This invention relates to a turret traversing and control mechanism, and it has particular reference to the provision of means whereby a gun platform, such as a tank turret, may be either rapidly or slowly rotated in either direction, and quickly stopped and held when the weapon is aligned with a target.

Heretofore, the turrets of combat weapons such as tanks have been provided with means for traversing by hand, or with power means to accomplish the same purpose. When the mounting for a medium tank, containing a 75 mm. cannon and a heavy caliber machine gun is traversed constantly by hand, an additional physical strain is imposed on the gunner which seriously detracts from his effectiveness. Recognized heretofore has been made therefore to power mechanisms relieving the gunner of constant manual operation, and providing him with an auxiliary or alternative method of bringing his weapons to bear on the target. One system heretofore proposed has been a hydraulic system, patterned, to some extent, after the systems heretofore utilized with naval ordnance. These have the advantage of permitting the gunner to arrest the motion quickly at any desired point. They also have the great disadvantages, for land warfare in which rapid sighting is often indicated, of not moving the turret in position as quickly as desired, and taking up too much space in a vehicle such as a tank. Attempts have also been made to employ electric drives for these turrets, but the systems heretofore proposed have been deficient in imposing too severe a drain on the electric batteries, and in developing low torques at low speeds, with consequent poor regulation under conditions of variable loading.

What is wanted is a control apparatus taking up the minimum possible space within the tank, permitting either rapid or slow traversing without attendant creep, and capable of either power or manual operation. The present invention contemplates the attainment of all these desiderata.

According to the present invention, there is provided a system of gearing which may be operated either manually, or from a power source such as an electric motor, and in either direction to the end that the turret may be swung to one side or the other of the body of the tank. In fact, the particular type of tank to which the present invention has been applied includes a turret which may be rotated 360°, but it will be understood that the invention may also be utilized when the traversing range is limited. The gearing is provided with a manually operable handle by means of which the gunner may turn his piece either way, as slowly as he likes, or as rapidly as his strength permits. There is also provided a connection between the motor and the gearing so that the motor may also rotate the turret, and the speed control for the motor armature is regulated, so that the motor may revolve at a creeping speed, or at a high speed enabling the turret to be spun around as much as ten or fifteen revolutions per minute. The motor regulator system is such that the moving system may be arrested rapidly, and the manual and power inputs are interconnected through the gearing so that they may be operated separately or conjointly without interference with each other.

The control of these means of actuation is given over primarily to the gunner, who sights as well as fires the cannon. However, means are also provided whereby the tank commander can himself operate the turret without the necessity of transmitting his orders to the gunner with attendant loss of time in getting on to the target under emergency conditions.

For a fuller understanding of the principles of the invention, and the advantages to be derived from the practice thereof, reference may be made to the following description of a preferred embodiment illustrated in the accompanying drawings, wherein:

Fig. 1 is a view of a tank equipped with a cannon, the turret therefor being broken away to show the control instrumentalities;
Fig. 2 is a section through the control and operating mechanism;
Fig. 3 is a section on the line 3—3 of Fig. 2, showing a motor brake;
Fig. 3A is a section along the line 3A—3A of Fig. 3, taken to show details of the brake spreader;
Fig. 4 is a perspective of the gearing, associated parts being eliminated for purposes of clarity;
Fig. 5 is a perspective of the manual control shaft, clutch, and associated parts;
Figs. 6 and 7 are sections respectively taken on the lines 6—6 and 7—7 of Fig. 5;
Fig. 8 is another perspective of the manual control shaft assembly, partially broken away;
Fig. 9 is a perspective of a cup included in the manual control shaft assembly; and
Fig. 10 is a wiring diagram for the motor and control circuits.

The invention is shown, in Fig. 1, as incorporated in a medium tank having track laying treads 20, an armored body 21, and a turret including a well 22 and head 23 which move together as one piece. The turret carries a cannon
24 or other ordnance which is elevated or depressed and fired by a gunner who may take his station on a seat 35. The entire turret is mounted for rotation in a horizontal plane by means of a fixed race ring 25 secured to the body 21, a concentrically disposed inner ring 27 secured to the head 23, and interposed balls 28. The head 23 and ring 25 are so formed as to approach each other closely through a labyrinthine gap, to reduce bullet splash and exclude as much dirt as possible, as shown in Fig. 2. Rotation of the turret, and thereby the traversing of the gun 24, is effected through the intermeshing of an internal ring gear 25, formed on the fixed race ring 25, and a driving pinion 31 mounted within the head 23, and which projects through an opening 32 formed in the side wall of the well 22.

In order to rotate the gear 31, and thereby the turret, there is provided, according to the present invention, a manual and power drive and control mechanism, designated by the letter C in Fig. 1, and shown in detail in the remaining views. This equipment appears in Fig. 1 to be behind the gunner's position, in fact it is located to one side, and has been illustrated in a different position to avoid overlapping. The unit C comprises a housing or casing 33 mounted on the turret wall by suitable means such as bolts 34 (Fig. 2), and in which the pinion 31 is located. A crank handle 35 projects above the housing, and the gunner may rotate it, in either direction to traverse under manual control.

The housing 33 also contains an electric motor 36 to provide a power drive for the pinion 31, and the flow of electricity to the motor is controlled by a switch box 37 provided with an operating handle 38. The structure of the box 37, as such, is not of the essence of the present invention, except as hereinafter pointed out in connection with a discussion of the wiring diagram, Fig. 4.

Here, in conjunction with this introductory description, it will be sufficient to note that the gunner may revolve the handle 38 in either direction to turn the turret one way or the other. Electric connections from the switch 37 lead to a resistance box 39 and thence to the motor 36 through cables 40 and 41. Additionally, the connection of the motor 36 to the line is made by the tank commander whose post cannot be shown in Fig. 1. For such purpose, the box 39 is wired to a junction box 43 through a cable 44, and the connections to the commander's control switch are taken through these elements. As thus far described, it will be apparent that the gunner may traverse either manually, by means of the handle 38, or by power drive by manipulating the handle 38, while the tank commander may also govern turret operation by his switch which leads to the motor circuits.

In order to provide for both manual and power operation in either direction of rotation, there is provided a planetary gear system having inputs from both the handle 35 and the motor 36, and an ultimate output through the pinion 31 which moves in a horizontal plane by means of a toothed wheel as initially to Fig. 2, it will be seen that the housing 33 of Fig. 1 includes a depending barrel 51 to which is fitted the field winding 52 of a direct current motor 56, whose armature 53 is rotationally mounted in bearings 54 and 55 carried by end pieces 56 and 57. The end piece 56 may also carry the brushes 58 for the commutator 59. The upper end of the motor shaft 61 has keyed thereto the rotor members 62 and 63 of an eddy current brake, whose field winding 64 is mounted in the bore of the barrel 51. The shaft 61 extends above the end piece 67 into a housing section 65 where it is formed with a split end section receiving a mechanical brake drum 68. The shaft 61 is here connected, by means of a splined coupling 67, to an extension shaft 61a, rotatably mounted in suitable bearings carried by an upper housing section 65. As will be discussed in detail later, the current supplied to the motor 36 is so regulated as to cause rotation of the shafts 61 and 61a in either direction and at varying speeds. The eddy current brake is employed in this connection to secure speed control. The mechanical brake within the housing section 65 is provided to lock the motor shafts when the armature 53 is at rest, and the application or release of this brake may also be effected through the electric circuits.

The mechanical brake, which is of a known type, comprises shoes 80 adapted to be pressed against the inner wall of the drum 66, and coupled at adjacent ends through an adjustor 70, which is anchored to the upper wall 72 of the section 56, and an actuator 71 whose operating boss 72 or adds the motion. Application of the brake is effected by upward movement of the actuator 71, which carries with it a spreader 74, best shown in Fig. 5A. This piece is conical, and it engages the pins 75, formed with tapered slots 76, through rollers 77. When the actuator 71 is pulled up, the tapered faces wedge the rollers between them, thus pushing the pins 75 outward to force the shoes 80 into engagement with the drum 66. When the spreader drops, the shoes are retracted by tension springs 78 which interconnect them, as shown in Fig. 3. The spreader is operated by a solenoid 81, secured to a bracket on the housing section 56, and whose plunger 82 is normally extended by a compression spring 83. The solenoid plunger and the brake actuator are interconnected by a lever 84, pivoted to a bracket 85 mounted on the wall 73. When the solenoid is energized, the plunger 82 is pulled up, thereby depressing the spreader 74 to release the rollers 77, and permitting the shoes to be pulled in by the springs 78. When the solenoid is deenergized, the spring 83 forces the plunger 82 down, the spreader 74, and thereby apply the brake.

The upper housing section 68, which rests on the wall 73 of the section 56, is formed with an internal vertical wall 86 which cooperates to seal the brake housing 85 and solenoid plunger from oil and dirt. The vertical wall 86 also carries the bearings for the extension shaft 61a, and additional bearings for an idler shaft 77 which is mounted parallel to the shaft 61a, as illustrated in Fig. 2. The shaft 61a is provided with a pinion 88 keyed thereto, which meshes with an idler gear 89 mounted on the shaft 71. The gear 89 in turn meshes with the external teeth of a ring gear 81. The apparatus, as thus far described, constitutes the power input for the planetary gearing system whose ultimate output is the pinion 31, and forms the subject of this invention. In connection with the discussion to this point, it will be understood that the shaft 61a may be rotated in either direction, thereby imparting a like rotation to the ring gear 81, or, the shaft 61a may be locked through the mechanical brake, thereby holding the ring gear stationary.

As viewed in Fig. 2, the brake housing 65 is formed at its right hand side with an additional housing section 93 in which is disposed a mount-
power and manual input, differentiation occurring in the usual fashion through the planetary

gear system. It will accordingly be seen that both inputs may be operated simultaneously, and

either the same or in opposite directions of rotation, without interference or binding in the gearing.

Referring now to Figs. 5 to 9 inclusive, there is illustrated the means whereby the shaft 95 may be connected to or disconnected from the sun

gear 91, and the shaft may also be locked automatically when the power drive is utilized in

preference to the manual drive. This assembly includes a type of clutch sometimes called a

wind-up spring clutch, which has heretofore been used to provide a ratchet or overrunning connec-
tion between two parts. The simple wind-up spring clutch is, however, usually thought of as

permitting motion in one direction, but not the opposite direction, whereas in the instant case, it

is desired to provide motion in both directions, and with a dual input of power. Accordingly, a

more extensive arrangement must be provided.

The manually rotatable shaft 95 is provided, within the well portion 93, with a cup 121 having a

reduced end 123 which is secured to the shaft 95 by means of a pin 123 inserted through the

cup 124. The cup is formed with a narrow slot 125 and with a wide slot 126, the center lines of these

slots lying in substantially the same diameter. Mounted within the cup 121 is an internal brake

piece, best shown in Fig. 8, and designated by the reference numeral 128. This piece is formed

with a key 129 which fits into the slot 125 with considerable clearance, and a diametrically

opposed key 131 having a reduced portion 132 which is located in the slot 126. The parts are so di-

mensioned that the reduced portion 132 is concentric with the outer surface of the cup 121. The

piece 126 is also formed with an upwardly extending portion 133 adapted to fit within the bore 98

with a press fit. The hub members 99 and 96, together with the sun gear 97 are, as previously in-
dicated, telecopically mounted on the shaft 95.

Encircling the outer wall of the cup 121 and engaging the reduced portion 132 of the key 131

is a flat coil spring 135 whose ends 136 and 137 abut the key 131 on opposite sides thereof. The

normal clearance between the key 131 and the spring 135, with respect to the key 131, is somewhat

less than the clearance between the side faces of the key 129 and the side walls of the slot 125. Hence, upon rotation of the cup 121 through the

shaft 95, with respect to the piece 126, the key 131 will tend to engage one or the other of the

spring ends 136 or 137 prior to contact between the key 129 and the side walls of the slot 125.

The outer surface of the spring 135 fits freely within the bore of the housing 95.

Welded to the top of the body, convolutions of the spring 135 are inwardly extending ears 138

and 139 which are positioned in close proximity to the opposite side walls of the big slot 125. The

normal clearance between the ears and the walls of the slot is slightly greater than the clearance

provided for between the key 129 and the ends of the spring, but is normally a little less than the

clearance provided between the key 129 and the slot 125.

The hub piece 98 is formed with a flange portion 141 formed with diametrically opposed flats

142 and 143 having a light press fit over the adjacent ends of the keys 129 and 131. It will thus

be understood that the cup 121 is rigidly secured to the shaft 95, the internal sleeve piece 128 is,

through its extension 133, lightly press fitted into
the bore of the hub section 95, and the slots 142 and 144 fit over the keys 129 and 131, thereby coupling the pieces 128 and 99 together practically as an integral assembly. The coupling between the cup 121 and the sleeve piece 128 and thereby the sun gear 97 is effected through the coil spring 135 and the way in which it engages with its associated members.

The functioning of the construction may best be understood by considering first the effect of rotating the shaft 95. This causes one side wall or the other of the big slot 126 on the cup 121 to engage, in the first instance, its associated sleeve or ear 139 or 138. The thrust on the ear causes the spring 135 to wind up on itself and thus withdraw from holding engagement with the internal wall of the housing 85. At about the time that the spring is so wound up on itself, one wall of the slot 125 comes into contact with the adjacent side face of the key 129, and accordingly power is transmitted from the shaft 95 to the cup 121, and then into the internal piece 128 through the key connection 129. As the internal piece and hub 98 to slip with respect to each other, is of course, forestalled by the key connection between the keys 129 and 131 and the slots 142 and 143. With the spring relieved, rotation of the shaft 95, therefore, causes rotation of the sun gear 97, and traversing of the turret through the gearing previously described.

Let it next be assumed that the shaft 95 is not manually actuated, but that the drive takes place through the motor 36. In this instance, there is a rotation of the gear 91 and planet gears 103, with a consequent reaction on the sun gear 97 tending to rotate it in one direction or the other. This causes an attempted rotation of the internal piece 128, and with it rotative effort on the key 131 as well as the key 129. Since the normal clearance between the spring ends 136 and 137 and the key 131 is less than the normal clearance existing at the ears 138 and 139, or adjacent the key 129, there is a thrust on the end of the spring, tending to unwind it. The spring therefore expands and, the harder the thrust, the greater the unwinding tendency. The convolutions of the spring 135 are, therefore, wedged against the internal hole of the housing 93, causing a binding effect and producing a braking action on the sleeve 98 and thereby on the sun gear 97.

If the gunner should rotate the handle 35 in either direction while the power is being applied, he will simply take up the few thousandths clearance or free play between the edges of the slot 126 and one or other of the ears 138 and 139. This will tend to wind up the spring and therefore release the sun gear 97. The gunner may, therefore, as a matter of pure mechanics, either add or subtract from the drive imparted by the motor, but the net result depends upon the relative speeds and directions of rotation. Normally, of course, the gunner would be too preoccupied, or at least disinclined, to engage in such tactics, but he is always free to do so. This therefore permits him to transfer immediately from power to manual drive, without bringing the system to rest or being called upon to shift any gears. It may also be noted that he is free at all times to place his controls in a neutral or non-driving position, and the system is then immediately arrested without tendency to creep.

It will thus be seen that there is a braking system provided for the motor to hold the ring gear 91 when manual actuation is desired, and another braking system for the sun gear 97 when power operation is preferred. Obviously, the braking system used for the sun gear 97 could also be applied for the motor shaft 61, and a different type of brake could be applied to the sun gear driving system. The combination described is, however, quite advantageous for tank service, since it permits getting the parts into more compact form, and in an installation where space is at a premium.

Consideration will next be given to the arrangement provided for controlling the speed of the motor 56, and thereby the traversing rate of the turret 21, and, in its associated sleeve or ear 139 or 138. The operation is preferred. Obviously, the braking system used for the sun gear 97 could also be applied for the motor shaft 61, and a different type of brake could be applied to the sun gear driving system. The combination described is, however, quite advantageous for tank service, since it permits getting the parts into more compact form, and in an installation where space is at a premium.

Referring again to Figs. 2 and 4, the pieces 62 and 63, which are the brake pads carried by the motor shaft 61, are soft iron, each formed with a series of poles 151 whose end faces are slightly curved, and traversing of the motor shaft 61, and the selection of the armature pole 152, and the pole 91 152 laid in spaced slots formed in iron rings 153 and 154, the rings lying on either side of the pole 154, and the rings being interconnected along the faces of the rings, as indicated by the reference numeral 155. When current is supplied to the winding 64, and the motor is revolved, the flux emanating from the poles 151 rotates with the poles and thereby induces eddy currents in the stationary conductors 153 and their connectors 155. The action, which may be likened to that occurring in a short-circuited generator, develops a torque resisting the rotation of the armature 53, and so provides a braking force as long as the field winding 64 is energized. An excessive braking action, or locking of the poles 151 against the rings upon starting, is avoided by canting the poles so that as one edge is aligned with a segment between the conductors, the opposite edge is displaced therefrom.

In the present system, the driving force of the motor and the braking force of the eddy current brake may be modulated by varying the quantity of electricity supplied to each. In the present system, it is proposed to institute action by supplying a small amount of current to the motor armature, but a lot of energy to the brake field, and the only means of increasing the motor current, and decrease the brake current, in step-by-step fashion. While these current controls may be obtained by various forms of circuits, we find it advantageous to embody two features which aid in effecting good regulation and control. First, insofar as it is expedient to make it so, the motor armature resistance is a network of parallel resistances, rather than the customary series resistance of the usual starting box. With the network plan, the currents may be supplied in suitable increments, but the amount of current carried by any branch can be limited, thereby safeguarding against arcing, and permitting the employment of small and easily actuated switches to cut in or disable any element of the circuit.

Further, we propose the introduction of the resistance for the brake coil circuit by taking, at least in part, the resistances used in the armature
circuit, the degree of utilization being determined by the opening or closing of switches which bridge increments of the network resistance, and permit of their connection in series. This plan contemplates the interconnection of the armature and brake circuits to control the brake field voltage drop without adversely affecting the supply of armature current, and achieve regulation comparable with that herebefore attainable only with more complicated and expensive systems. With such type of control, the tendency of the motor to change speed with a change in external load is offset by an automatic modulation of the braking action acting in the opposite sense. Thus, if the load increases to decrease motor speed, the tendency toward speed reduction curtails the braking current, thus maintaining the total torque substantially constant. If the motor speed tends to increase, the brake torque also tends to increase, thereby again restoring the system to balance. This provides for good speed regulation, and assures a smoothness in operation, and elimination of creeping, which is very desirable in traversing mechanisms.

A wiring diagram for the control circuits of a tank motor and brake is shown in Fig. 10. Current is supplied from a 24-volt battery B to the motor armature 53 and field winding 52, as well as the brake coil 64 and the solenoid 81 of the mechanical brake. The various resistances for the circuits are disposed in the box 38 of Fig. 1, while the circuit switches are located in the box 37 for actuation by the handle 38 in accordance with the drum controller plan of manipulation. The tank controller's control is included in Fig. 10 as that part within the dotted rectangle at the foot of the sheet. The system, as herein illustrated, contemplates the control of the motor speed as a substantially linear function of the armature voltage and a generally inversely diminished the braking coil voltage drop. Having selected these actual rates, the values of the various resistances may then be chosen to proportion the increments of increase or decrease of current.

Referring to the diagram, it will be assumed that the switches are all in the positions shown, and the initial operation will be through the gunner's controller. The motor 53 is stopped, and the mechanical brake is set. To institute power operation, the gunner must first close master switch M, the other switch T in the battery line being a maintenance dock switch which is normally closed. Initial movement of the controller handle 38 will first close either switches F, F', or R, R', conditioning the motor for operation in one rotary direction or the other, by excitation of the field 52 through either of these circuits.

For "forward" rotation, from battery 50 and switches M and T into wires 161 and 162 to normally closed switch 163 in the commander's controller, through wires 164 and 165 to switch P, and thence through wires 166 and 167 to the field winding 52 of the motor; returning via wires 168, switch 81 placed simultaneously with switch P, wire 169 to normally closed switch 171 in the commander's controller, and thence via wire 172 to the ground and the opposite side of the battery.

For "reverse", rotation, from the battery to wire 164 as before, thence via wire 175 to the contacts of switch R, and thence via wire 161 to wire 168 and winding 82 to energize the field with opposite polarity; returning via wire 167 to the contacts of switch R, thence via wire 161 to wire 168, switch 171, and ground. The initial operation of the controller thereby energizes the field for driving in one direction or the other. Concurrent with the supply of current to the field 52, current flows through the coil 81 in series with the field, which is the energizing coil for a solenoid switch or contactor whose points are indicated at S. Closing of the contactor S now energizes the solenoid coil 81 to release the mechanical shaft brake, the current flowing through wires 177, 178, and 179 to the brake circuits, as previously set forth, now begins to have its effect. The next controller position closes Switch No.
5, thereby short circuiting resistance 182. This change again does not appreciably alter the armature current, but it does not decrease the brake current by decreasing the voltage applied to conductor 280. The throwing of double pole switch No. 6 effects two changes, one to add resistance No. 5, herefore by-passed through switch No. 6, to resistance 181, thus increasing the brake line resistance. The resistance 209 is also added in series to the armature path extending from resistance 181 through 184, a change which, taken alone, would tend to offset the closing of switch 5. However, switch No. 6, in its alternative position, introduces resistance 211 to the armature network, the new branch bridging wires 178 and 186 to admit more current to the wire 187.

Switches Nos. 7 and 8, next actuated by the controller, repeat the step-by-step changes effected by movement of switches Nos. 5 and 6 respectively. Switch No. 8 introduces resistance 212 in series with the brake field 64 and also introduces resistance 213 as a new branch for the armature network. Switches Nos. 9 and 10 provide for further incremental changes in the brake circuit resistance by placing resistances 214 and 215 in series with resistance 181 and the wire 208. They also add new branches to the network by introducing resistances 216 and 217.

A further branch is added to the armature network by closing switch No. 11 to introduce resistance 218. The clearing of switch No. 12 eliminates resistance 184 from the network branch extending from resistance 181 to wire 185. With the resistance 184 in this branch has the maximum ohmic value. Additional branches for the armature network are added by the throwing of switches 13 and 14, which admit current through resistances 219 and 221. The conductance of the armature network is now very close to its maximum value, corresponding to an approach to maximum motor speed.

When the switches 13 and 14 are thrown, it will be noted that they successively open the path to the brake coil 64, heretofore taken through jumpers 208 and 201, and close the brake circuit to flow through series resistances 222 and 223 respectively. The resistance in the brake energizing circuit is now at a maximum, and therefore, the impressed brake voltage has been brought close to its minimum value. It will have been observed, therefore, that as the various switches have been successively actuated, armature current has increased, while braking effect has decreased.

When switch No. 15 is thrown to its alternative position, the following events occur: The exciting circuit for the brake is broken, since wire 202 is disconnected from resistance 223, thus opening the circuit, and reducing the braking effect to whatever may attach to the residual magnetism. The armature circuit wire 187 is connected to ground through coil 52, thereby energizing this circuit and closing the armature's circuit. Closing of these points directly connects wires 178 and 187 through wire 224, thereby admitting the maximum current to the armature 53. It may be noted that the coil 52 is of the type requiring a predetermined minimum voltage for its operation, and if the controller handle 38 should be moved rapidly from neutral to the No. 15 position, switch 52 would not immediately close, but would be delayed until the armature had picked up some speed. The motor is, therefore, protected against a destructively excessive starting current.

It will be seen that the handle 38 may be swinging back and forth in the same way as any manual controller handle to adjust the speed of the motor 38. If the runner should desire to change direction suddenly, he simply reverses the controller handle, the electric braking action becoming progressively greater as the neutral position is reached, and the mechanical brake engaging at the neutral point to arrest the movement of the turret.

If, at any time, the tank commander should elect to operate the traversing motor, he may do so by manipulating the switches in his controller. Switches 163 and 171 are, as heretofore explained, interposed in the circuit for the motor field 82. Throwing of these switches to their alternative positions therefore interrupts the field current, de-energizes the coil 11 to open contactor 53, thereby opening the armature circuit, the energizing circuit for the eddy current brake, and the solenoid 31 to apply the mechanical brake. If the motor is operating when these switches are thrown, the system is accordingly quickly brought to rest. Switch 204, interposed in the circuit for the brake coil 54, may be set to throw in sequence to the movement of switches 163 and 171, and, with it, a companion switch 226.

The movement of switch 204 interrupts the circuit between the wire 203 and the ground, thereby precluding the re-establishment of the eddy current brake supply circuit. This movement also sets up a conditioning circuit for the armature 53 as follows: A wire 227, leading to a contactor solenoid 52, passes through switch 204 and wire 228 to ground. Energization of the coil 52 causes the closing of contactor switch 52, to establish a connection between wires 178 and 187 through a protective resistance 229, thereby providing for flow of current to the motor armature when the contactor S3 is again closed. At the same time, the movement of switch 226 establishes a shunt circuit through the coil 52, by flow from wire 187 into coil 52, thence through wire 231, switch 226, and wire 228 to ground. When the voltage in this circuit is sufficient to close switch 52, a direct armature circuit through wire 242 will be re-established.

Switches FC and FC' operate together to provide for "forward" motion, while switches RC and RC' are actuated together for "reverse" motion. Upon movement of switches FC and FC', a motor field circuit is established as follows from wires 161 and 162 through switch 163 to wire 233, thence via wire 234 to wire 167 and field winding 52, returning through wire 168 to wire 235 to switch FC', then via wire 236 to switch 171 and to ground through wire 172. The revering circuit is from wire 233 to switch RC' into wire 235 and thence to wire 165, returning through wire 234 to switch RC into wire 236 and to ground, via wires 171 and 172.

Either condition energizes coil 52, thus closing switch 52, releasing the mechanical brake, and permitting current to flow through resistance 229 and finally through wire 224. It will be noted that the eddy current brake is not brought into play by the commander's controller, nor does his control involve a large series of steps in admitting current to the armature. This is because the operation of the turret by the commander, at a remote post, is in the nature of an emergency action, he wants to get
the guns laid toward the target as quickly as possible. Therefore the resistance interposed in
his armature circuits is as small as it may be
without incurring too great a risk of burning
out the motor. It will be understood, however,
that the commander's controller may be made to
include a series of steps, if so desired.

While the invention has been described by re-
ference to an embodiment thereof as adapted to
a military tank, it will be obvious that it is not
so limited, but that its principle may be utilized
in many other relationships. It is also apparent
that various parts and sub-combinations may
be utilized effectively without adoption of the
whole, and that the nature of the invention ad-
mits of numerous modifications and variations
without departure from its principles. The fore-
going description should therefore be considered
as illustrative, and not limiting, and it is in-
tended that the scope of the invention should
be deemed commensurate with the following
claims:

We claim:

1. Traversing mechanism comprising a driv-
ing pinion, an electric motor having a shaft con-
nected to the pinion, a mechanical brake for
the shaft, an electrical brake for the shaft,
means for supplying varying quantities of cur-
rent to the motor to change the speed thereof,
means operating as an incident to the initial
energy of the motor to release the me-
chanical brake, means for supplying varying
quantities of current to the electrical brake
to change the retarding effect thereof, said last
named means being actuated to decrease the
supply of current to the brake as the means
for supplying current to the motor is actuated
to increase the motor speed.

2. Traversing mechanism comprising a gear-
housing and a driving pinion, a motor
mounted on the housing and having a shaft
operatively connected to the pinion through
gearing in the housing, a mechanical brake for
the motor shaft, means on the housing for oper-
ating the mechanical brake, an electrical brake
having a shaft carried part and a stationary
part supplying electrical energy to the
motor field and armature and to the elec-
trical brake, and means for varying the energy
supplied to said armature and electrical brake,
said last named means including resistances so
arranged that energy supplied to the brake is
decreased as the energy supplied to the armature
is increased.

3. In a traversing mechanism including a
45 driving motor having a driving shaft, an elec-
trical brake having a part carried by the shaft,
a source of current for the motor and the brake,
control means for progressively supplying in-
creasing quantities of current to the motor and
concurrently supplying decreasing quantities
of current to the brake, a second control means,
and means operative through the second control
means for interrupting the supply of current
through the first control means and directly es-

4. In a traversing mechanism including a driv-
ing motor, a motor shaft, an electrical brake
having a shaft carried part and a fixed part,
a source of current, a supply circuit from the
source to the motor armature, said armature
supply circuit including a plurality of resistances
connected in parallel, switch means in said
supply circuit for introducing or disabling said
resistances to vary the current supplied to the
armature, a supply circuit for the electrical
brake, said brake circuit including a resistance
connected in series with the brake and source
of current, switches for changing the value of
the last named resistance and thereby the poten-
tial impressed on the brake, said last named
supply circuit being interconnected with the
armature circuit in such manner that part of
said last named resistance is supplied by the
parallel resistances of the armature circuit.

5. In a traversing mechanism, a driving motor,
a motor shaft, a motor driven electrical brake
having a shaft carried part and a fixed part,
a source of current, a supply circuit from the
source to the motor armature including a net-
work of parallel resistances, means for changing

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<td>1,175,346</td>
<td>Dearborn</td>
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