T. E. BARNUM.

DRIVING MECHANISM FOR TURRETS AND THE LIKE.

APPLICATION FILED AUG. 27, 1907.

1,130,053. **Patented Mar. 2, 1915.**

5 SHEETS—SHEET 1.

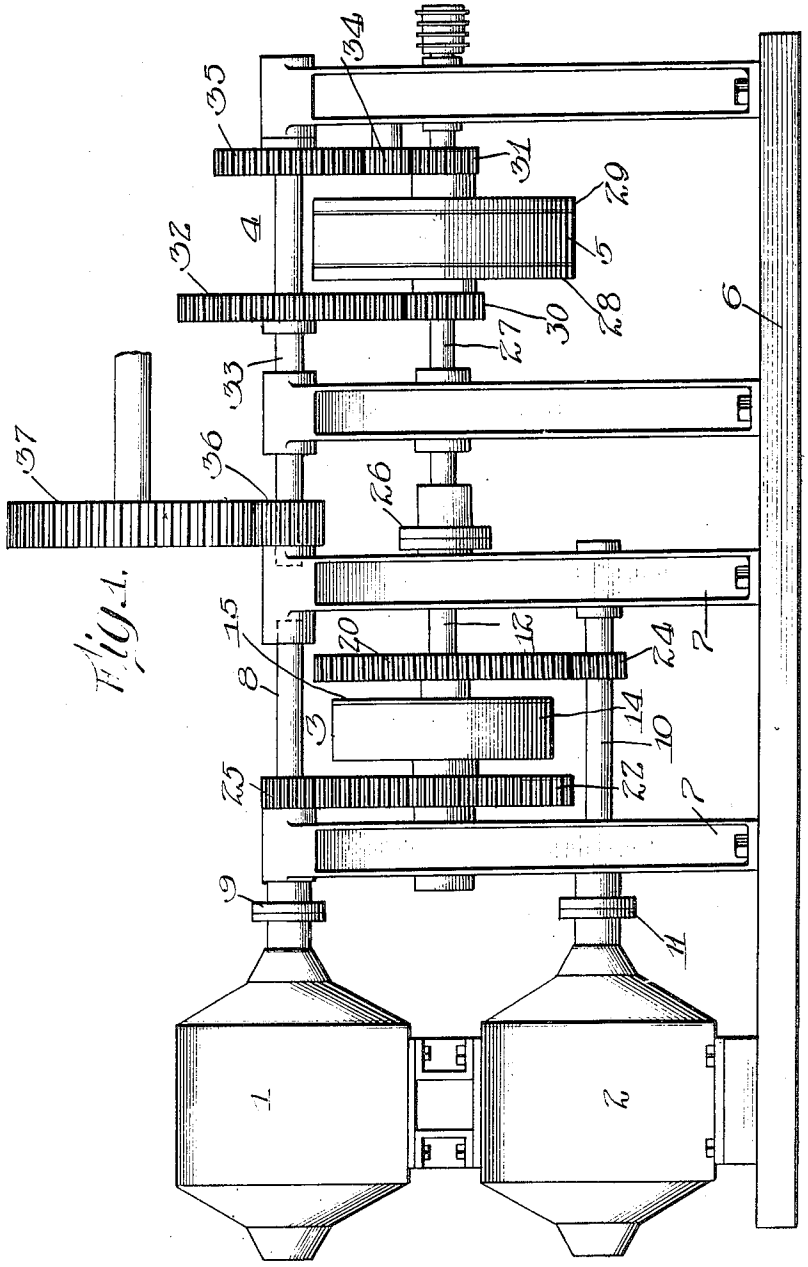


Fig. 1.

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Fig. 2.

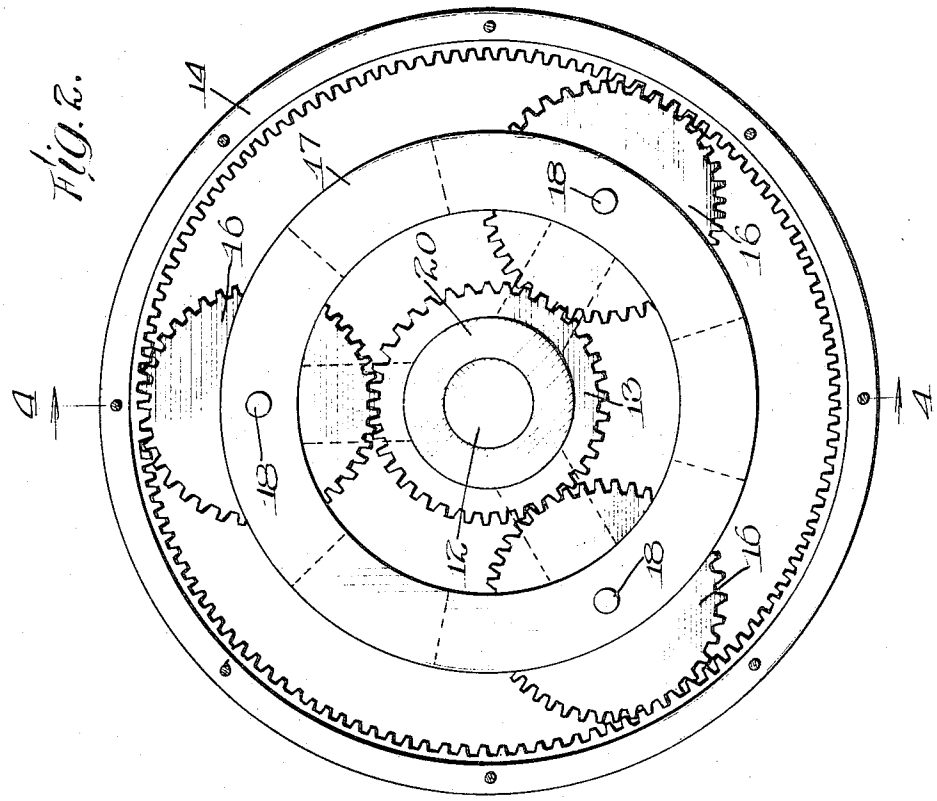
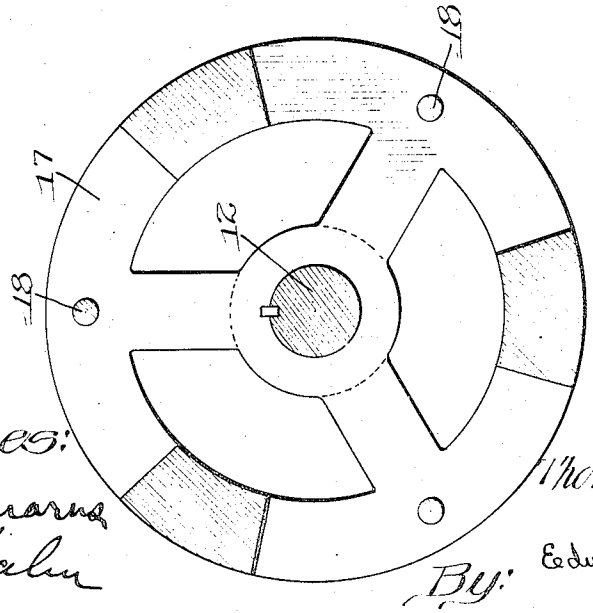


Fig. 3.



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5 SHEETS—SHEET 3.

Fig. 4.

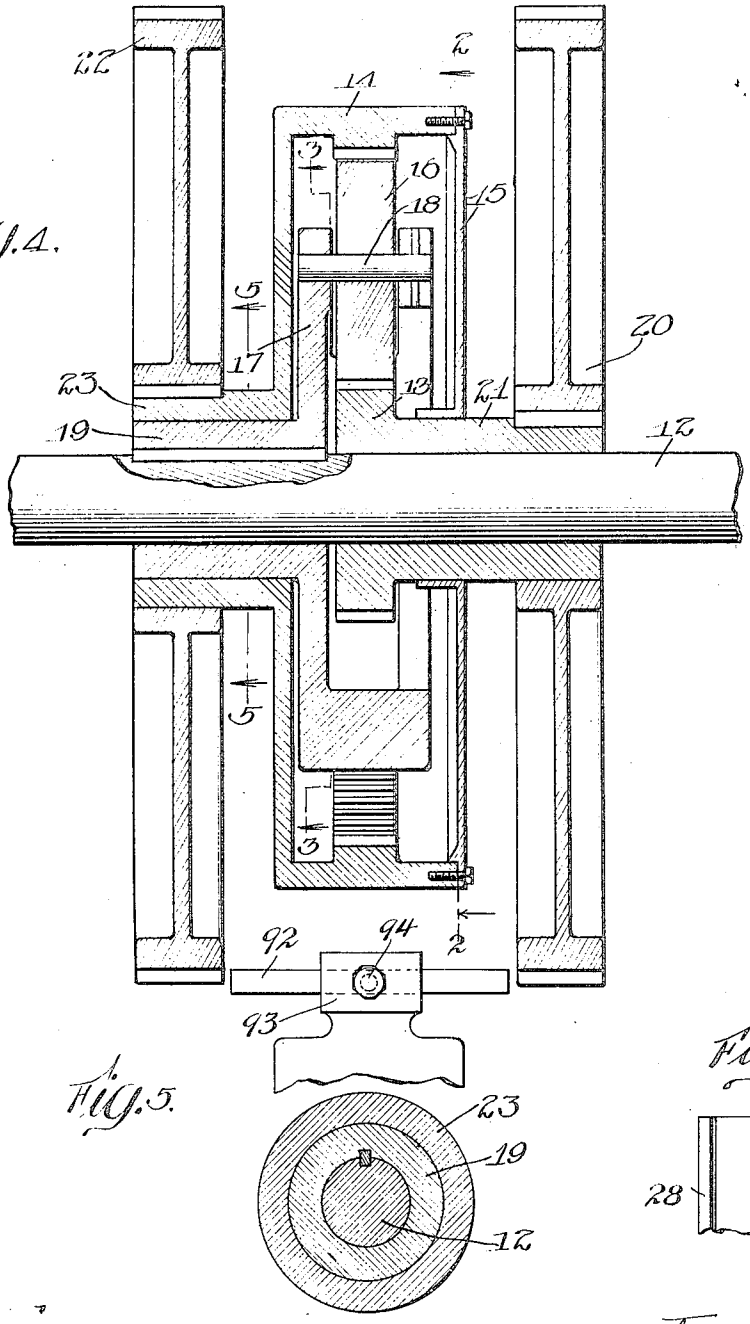
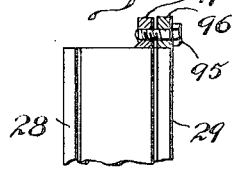


Fig. 5.

Fig. 6.



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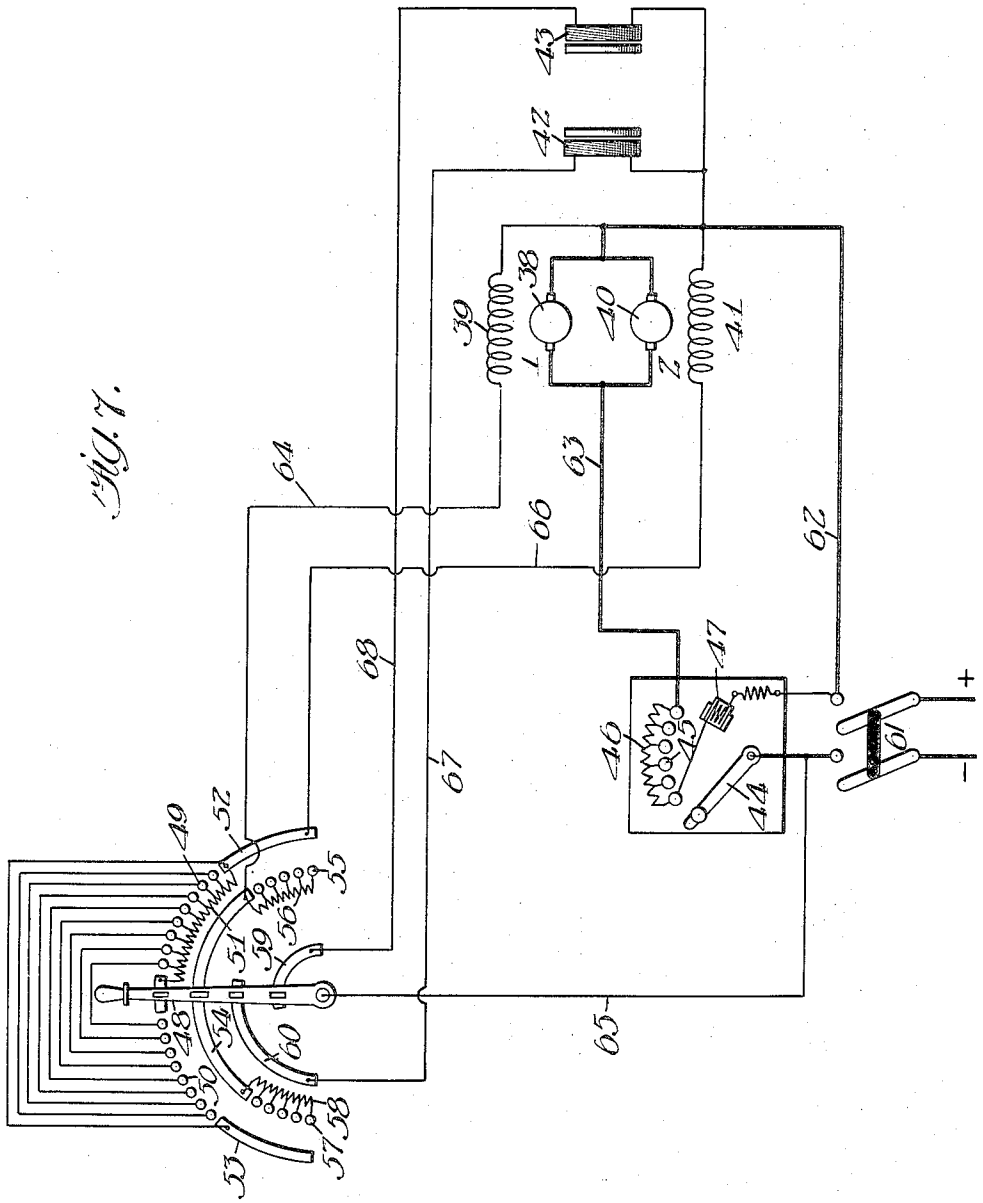
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5 SHEETS—SHEET 4.

Fig. 7.



Witnesses

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DRIVING MECHANISM FOR TURRETS AND THE LIKE.

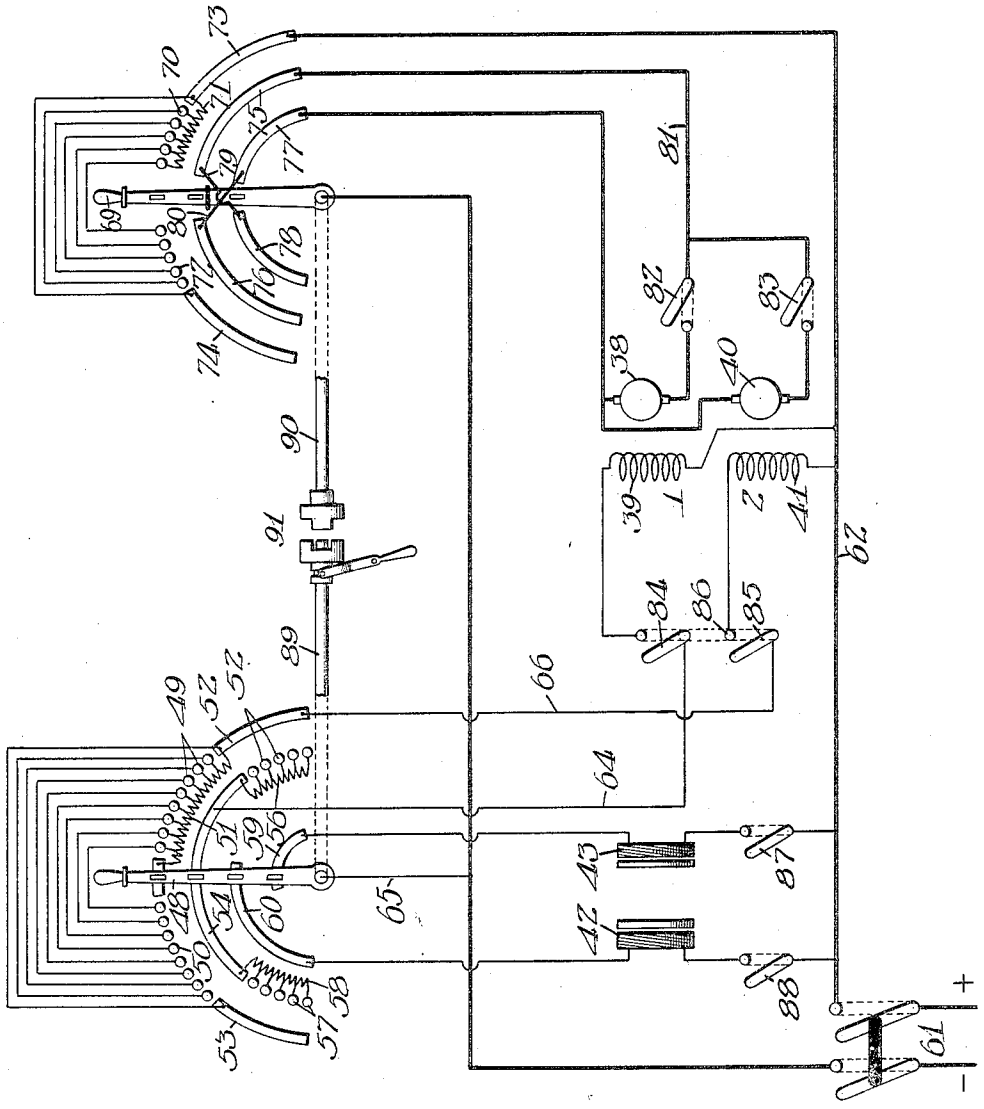
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5 SHEETS—SHEET 5.

Fig. 8.



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UNITED STATES PATENT OFFICE.

THOMAS E. BARNUM, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO CUTLER-HAMMER CLUTCH CO., OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

DRIVING MECHANISM FOR TURRETS AND THE LIKE.

1,130,053. Specification of Letters Patent. Patented Mar. 2, 1915.

Application filed August 27, 1907. Serial No. 390,302.

To all whom it may concern:

Be it known that I, THOMAS E. BARNUM, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented new and useful Improvements in Driving Mechanism for Turrets and the like, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention relates to improvements in apparatus for operating gun turrets and like heavy masses.

The object of my invention is to provide means by which the turret may be operated at varying speeds having a wide range of acceleration.

My invention further contemplates the provision of means whereby armored gun turrets or like heavy masses may be moved intermittently at various speeds and be held in fixed position.

For the purpose of disclosing my invention, I have illustrated one form of the same in the accompanying drawings.

In said drawings:

Figure I is a side elevation of a device embodying my invention, Fig. II is a detached sectional view on the line 2—2 of Fig. IV showing the differential gear, Fig. III is a view of the hub of the differential gear, Fig. IV is a sectional view on the line 4—4 of Fig. II, Fig. V is a sectional view on the line 5—5 of Fig. IV, Fig. VI is a partial view of the clutch and one form of locking means therefor, Fig. VII is a diagrammatic view of the circuit arrangement of one form of controlling means for controlling the motors I employ, and Fig. VIII is a diagrammatic view of another form of controlling means which may be employed for controlling the motors.

The apparatus illustrated in Fig. I comprises the general combination of two motors 1 and 2, a differential gear 3 operated by these motors having its driven members driven in relatively opposite directions and reversing means 4 including a double magnetic clutch 5 of any desired type. The motors constitute the prime mover for the speed varying mechanism and are adapted to normally run at such speed ratio as to establish a zero speed in the driving shaft of the mechanism through the agency of the differential gear.

Describing the apparatus more specifically, I provide a suitable base 6, having extending therefrom standards or supports 7 in which are formed bearings for the various shafts of the apparatus, and on which are mounted the motors 1 and 2, the motor 1 being arranged upon the top of the motor 2. The shaft of the motor 1 is connected to a suitable shaft 8, mounted in journals formed on the standards 7, by any desirable coupling mechanism 9. The shaft of the motor 2 is likewise connected to a shaft 10 by the suitable coupler 11. Mounted upon a shaft 12 arranged between the shafts 8 and 10 is the differential gear 3, which is driven from the shafts 8 and 10.

The differential gear comprises, as illustrated in Figs. 3 to 5, a pinion or gear 13, mounted to run loosely upon the shaft 12; an internal gear 14 also mounted to run loosely with respect to the shaft 12 and which together with its cover 15 forms a housing or casing for the parts of the differential gear; a plurality of pinions 16 and a hub or driven member 17 having stub shafts 18 upon which the gears 16 are mounted. The hub is keyed to the shaft 12 and is provided with an extension 19 which forms a bearing or hollow shaft for the gear 14. A gear wheel 20 is keyed upon the extension 21 of the hub of the gear 13, and a similar gear wheel 22 is keyed upon an extension 23 of the hub of the internal gear 14. The gear wheel 20 is adapted to mesh with and be driven by a pinion 24, mounted upon the shaft 10, and the gear wheel 22 is adapted to mesh with and be driven by a pinion 25, mounted upon the shaft 8, whereby the two members 13 and 14 of the differential gear 3 are driven in relatively opposite directions. The shaft 12 which is the driven shaft of the differential gear 3 is connected by a suitable coupling 26 with a shaft 27, having mounted thereon the double clutch 5. The central member of the clutch is preferably secured upon the shaft 27, while the two members 28 and 29 are respectively loosely mounted upon the shaft and have formed upon extensions of the hubs thereof, pinions 30 and 31. The pinion 30 is adapted to mesh with a gear 32, mounted upon a shaft 33, and the pinion 31 is adapted to drive

the shaft through the idler 34 and gear 35, also mounted upon the shaft 33. The shaft 33, when member 29 of the clutch is connected with the central member, is adapted to be driven in an opposite direction from that which it is driven when the clutch member 28 is connected to the central clutch member. The shaft 33 is provided with a pinion 36 which meshes with a gear 37 of the turret operating mechanism.

The speed at which the turret operating mechanism is adapted to be driven is controlled by the variation of the relative speed of the motors 1 and 2 and the direction of operation of the turret is adapted to be controlled by the reversing gear 4. For zero speed of the turret the motors 1 and 2 are adapted to be driven at the speed ratio of 1 to 3, whereby the gear 13 is in practice driven at a rate of speed three times greater than the internal gear 14. With this speed ratio of the members 13 and 14 of the differential gear, the hub 17 thereof will receive no motion from either one of the members 13 and 14 of the differential, and the shaft 12 will therefore remain stationary. The result is that the driven gear 37 of the turret operating mechanism is at rest. However, upon a variation of the difference in the speed ratio of the motors 1 and 2, the equilibrium in the differential gear 3 will be upset, causing the central member or hub 17 of the differential gear to rotate the shaft 12 at a speed depending upon the variation of the speed ratio of the motors 1 and 2. For the purpose of more fully understanding the operation of my invention, we will assume that the motor 1 normally operates at a speed of 300 revolutions per minute, while the motor 2 normally operates at a speed of 900 revolutions per minute, under which circumstances the hub of the differential gear remains stationary. Now assuming that it is desired to start the turret to moving, the speed of the motor 2 is run down from 900 revolutions per minute to 300 revolutions per minute, while the motor 1 is permitted to continue to operate at its normal speed of 300 revolutions per minute. This speed ratio affects a change in the speed ratio at which the gears 13 and 14 are driven, and the difference is immediately taken up by the hub 17, which starts the shaft 12 to rotating at a reduced speed, and thereby operates the turret. Keeping the motor 2 at 300 revolutions per minute, the motor 1 is now run up to 900 revolutions per minute, increasing the difference of the ratio of speed of the members 13 and 14, and thereby increasing the speed at which the hub 17 and with it the shaft 12 is rotated. By any intermediate variation of the speed ratio of the motors 1 and 2, the speed at which the shaft 12, and with it through the reversing gear, the turret operating mechanism may be varied within a wide range. When the motors are operating at their normal speed ratio, the differential gear acts as a clamp to maintain the shaft 12, and with it the turret operating mechanism in a locked position.

It will be noted from above that the differential gear only drives the shaft 12 in one direction and in order that the direction of operation of the turret control mechanism may be changed, the reversing gear 4 is provided, by which, by connecting either the member 28 or the member 29 to the central member 5, the direction of operation of the shaft 33 and with it the direction of operation of the turret operating mechanism 37 may be changed.

Fig. VII diagrammatically illustrates a simple form of controller for my variable speed mechanism, and the electrical connections between said controller and the motors and clutches. The motor 1 is provided with an armature 38 and a field 39. The motor 2 is provided with an armature 40 and a field 41. The clutch is provided with coils 42, 43, one for attracting the clutch member 28, and the other for attracting the clutch member 29. The starter by which the motors are initially set in operation is provided with a switch 44, which moves over a series of contacts 45 connected to a starting resistance 46. The switch 44 is held in its final position by means of a retaining magnet 47. It will, of course, be understood that any means may be employed to start the motors. I have simply shown a conventional starter for the purpose of illustration.

The controller is provided with a pivoted switch arm 48 which normally stands in a central position as illustrated in the drawing and may be moved either to the right or to the left. On the right hand side of said arm is a series of contacts 49. On the opposite side is a series of contacts 50. These contacts are connected to a field resistance 51 for the field of the motor 2. The two sets of contacts 49 and 50 are cross-connected so that one resistance will suffice for the two sets of contacts. Beyond the sets of contacts 49 is a contact segment 52, and beyond the contacts 50 is a segment 53, the segments 52 and 53 being cross-connected. In the same arc with the contacts 49 and 50 is a segment 54. On the right of segment 54 and in the same arc with the segment 52 is a series of contacts 55 connected to a field resistance 56 for the field of the motor 1, and on the left of segment 54, in the same arc with segment 53 is a series of contacts 57 to which is connected field resistance 58, also for the field of the motor 1. On the right of the switch arm is a segment 59 connected to the clutch winding 43, and on the left of said arm is a segment 60 connected to the clutch winding 42.

I shall now describe the operation of the

controller and the action it produces upon my variable speed mechanism. If the main line switch 61 be closed, and the switch arm 44 of the starter be moved to the right, the motors will be started and motor 1 will run at 300 revolutions per minute, and motor 2 at 900 revolutions per minute. The armature circuits of these motors extend from the positive line through conductor 62, thence through armatures 38 and 40, conductor 63, switch 44, to the negative line. The field circuit of motor 1 extends from conductor 62, through field winding 39, conductor 64, segment 54, controller switch 48, and conductor 65 to the negative line. The field circuit of the motor 2 extends from the conductor 62, through field winding 41, conductor 66, segment 52, resistance 51, controller switch 48, and conductor 65 to the negative line. Both clutch windings are energized when the controller switch stands in its central position. One of these circuits extends from the conductor 62, through winding 42, conductors 67, and segment 60 to switch arm 48, and the other from conductor 62, through clutch winding 43, conductor 68, segment 59 to controller arm 48. If the controller arm be moved to the right it will disengage segment 60 and accordingly clutch winding 42 will be deënergized, and accordingly the clutch will drive through the member 29. If the controller switch be moved to the left it will be disengaged from the segment 59 and clutch winding 43 will be left deënergized. Accordingly the clutch will drive through clutch member 28. It will thus be seen that the direction in which the reversing clutch will drive depends upon the direction in which the controller arm is moved.

As previously stated the motor 1 runs at 300 revolutions per minute, and the motor 2 at 900 revolutions per minute, while the controller switch stands in its central position. If this switch be moved, either to the right or to the left, the resistance 51 will be removed gradually from the circuit of field winding 41, and accordingly the speed of motor 2 will be decreased from 900 revolutions per minute to 300 revolutions per minute. The resistance 56 will then be inserted, step by step, into the circuit of field winding 39, and accordingly the speed of motor 1 will be increased from 300 revolutions per minute to 900 revolutions per minute.

Fig. VIII diagrammatically illustrates another form of controller for my variable speed mechanism by means of which either one of the motors may be made to operate the driving shaft in the event that the other of said motors breaks down or is otherwise disabled. In this form of controller, I employ a different starting device from that formerly described. In practice the speed controller and starting device would preferably be of the drum type but for the purpose of illustration I have shown other types. This starting device is provided with a pivoted contact member 69, comprising two sections suitably insulated from one another, and which normally stands in a central position as illustrated in the drawings, and may be moved either to the right or to the left. On the right hand side of the contact arm is a series of contacts 70 to which is connected a starting resistance 71. On the left hand side is a series of contacts 72 cross-connected with the series of contacts 70. Beyond the set of contacts 70 is a segment 73 and beyond the series of contacts 72 is a segment 74. In the same arc as the contacts 70 and the segments 73 is a segment 75, and in the same arc as the segment 74 and the contact 72 is a segment 76. In the same arc as the contact 75 is the segment 77 and in the same arc as the segment 76 is a segment 78. Segments 75 and 78 are connected by a conductor 79 and segments 76 and 77 are connected by a conductor 80. The segment 73 is connected by a conductor 62 to the positive side of the main line. The segment 75 is connected by conductor 81 to one side of the armatures 38 and 40 and segment 77 is connected to the other side of the armatures. In the circuit of the armature 38 is a switch 82 and in the circuit of the armature 40 is a switch 83. The speed controller employed in this instance is the same as that shown in Fig. 5, and the circuit connections between the controller and the fields of the motors are substantially the same, but in this form of control I provide a switch 84 in the circuit of the field 39 and a switch 85 in the circuit of the field 41. The arrangement of these switches is preferably such that the switch 84 may be opened and made to engage with the contact 86 of the switch 85 where the same is open for the purpose hereinafter set forth. The circuit connections between the controller and the magnetic clutches is also substantially the same as those previously set forth, and I provide a switch 87 in the circuit of the clutch winding 43 and a switch 88 in the circuit of the clutch winding 42. In this form of controller I also provide means whereby the controller arm 48 and the movable contact member 69 may be coupled together so that the controller arm may be operated simultaneously with the movable contact member by operating the latter. Any desired means may be employed to so couple the starter arm and the controller arm and in this instance I have diagrammatically shown the same mounted on two alining shafts 89 and 90, said shafts having a coupling device 91 for locking the same together.

I shall now describe the operation of the controller and the action it produces upon my variable speed mechanism. The main

line switch 61 and also the switches 82 and 83 are first closed. Now, if the movable contact member 69 is moved to the right, current will flow from the positive side of the main line by conductor 62 to the segment 73, through all of the starting resistance 71, across arm 69, to segment 75, by conductor 81, through the armatures and back to segment 77, thence through the arm 69 to the negative side of the main line. As the movement of the arm 69 is continued the starting resistance is gradually removed from circuit until finally said arm engages the segment 73. It is obvious that by moving the movable contact arm 69 to the left a circuit will be closed through the armatures and current will flow therethrough in an opposite direction. The circuit of the fields, assuming that the switches 84 and 86 are closed may be traced as already described; so also may the circuits through clutch windings 42 and 43 be traced as already set forth if the switches 87 and 88 are closed. When the motors have been started, and assuming that the clutch 91 is open as shown in the drawing, the speed of the two motors may be controlled by moving the controller arm 48 in one direction or the other as desired and the results obtained will be the same as already described in connection with Fig. VII. Assuming now that motor 2 breaks down, or becomes otherwise disabled, or the parts through which it is adapted to drive become disabled, motor 1 may be made to alone drive the driven shaft in the following manner. The switch 83 in the armature circuit of motor 2 is first opened. Then the switch 85 in the field circuit of motor 2 is opened; then both of the switches 87 and 88 in the clutch circuits are opened and the mechanical clutch 91 is actuated to lock the shafts 89 and 90 together.

When the foregoing adjustments of the controller have been made it is only necessary to lock the member of the differential gear connected to the disabled motor and to lock one of the clutch members 28 or 29 to the clutch member 5. This may be readily accomplished in various ways which will be apparent to those skilled in the art. For example, the differential gear might have associated therewith a locking device such as that shown in Fig. 4. This device comprises a bar 92 slidable in a support 93 fixed to any suitable stationary part, said bar 92 being adapted to be moved to the left to enter between adjacent teeth of the wheel 22 or to the right to enter between adjacent teeth of the wheel 20, and to be locked in any position by a set screw 94. The parts of the clutch may be locked together in any suitable manner, such as that illustrated in Fig. 6. In this figure, the clutch members 5 and 29 are shown as locked together by a bolt 95 passing through an ear 96 on the clutch member 29 and threading into an ear 97 on the clutch member 5. Of course, any number of such locking devices might be employed.

I shall now describe the operation of the controller with this arrangement of the parts. Assuming the main switch 61 to be closed, when the contact member 69 is moved either to the right or to the left according to the direction in which it is desired to drive the driven shaft, circuit will be closed through the armature 38 of the motor 1 and may be traced as previously set forth. The circuit through the field 39 of the motor 1 is also the same as described, and it will therefore be understood that the motor 1 starts to operate at its lowest speed. Bearing in mind that the controller arm 48 is now operated simultaneously with and by the movable contact arm 69 it will be seen that until all of the starting resistance 71 is cut out of the armature circuit, the field strength of the motor 1 will remain the same, as the controller arm 48 is in the meantime traveling over the segment 54. At this time the motor 1 will drive the driven shaft through the locked differential gear and clutch in one direction or the other in accordance with the direction in which the arm 69 was previously moved. If now it is desired to further increase the speed of the driven shaft, movement of the arm 69 is continued over the segment beyond the resistance and it will readily be seen that the controller arm 48 will at the same time be moved over the series of contacts connected with the field resistance of the motor 1, thereby inserting said resistance into circuit with the field and increasing the speed of the motor and consequently the speed of the driven shaft. From the foregoing it will be seen that both the speed and direction of the motor 1 may be controlled by moving the single contact arm 69. Assuming now that motor 1 becomes disabled instead of motor 2, the switches 82, 84, 85, 87 and 88 are all opened, and the clutch 91 thrown into operative position. The switch 84 is then thrown into engagement with contact 86, thereby establishing a field circuit for motor 2 which may be traced as follows: from the positive side of the main line by conductor 62 through the field 41, to contact 86, switch 84, conductor 64 to segment 54, controlling arm 48 to conductor 65, thence to the negative side of the main line. It is therefore apparent that the circuit for this motor is the same as previously traced for motor 1 and that therefore the operation of my device when this motor operates the driven shaft, is the same as that when motor 1 was operating the driven shaft. This form of control is particularly adapted to provide means whereby my mechanism may be operated in an emergency even though one of the

motors or some part connected therewith is disabled.

Having thus described my invention what I claim as new and desire to secure by Letters Patent, is:

1. In combination, a member to be operated at variable speeds in opposite directions, a prime mover therefor, a differential gear operatively connected to said prime mover and reversing connections between said differential gear and said member to control the direction of operation of the latter independently of the former, thereby permitting said differential gear to be utilized exclusively for speed variation to increase the range of speed variation obtainable for said member.

2. In combination, a member to be operated at variable speeds in opposite directions, a prime mover therefor, a differential gear operatively connected to said prime mover and reversing connections between said differential gear and said member to control the direction of operation of the latter independently of the former, thereby permitting said differential gear to be utilized exclusively for speed variation to increase the range of speed variation obtainable for said member and a common control member for said prime mover and said reversing connections.

3. In combination, a member to be operated at variable speeds in opposite directions, a prime mover, a differential gear operatively connected to said prime mover, and connections between said differential gear and said member for changing the direction of operation of the latter independently of the former and means tending to insure a predetermined speed reduction of the driven member of said differential gear prior to variations in the connections between the same and said member.

4. In combination, a member to be operated at variable speeds in different directions, two electric motors and a differential gear and reversing gearing interposed between and connecting said motors to said member, said reversing gearing being controllable to reverse the direction of operation of said member independently of said differential gear and said motors and said differential gear being connected to operate in a direction independent of the relative speeds of said motors to increase the range of speed variation for said member obtainable with said motors.

5. In a variable speed mechanism, in combination, a driven member, a differential gear, gearing for operatively connecting said differential gear to said driven member, magnetic clutching means controlling said gearing to reverse the operation of said driven member without reversing the operation of said differential gear, a large motor and a small motor for operating said differential gear, and a single controller for controlling the operation of said motors and said clutching means to cause said driven member to be operated in either direction and to vary the speed of said member in small increments or decrements throughout a wide range.

6. In a variable speed mechanism, in combination, a driving shaft, a driven shaft, reversing gearing for connecting said driving shaft to said driven shaft, electro-magnetic clutches controlling said gearing to determine the direction of operation of said driven shaft, electrically controlled means for varying the speed of said driving shaft, and a single controller for said means and said clutches.

7. In a variable speed mechanism, in combination, a driving shaft, a driven shaft, reversing gearing for operatively connecting said driving shaft to said driven shaft, electromagnetic clutching means controlling said gearing to determine the direction of operation of said driven shaft, a differential gear, two electric motors for operating said driving shaft through the medium of said differential gear, and a single controller for varying the relative speeds of said motors and for controlling the operation of said electro-magnetic clutching means.

8. In a variable speed mechanism in combination, a driven member, a differential gear, two motors, connections for enabling said motors to jointly drive said driven member through said differential gear, a single controller for varying the relative speeds of said motors, means for varying the connections between said differential gear and said driven shaft to change the direction of operation of said driven shaft without changing the direction of operation of the differential gear, means for disconnecting one motor from said controller and an auxiliary controller adapted to be connected to said first mentioned controller to move in unison therewith when one motor is disconnected, said auxiliary controller being adapted to cause the other motor to operate in either direction.

9. In a variable speed mechanism, in combination a driven element, two motors, driving connections, including a differential gear, interposed between said motors and said driven element, said connections being adapted to reverse the direction of operation of said driven element without reversing said motors, and a controller common to both motors for varying the relative speed thereof, said controller being adapted to vary the speed of one motor and reverse the direction of operation thereof when the other motor is disconnected from circuit.

10. The combination with a pair of motors, of a differential gear associated there-

with, a driving shaft adapted to be operated by said differential gear, the motors being adapted to normally run at such relative speeds as to establish a balanced condition of said differential gear, a pair of electromagnetic clutch members loosely mounted on said shaft, a complementary clutch member common to said first mentioned clutch members and rigidly secured to said shaft, a driven shaft, gears mounted on said driven shaft and coöperating gears connected to the loose clutch members, said gears being so associated that when one clutch is operated the driven shaft will be rotated in one direction, and when the other clutch is operated said shaft will be rotated in the opposite direction, and a single controller for varying the relative speeds of said motors and for controlling the operation of said electromagnetic clutches.

In witness whereof, I have hereunto subscribed my name in the presence of two witnesses.

THOMAS E. BARNUM.

Witnesses:
ALEXANDER H. LIDDELL,
FRANK H. HUBBARD.