **26** and **27**. The negative side **27** of the source may be grounded to the frame as indicated.

A control potentiometer **28** is connected across the direct current source **26**, **27** through the contacts **29***a* of a relay **29**. Another potentiometer **30** and additional resistor **31** are connected in series relationship across the output brushes of the armature reaction excited dynamoelectric machine **20**.

The control field winding **20***a* of the dynamoelectric machine **20** is connected between the midpoint **28***a* of potentiometer **28** and the movable contact **30***a* of potentiometer **30**, whereas the movable contact **28***b* of potentiometer **28** is connected through normally closed contacts **32***a* of a relay **32** to conductor **22** which is connected to the lower terminal of potentiometer **30**. As a result of these connections, a voltage is applied to the main control field winding **20***a* of dynamoelectric machine **20** which is equal to the difference of the control voltage between the midpoint **28***a* of potentiometer **28** and the movable contact **28***b* and the voltage across the active portions of the potentiometer **30** and resistor **31** between the slider **30***a* and conductor **22**. As a result of these connections, the dynamoelectric machine **20** is caused to generate a voltage which is proportional to the difference of the control voltage produced by the potentiometer **28** and the voltage across predetermined portions of potentiometers **30** and **31** between the slider **30***a* and the conductor **22** and as a further result, the motor **18** is caused to rotate at a speed proportional to this difference voltage. As previously pointed out, only a very small current is required to excite the control field winding **20***a*, and accordingly, the voltage drop across the predetermined portions of the potentiometers **30** and **31** are closely regulated to the control voltage of potentiometer **28**. Likewise, the speed of the motor **18** is caused to correspond closely to the control voltage of potentiometer **28**.

For the purpose of elevating the gun **12**, a second electric motor **33** is provided and this motor is geared to the trunnion **13** through sector and pinion gears **34** and **35**. The motor **33** is supplied and controlled by means of apparatus **36** which is in all respects identical with the apparatus within the dotted rectangle **37** which supplies and controls the train motor **18** and which has been described in the foregoing. Duplication of this apparatus is therefore omitted for the

purpose of simplifying the drawing. The potentiometer **38** corresponds in function with the potentiometer **28** and produces a reference control voltage with respect to which the speed of the elevation drive motor **33** is regulated.

For the purpose of initiating and controlling the train and elevation movements of the turret, a manually operated master controller **39** is provided. This master controller **39** may be mounted in any convenient location within the turret. It is illustrated as being mounted on the train ring gear **17**.

As shown, the master controller **39** is provided with a pistol grip **40** which is pivotally mounted on a shaft **41**. A sleeve **42** having a worm thread is slidably mounted on the shaft **41** and is connected by means of an L-shaped yoke to the arm of the pistol grip **40**. The worm threads of the sleeve **42** mesh with a sector gear **42***b* which is mechanically coupled to the slider of the potentiometer **38**. Springs **42***c* and **42***d* urge the sleeve **42** to a position such that the slider of the potentiometer **38** is in the central or zero voltage position when the grip **40** is released.

The shaft **41** is journaled in suitable bearings (not shown), and is connected through suitable gearing to a movable contact **28***b* of potentiometer **28**. It will thus be seen that if the pistol grip **40** is moved in a vertical direction, the slider of the train elevation control potentiometer **38** will be moved from its central position and similarly, if the pistol grip **40** is moved in a horizontal plane, the slider of the train control potentiometer **28** will be moved.

A "dead man's" switch **43** is mounted in a suitable position on the master controller **39**. Preferably, this dead man's switch **43** is mounted on the left-hand side of the controller **39** so that it can be grasped by the left hand while the pistol grip **40** is being grasped by the right hand. The contacts of the dead man's switch **43** are included in the energizing circuit of the control relay **29**.

In order to prevent the machine gun **12** from firing into the structure of the airplane, a contact mechanism **44** is provided in the circuit of the firing solenoid **45**. This contact mechanism comprises a movable contact member **44***a* mounted on a lead screw **44***b* and a cam surface contact member **44***c* which cooperates with the contact member **44***a*. The lead screw **44***b* is connected by gearing to one of the trunnions of the gun, as shown, or to some other point of the elevation drive, and the cam member **44***c* is connected to the train drive pinion **19**. The contact **44***a* moves along the lead screw when the gun **12** is elevated, and the cam member **44***c* rotates as the turret is rotated in train. The shape of the surface of the cam contact **44***c* is such that it is not in contact with the contact member **44***a* whenever the gun **12** is in such a position that it could be fired into any part of the fuselage. As a result, when the gun is in such a position, the circuit of the firing solenoid is interrupted and the gun cannot be fired.

For the purpose of stowing the gun **12** in a predetermined position in train when manual pressure on the dead man's switch **43** is released, suitable means, illustrated as a directional switching device **46**, is provided which cooperates with the control relay **32** to control the excitation of the field winding **20***a* of dynamoelectric machine **20**. The directional switching device **46** is actuated by means of a cam **46***a* which is driven in response to, or in accordance with, the train move-

ment of the turret through suitable driving connections (not shown). The cam 46a is constructed so that one-half of its perimeter is higher, i. e., farther from the center than the perimeter of the other half. Its initial adjustment is such that the cam follower 46b rests in a depression or slot when the gun 12 is in a predetermined neutral position in train. If the turret is rotated in one direction from the neutral position, the cam follower 46b remains motionless and the movable contact 46c of the directional switch remains in contact with the upper stationary contact of the switch. If the turret is moved in the opposite direction from its neutral position, the cam follower rides up on the high portion of the cam and actuates the movable contact member 46c from the upper position in which it is shown to the lower position in which it bridges the lower stationary contact of the switch. The upper and lower stationary contacts 46d and 46e of a directional cam switch 46 cooperate with the contacts of the dead man's switch 43 to control the excitation of dynamoelectric machine 20 so as to cause the turret to be driven in that direction in train which provides the shortest path to the neutral.

The cam switch 46 is also provided with a cam member 46f which is driven by, or in accordance with the movement of the turret in train and which has a slot into which the cam follower 46g is moved when the turret is in the neutral position in train. When the cam follower is in the slot, the movable contact bridges the upper stationary contacts 46h and when the cam follower is on the high portion of the cam, the movable contact bridges the lower stationary contacts 46i. The contacts 46h and 46i cooperate with the elevation return to neutral switch 48 and the upper limit switch 49 to effect operation of the elevation motor 33 in a direction to return the gun to a predetermined neutral position in elevation.

For the purpose of controlling the train and elevation motors 33 and 36 in such a manner as to cause the gun 12 to clear any portion of the contour of the fuselage which may present an obstacle to the movement of the gun, the interfering contour is provided with a contour limit 50, and a contour following switch 51 is provided which cooperates with the contour limit 50 to control the control field windings of the dynamoelectric machines from which the control and elevation motors are supplied. The contour following switch 51 may be mounted on the gun itself as indicated in Fig. 1, or it may be mounted on any portion of the mechanism which partakes of the motion of the gun and in such a position that it engages the contour limit as the gun approaches the contour which must be cleared.

The switch 51 is provided with a movable contact 51a which normally engages and closes stationary contacts 51g. It is also provided with normally closed contacts 51b and normally open contacts 51c, 51d, 51e, and 51f. The contacts 51b, 51c and 51d are mounted in a supporting member 51i of insulating material. The contacts 51e and 51f are similarly mounted in a supporting member 51j. These contacts are operated by means of an operating lever 51k which is rocked about its pivot in response to longitudinal movements of a plunger 51l. These longitudinal movements of the plunger 51l are in turn produced by rocking movement of the contour follower 51 about its pivot 51n in response to engagement with the contour 50.

With the foregoing understanding of the elements and their organization in the system, the operation of the system itself will readily be understood from the following detailed description. The system is placed in condition for operation by closing the contacts of the master switch 52. The energizing circuit for the operating coil of the dead man's relay 29 is completed when the gunner grasps the dead man's switch 43. As shown, the movable contact member 43a of the dead man's switch is biased into engagement with the stationary contact 43b by means of a spring 43c. When the gunner grasps the switch 43, the movable contact member 43a is moved against its bias into engagement with the stationary contact 43d to complete an energizing circuit for the relay 29. This circuit is traced from the positive side 26 of the control source through conductor 53 and contacts of the elevation clutch switch 54 and the train clutch switch 55 and contacts 43a and 43d of the dead man's switch, and thence by conductor 56 and the coil of the dead man's relay 29 to ground and the negative side 27 of the control source. In response to energization, the dead man's relay 29 open its normally closed contacts 29b and closes its normally open contacts 29a. Contacts 29a in closing complete the energizing circuit for the operating coil of the master switch relay 57 which picks up in response to energization and closes its contacts 57a. Assuming the circuit breakers 58 and 59 to be closed, the drive motor 25 for the special dynamoelectric machine 20 and the corresponding drive motor in the elevation controller 36 are connected to the source to drive the dynamoelectric machine 20 and the corresponding dynamoelectric machine in the elevation controller 36 at a speed which is preferably substantially constant.

The closing of contacts 29a of the dead man's relay completes the connection of the field windings 18a and 33a of the train and elevation drive motors 18 and 33, respectively, to the source. It will also be noted that the closing of contacts 29a connects the train control potentiometer 28 and the elevation control potentiometer 38 across the source. The closing of contacts 57a of the master relay also completes the circuit for the firing solenoid 45 as far as the firing trigger 45a.

The turret is rotated in train by moving the pistol grip 40 to the right or to the left depending upon whether it is desired to rotate the turret clockwise or counterclockwise. Rotation of the pistol grip 40 in a clockwise direction in a horizontal plane will rotate the slider 28b of the train control potentiometer 28 in a clockwise direction from its neutral position. As a result of the movement of the slider 28b from its neutral position, a control voltage is applied to the control field winding 20a of a polarity such that the voltage generated by the dynamoelectric machine 20 will cause the train drive motor 18 to rotate the turret in a clockwise direction. Since the voltage supplied to the armature of the motor 18 is also supplied to the potentiometers 30 and 31, the voltage drop between the slider 30a and the conductor 22 is subtracted from the control voltage of the potentiometer 28, and the control field winding 20a is energized by the difference of these two voltages. A condition of balance is quickly established with the train drive motor 18 operating at a speed proportional to the control voltage from the potentiometer 28. Movement

of the turret in a clockwise direction brings the low portion of the perimeter of the cam **46a** against the cam follower **46b** and consequently the movable contact member **46c** remains in contact with the stationary contact **46d**. Simultaneously the cam disk **46f** is rotated from its neutral position and the cam follower **46g** is forced out of the neutral slot and up onto the high portion of the cam with the result that the movable contact is caused to open contacts **46h** and to close contacts **46i**.

The movement of the gun **12** in elevation is accomplished by an operation which is identical with the operation in train, with the exception that it is initiated by vertical movement of the pistol grip **40**.

As the gun **12** is brought to bear on the target, the operator ceases both the lateral and vertical pressure on the pistol grip **40**, and the sliders of the control potentiometers **28** and **38** are returned to their central or zero voltage positions, with the result that the control field winding **20a** of dynamoelectric machine **20** which supplies the train motor **18** and the control field winding of the dynamoelectric machine which supplies the elevation motor **33** are deenergized, and the voltages supplied to the train drive motor and the elevation drive motor are reduced to zero.

It may be desired to move the gun rapidly from its position bearing on one target to another position bearing on a new target. For this purpose, a high speed switch **40a** is mounted on the pistol grip **40**. Depression of this high speed switch causes it to close its contacts to complete an energizing circuit for the operating coil of the high speed relay **60**. This circuit is traced from the positive side **26** of the source through conductor **53**, the contacts **54** and **55** of the elevation and train clutch switches, contacts **43a** and **43d** of the dead man's switch, and thence by conductor **56** and the contacts **40a** of the high speed switch through the operating coil of relay **60** to ground and the negative side **27** of the source. A similar circuit is completed for the operating coil of the high speed relay of the elevation controller **36** which is connected in parallel with the operating coil of relay **60** by means of conductor **61**. Alternatively, the high speed relay **60** and the high speed relay of the elevation controller may be combined into a single relay with the contacts of both relays mounted on the single structure. In response to energization, high speed relay **60** closes its contacts **60a** and **60b**. Contact **60a** in closing short circuits the entire potentiometer **31**, and as a result, the dynamoelectric machine **20** must generate a higher voltage in order to bring about the balanced condition between the voltage derived from the potentiometer **30** and the voltage of the train control potentiometer **28**. This higher voltage is applied to the train drive motor **18** and as a result, the motor is caused to operate at an increased speed. Preferably, the amount of resistance short circuited by the contacts **60a** is such that the speed of the motor **18** is tripled.

The high speed operation of the elevation drive is identical with the high speed operation of the train drive.

If the dead man's switch **43** is released at a time when the gun **12** is not in its neutral position, the control will function to stow the gun in its neutral position both in train and in elevation.

Release of the dead man's switch **43** forces the

movable contact **43a** to move out of engagement with the stationary contact **43d** and to move to its biased position in contact with the stationary contact **43b**. Separation of the contacts **43a** and **43d** interrupts the energizing circuit for the operating coil of the dead man's relay **29** which drops out to open its normally open contacts **29a** and close its normally closed contacts **29b**. Contacts **29a** in opening remove power from the train control potentiometer **28**. Contacts **29b** in closing short circuit the portion of the control potentiometer **28** between the neutral point **28a** and the slider **28b**. As a result, the control field **20a** of the dynamoelectric machine **20** is rapidly deenergized and the voltage supplied to the train drive motor **18** is rapidly reduced to zero. The closing of contacts **43a** and **43b** of the dead man's switch completes an energizing circuit for the operating coil of the train return to neutral relay **32** which is traced from the positive side **26** of the source through conductor **53** and contacts **54** and **55** of the elevation and train clutch switches, respectively, through contacts **43a** and **43b**, contacts **46i** of the cam switch bridged by the movable contact member and conductor **62** through operating coil of relay **32** to ground and the negative side **27** of the source. Responsively to energization, relay **32** picks up and opens its normally closed contacts **32a** and closes its normally open contacts **32b** and **32c**. Since contacts **32b** are connected in parallel with contacts **29a**, the master relay **57** remains picked up.

When the turret was rotating in train in a clockwise direction during normal operation, the slider **28b** of potentiometer **28** was on the positive half of the potentiometer with the result that the polarity of the lower terminal of the field winding **20a** was positive and the polarity of the upper terminal was negative. The opening of contacts **32a** interrupts the connection between the potentiometer **28** and the control field winding, and the closing of contacts **32b** and **32c** connects the control field winding **20a** to the source **26**, **27** for the reverse polarity. The circuit is traced from the positive side of the source **26** through conductor **53**, contacts **32b** of relay **32**, conductor **64**, right half of potentiometer **28**, conductor **65**, field winding **20a**, potentiometer **30** to conductor **22**, contacts **32c** of relay **32**, contacts **46d** of the directional cam switch to ground and the negative side **27** of the source. As a result, the dynamoelectric machine **20** is caused to generate a voltage of reverse polarity, and the train motor **18** drives the turret in a counterclockwise direction.

When the turret arrives at the neutral position in train, the cam disks **46a** and **46f** are returned to the positions in which they are illustrated. In the neutral position, the cam follower **46g** is forced upward into the slot in the cam **46f**, thereby moving the movable contact member out of engagement with the stationary contacts **46i** and into engagement with the stationary contacts **46h**. The opening of contacts **46i** interrupts the energizing circuit for the operating coil of the train return to neutral relay **32**, which, responsively to deenergization drops out and closes its normally closed contacts **32a** and opens its normally open contacts **32b** and **32c**. The opening of contacts **32b** and **32c** disconnects the control field winding **20a** of dynamoelectric machine **20** from the source, thereby rapidly to reduce the voltage of the dynamoelectric machine **20** to zero and to stop the train drive motor **18**.

The closing of contacts **46h** completes an ener-

gizing circuit for the operating coil of the elevation return to neutral relay 66. This circuit is traced from the positive side 26 of the source through conductor 53 and the contacts 54 and 55 of the clutch switches, contacts 43a and 43b of the dead man's switch, contacts 46h of the cam switch, conductor 67, contacts of the elevation return to neutral switch 48, contacts of the upper limit switch 49, conductor 68, operating coil of relay 66 to ground and the negative side 27 of the source. In response to energization, relay 66 opens its normally closed contacts 66a and closes its normally open contacts 66b and 66c. Since contacts 66c are in parallel with contacts 32b, the master relay 57 remains energized and picked up. Contacts 66a in opening disconnect the potentiometer 38 from the control field winding of the dynamoelectric machine in the elevation controller 36 which supplies the elevation drive motor 33, and contacts 66b and 66c in closing connect this field winding to the source 26 and 27 for energization of the proper polarity to cause the elevation motor 33 to drive the turret toward the neutral position in elevation. When the gun reaches the neutral position in elevation, the sector 34 opens the contacts of the elevation return to neutral switch 48, thereby to interrupt the energizing circuit for the operating coil of the elevation return to neutral relay 66. Responsively to deenergization, relay 66 drops out and closes its normally closed contacts 66a and opens its normally open contacts 66b and 66c to leave the system in a reset condition with the gun 12 stowed in a predetermined neutral position both in train and in elevation. The opening of contacts 66c interrupts the energizing circuit for the operating coil of master relay 57 which opens its contacts 57a to disconnect the motor 25 and the corresponding motor in the elevation controller from the source.

If, during normal maneuvering, the gun should approach the contour of the fuselage, the switch 51 will engage the contour limit 50 before the gun strikes the fuselage. When this occurs, it is desirable that the gun shall be moved in a manner to clear the obstruction formed by the contour of the plane. Assuming that during this operation, the gunner has depressed the high speed switch 40a to effect high speed operation of the turret both in train and in elevation, the first operation performed in response to the engagement of the switch 51 with the contour limit 50 is to move the movable contact member 51b out of engagement with its stationary contact, thereby to deenergize the operating coils of the high speed relay 60 and the corresponding high speed relay in the elevation controller 36. Subsequently the contacts 51c and 51e are closed. Contacts 51e in closing reduce the voltage supplied from the train control potentiometer 28 to the control field winding 20a of the dynamo-electric machine 20 which supplies the train drive motor 18, and the closing of contacts 51c performs a similar function with respect to the elevation controller. As a result, the speeds of both the train drive motor 18 and the elevation drive motor 33 are rapidly reduced.

Following the reduction in the speed of the motors 18 and 33, the contacts 51f are closed thereby reducing to zero the voltage which is supplied from the control potentiometer 28 to the control field winding 20a, thereby reducing the voltage of the dynamoelectric machine 20 to zero and stopping the train motor 18. Simultaneously, the movable contact 51a is moved out of engagement with the normally closed stationary contact 51g and into engagement with the normally open stationary contact 51h, thereby connecting the field winding of the dynamoelectric machine which supplies the elevation motor 33 to the source 26, 27 for energization in such a direction that the elevation motor 33 elevates the gun 12. Finally, the contacts 51d are closed, thereby to recomplete the energizing circuit for the operating coil of the high speed relay. As a result, the high speed relay in the elevation controller 36 effects operation of the elevation motor at high speed in the manner described in the foregoing.

As a result of the stopping of the driving of the turret in train and the elevation of the gun 12 at high speed, the gun is caused to clear the contour. As soon as the gun does clear the contour of the plane, the contacts of the switching device 51 which were previously described as being closed in a predetermined order are restored to their original positions and the normal operation of the turret is resumed.

An additional feature in the operation is provided by the upper limit switch 49 which serves to limit the travel of the gun to a maximum elevated position. When the gun reaches this maximum position, the movable contact of the limit switch 49 is actuated into engagement with the lower stationary contact 49a to complete an energizing circuit for the operating coil of the elevation return to neutral relay 66. This circuit is traced from the positive side 26 of the source through conductor 53, contacts 54 of the elevation clutch switch, conductor 69, contacts 49a of limit switch 49, conductor 68, operating coil of relay 66 to ground and the negative side 27 of the source. Responsively to energization, relay 66 opens its normally closed contacts 66a and closes its normally open contacts 66b and 66c to cause the elevation motor 33 to depress the gun in the manner described in the foregoing. Thus, the traved is limited and the gun is returned automatically to its operating range.

Although in accordance with the provisions of the patent statutes, this invention is described as embodied in concrete form and the principle thereof has been described together with the best mode in which it is now contemplated carrying out that principle, it will be understood that the apparatus shown and described is merely illustrative and that the invention is not limited thereto, since alterations and modifications will readily suggest themselves to persons skilled in the art without departing from the true spirit of this invention or from the scope of the annexed claims.

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

1. A gun turret control system comprising an electric motor for driving a member in train, a second electric motor for driving said member in elevation, manually operated controlling means for said motors including a hand grip switch device having an element manually movable to one position to prepare circuits for the energization of said motors and movable to a second position in response to release of manual pressure, and means responsive to movement of said switching device to said second position for energizing said first motor to drive said member toward a predetermined position in train and for energizing said second motor to drive said member toward a predetermined position in elevation, and limit switch mechanism responsive to movement

of said member for stopping said motors with said member in said predetermined positions in train and elevation.

2. A gun turret control system comprising in combination, a first electric motor for driving a member in train, a second electric motor for driving said member in elevation, a master controller for both said motors, said master controller being provided with a switching device having a contact element manually movable to a first position and biased to move to a second position in response to release of manual pressure, switching means responsive to the direction of rotation of said member in train from a predetermined neutral position for preparing control circuit for said first motor to effect the return of said member to said neutral position, means responsive to the return of said manually movable switch element to said second position for completing said prepared circuits to effect return of said member to said neutral position, and means responsive to return of said member to said neutral position for energizing said second motor to return said member to a predetermined position in elevation.

3. A gun turret control system comprising in combination, a first electric motor for driving a member in train, a second electric motor for driving said member in elevation, a master controller for both said motors, said master controller being provided with a switching device having a contact element manually movable to a first position and biased to move to a second position in response to release of manual pressure, switching means responsive to the direction of rotation of said member in train from a predetemined neutral position for preparing control circuits for said first motor to effect the return of said member to said neutral position, means responsive to the return of said manually movable switch element to said second position for completing said prepared circuits to control said first motor to drive said member toward said neutral position, limit switch mechanism responsive to arrival of said member at said predetermined neutral position for stopping said first motor and energizing said second motor to drive said member toward a predetermined neutral position in elevation, and limit switch mechanism responsive to arrival of said member at said predetermined position in elevation for stopping said second motor.

4. A gun turret control system comprising a first motor for driving a member in train, a second electric motor for driving said member in elevation, a switching device having an element manually movable to a first position for controlling the energization of said motors and biased to move to a second position in response to release of manual pressure, a directional cam switching device responsive to rotation of the said member in one direction from a predetermined neutral position for preparing control circuits to effect rotation of said first motor in the reverse direction, means responsive to movement of said switch element to said second position for completing said prepared control circuits to cause said first motor to drive said member toward said neutral position, limit switch mechanism for stopping said first motor with said member in said neutral position and energizing said second motor to depress said member toward predetermined neutral position in elevation, and limit switch mechanism for stopping said second motor with said member in said neutral position in elevation.

5. A gun turret control system comprising an electric motor for rotating a member about a predetermined axis, means for controlling the supply of voltage to said motor comprising a dynamoelectric machine provided with a control field winding, a master controller for said dynamoelectric machine comprising a manually movable element and a control potentiometer operated thereby for producing a control voltage, a second potentiometer connected across the terminals of said motor, electrical connections for applying to said control field winding the difference between said control voltage and the voltage across a selectable portion of said second potentiometer, a switching device responsive to movement of said member in one direction from a predetermined neutral position for preparing reverse connections to said field winding, a manually operated switching device operable in response to release of manual pressure for completing said reverse connections thereby to control said motor to drive said member toward said neutral position, and limit switch means for stopping said motor with said member in said neutral position.

6. A gun turret control system comprising a first electric motor for driving a member in train, a second electric motor for driving a member in elevation, a first dynamoelectric machine for controlling the supply of voltage to said first motor, a second dynamoelectric machine for controlling the supply of voltage to said second motor, each of said dynamoelectric machines being provided with a control field winding, means for supplying variable control voltages to said field windings thereby to energize said motors to drive said member, means responsive to movement of said member in one direction from a predetermined neutral position in train for preparing reverse polarity connections from the field winding of said first dynamoelectric machine to said control voltage producing means, a switch having an element biased to move to one position in response to release of manual pressure to complete said reverse connections thereby to control said first motor to drive said member toward said neutral position, limit switch mechanism for stopping said first motor with said member in said neutral position and for completing connections from said field winding of said second dynamoelectric machine to said control voltage producing means to control said second motor to drive said member toward a predetermined neutral position in elevation, and limit switch mechanism for stopping said second motor with said member in said neutral position in elevation.

7. A gun turret control system comprising an electric motor for rotating a member about a predetermined axis of rotation, a dynamoelectric machine provided with a control field winding for controlling the supply of voltage to said motor, means for varying the excitation of said control field winding to vary the speed of said motor, a contour limit for said member, a limit switching device mounted to partake of the movement of said member and to engage said contour limit when said member approaches an obstruction, and responsive to engagement of said limit switching device with said contour limit for controlling the excitation of said field to reduce the speed of said motor, to reverse the direction of rotation of said motor and to increase the speed of said motor in the reverse direction of rotation

thereby to cause said member to clear said obstruction.

8. A gun turret control system comprising a first electric motor for driving a member in train, a second electric motor for driving said member in elevation, a contour limit for said member, a limit switching device mounted to rotate with said member and to engage said contour limit, means responsive to engagement of said limit switch device with said contour limit for stopping both said motors and for energizing said second motor to elevate said member so that said member and limit switch device clear said contour limit, said limit switch device being operable upon clearing said contour limit to reenergize said motors to continue their original direction of rotation.

9. A gun turret control system comprising an electric motor for rotating a member about a predetermined axis of rotation, means for controlling the supply of voltage to said motor comprising a dynamoelectric machine provided with a control field winding, a device for producing a variable control voltage, a potentiometer connected across the armature circuit of said motor, connections for applying to said field winding a voltage proportional to the difference of said control voltage and the voltage across a predetermined portion of said potentiometer, a speed control switching means for altering said predetermined portion of said potentiometer thereby to effect operation of said motor at high speed, a contour limit for said member, a limit switching device mounted to partake of the movement of said member and to engage said contour limit when said member approaches an obstruction, and means responsive to engagement of said limit switch with said contour limit for controlling said speed control switching means to reduce the speed of said motor, for reversing the direction of rotation of said motor and for subsequently actuating said speed control switching means to effect operation of said motor at high speed in the reverse direction.

10. A gun turret control system comprising an electric motor for driving a member in elevation, means for supplying a voltage to said motor comprising an armature reaction excited dynamoelectric machine provided with a field winding, means for producing a reference control voltage comprising a manually movable master control member and a potentiometer operated thereby, a resistor connected across the armature circuit of said motor, connections for applying to said field winding a voltage proportional to the difference of said reference voltage and voltage across a predetermined portion of said resistor thereby to control the speed of said motor in accordance with said reference voltage, a speed control switching means for altering said predetermined portion of said resistor thereby to effect operation of said motor at high speed, a contour limit for said member, a limit switching device mounted to partake of the motion of said member and engageable with said limit when said member approaches an obstruction in its path, and means responsive to engagement of said switching device with said contour limit for actuating said high speed switching means to reduce the speed of said motor, for reversing the direction of rotation of said motor and for actuating said high speed switching means to effect operation of said motor in the reverse direction to elevate said member at high speed thereby to clear said obstacle.

11. A gun turret control system comprising a first drive unit for driving a member in train, a second drive unit for driving said member in elevation, each of said units comprising an electric motor, means for controlling the supply of voltage to said motor comprising a dynamoelectric machine provided with a control field winding, a device for producing a variable reference control voltage, a resistor connected across the armature circuit of said motor, and electrical connections for applying to said control field winding a voltage proportional to the difference of said reference voltage and a voltage across a predetermined portion of said resistor, a master controller having an element manually movable in one plane to actuate one of said reference voltage producing devices to effect rotation of said member in train and movable in a second plane to actuate the other of said reference voltage producing devices to effect rotation of said member in elevation, a speed controlling switch manually operable to alter said predetermined portions of said resistors to effect operation of said motors at high speed, a contour limit for said member, a limit switching device mounted to move with said member and to engage said contour limit when said member approaches an obstruction in its path, and means responsive to engagement of said limit switching device with said contour limit for actuating said speed controlling switch to reduce the speeds of said motors, for stopping said train drive motor and reversing the rotation of said elevation motor and for subsequently actuating said speed controlling switch to cause said elevation drive motor to elevate said member at high speed to clear said obstruction.

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