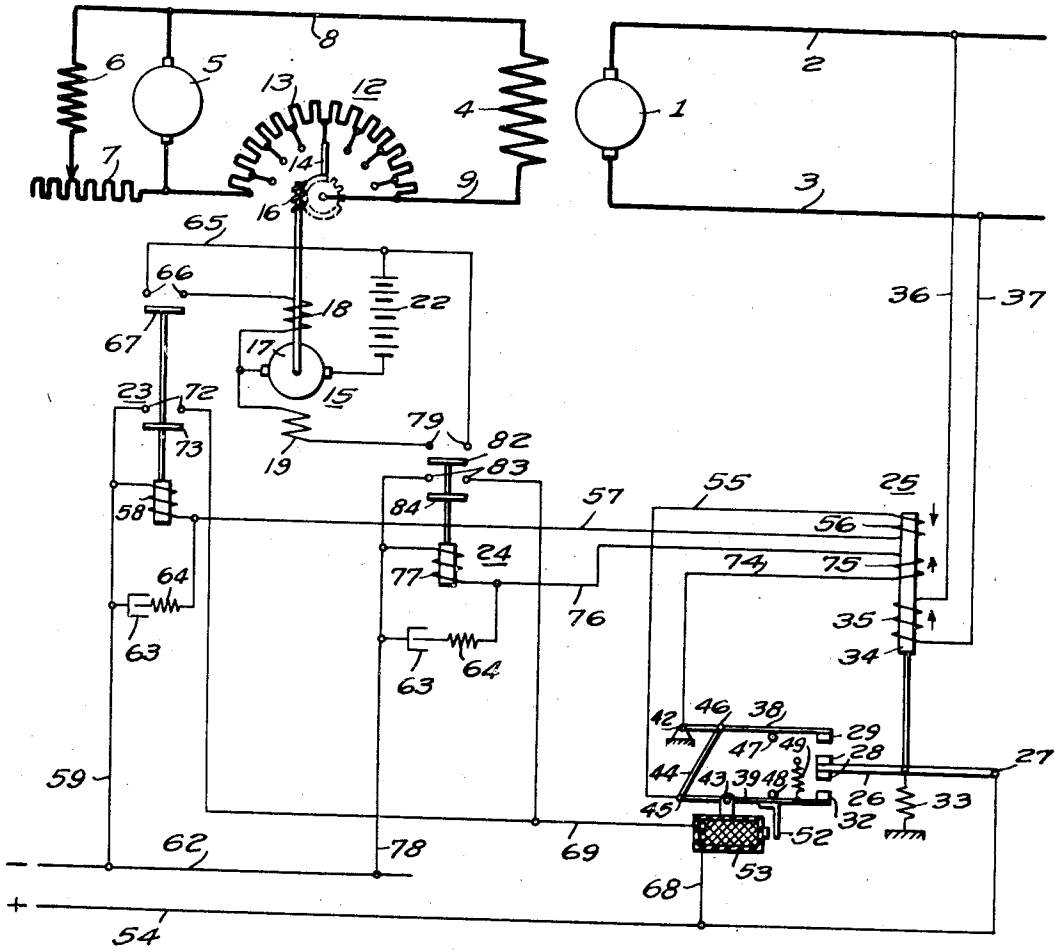
Aug. 26, 1941. J. F. KOVALSKY 2,254,039

VOLTAGE REGULATOR RELAY SYSTEM

Filed Jan. 13, 1938



WITNESSES:

E. A. McCloskey.

J. E. Hardy

INVENTOR

Joseph F. Kovalsky.

BY

Ezra W. Savage

ATTORNEY

Patented Aug. 26, 1941

2,254,039

UNITED STATES PATENT OFFICE

2,254,039

VOLTAGE REGULATOR RELAY SYSTEM

Joseph F. Kovalsky, Turtle Creek, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application January 13, 1938, Serial No. 184,839

5 Claims. (Cl. 175—320)

My invention relates to regulator systems and particularly to the control mechanism for governing the operation of rheostatic type regulators. In rheostatic type regulators, it is customary to provide a rheostat operating motor that is controlled by secondary or motor reversing switches that are, in turn, controlled by a primary relay that is actuated in accordance with variations in the quantity to be regulated, such as the voltage of a generator.

In delicate instruments, such as contact-making voltmeters that constitute the primary relays of voltage regulators, the floating contact members approach their cooperating contact members slowly and engage initially with very slight pressure. The contact surfaces of the engaging contact members are small and may become dirty by the accumulation of foreign matter, such as dust, which tends to form a high resistance film on the surface of the contacts, and which may limit the current passing therethrough to a value that is insufficient to cause the operation of the associated motor operating switch to its circuit closing position with the slight contact pressure normally prevailing at the initial engagement of the floating contact members of the primary relay with their cooperating contact members.

It is an object of my invention to provide means for causing sufficient contact pressure between the contact members of the primary relay of a regulator to assure operation of the regulating mechanism upon slight initial contact pressure of the contact members.

It is a further object of my invention to provide means for assuring positive contact pressure between the contact members of the primary relay of a regulator without disturbing the accuracy of the regulator action.

Referring to the drawing, the single figure is a diagrammatic view of apparatus and circuits comprising one preferred embodiment of the invention.

In the drawing, a direct-current generator is illustrated having an armature winding 1 for supplying electrical energy to a circuit represented by conductors 2 and 3, and a field winding 4 that is supplied with excitation current from an exciter generator having an armature winding 5 and a field winding 6 that is connected in shunt relation to the armature winding 5 through a variable resistor 7. The exciter generator armature 5 is connected to the generator field winding 4 by conductors 8 and 9 through a rheostat 12 having a resistor 13 and a movable arm 14 for varying the effective resistance in series with the field winding 4 in accordance with the operation of a pilot motor 15 that actuates the arm 14 through a gearing mechanism 16. The motor 15 comprises an armature winding 17 connected to the motor shaft, and differentially related field windings 18 and 19 that are adapted to be connected to a source of electrical energy represented by battery 22 upon the closing of the one or the other of two motor reversing switches 23 and 24 as controlled by a primary relay 25.

The primary relay 25 comprises a movable lever 26 that is pivotally supported at one end 27 and provided at the other end with floating contact members 28 that are adapted to engage cooperating contact members 29 and 32 in accordance with the movement of the lever 26 that is biased in one direction by a spring 33 and in the opposite direction by a magnet having a core 34 connected to the arm 26. The core 34 is energized by an operating winding 35 that is connected by conductors 36 and 37 to the circuit conductors 2 and 3, respectively, to be energized in accordance with the voltage output of the generator armature 1. The relay contact members 29 and 32 are carried, respectively, by levers 38 and 39 mounted upon supporting pivots 42 and 43, and connected by a link 44 extending between pivot points 45 and 46, so as to move the contact members 32 and 34 in opposite direction. Stops 47 and 48 are provided for limiting the movement of the contact carrying ends of the levers 38 and 39 toward each other under the influence of a spring 49 provided for that purpose. An armature 52 is provided on the lever 39 that is influenced by a magnet 53 to move the contact members 32 and 34 in a manner to be presently described.

If the voltage between conductors 2 and 3 drops below the value for which the primary relay 25 is adjusted, the upward pull on the winding 35 decreases sufficiently that the spring 33 pulls the lever 26 downwardly to cause engagement between contact members 28 and 32 to close an operating circuit for the motor reversing switch 23. This circuit extends from one terminal of a source of energy represented by the positive conductor 54 through the relay contact members 28 and 32, conductor 55, an auxiliary winding 56 provided about the core 34 of the primary relay 25, through conductor 57, winding 58 of the reversing switch 23, and conductor 59 to the other terminal of the source of energy represented by the negative conductor 62. Upon initial engagement of the contact members 28 and 32, the

auxiliary winding 56 about the core 34 is energized and acts oppositely to the winding 35 to increase the contact pressure between contact members 28 and 32 to increase the flow of current through the auxiliary winding 56 and through the operating winding 58 of the motor reversing switch 23. If the pressure of the initial engagement between the contact members 28 and 32 is insufficient to supply the current necessary for actuating the reversing switch 23 to its circuit closing position, the increase in contact pressure caused by flow of current through the winding 56 will assure the building up of current in the winding 58 to a value to cause operation of the switch 23 to its circuit closing position.

The closing of the switch 23 causes a circuit to be completed from one terminal of the battery 22 through conductor 65, the switch contact members 66 and 67, the field winding 18, the motor armature winding 17 to the other terminal of the battery 22 to operate the motor 15 to move the rheostat arm 14 in a counterclockwise direction to decrease that portion of the rheostat resistor 13 that is in circuit with the field winding 4, and thus increase the energization of the field winding 4 and of the generator armature 1.

A condenser 63 is provided, connected in series with a resistor 64 in parallel circuit relation with the winding 58 of the reversing switch 23 to provide a timing circuit for holding the reversing switch 23 closed for a predetermined time after interruption of the energizing circuit which is effected by the discharge of the condenser 63 through the winding 58. The charging of the condenser 63 takes place during the building up of the current in the winding 58 to a value sufficient to cause it to operate the switch 23 to its circuit closing position.

At the same time that the contact member 67 bridges the contact members 66, the contact member 73 bridges the contact members 72 to close a circuit from conductor 54 through conductor 68, the winding of the magnet 53, conductor 69, the contact members 72 and 73 of the reversing switch 23 and conductor 59, to energize the magnet 53 causing the armature 52 to be pulled downwardly and toward the left, as viewed in the drawing about the pivot 43, to move the lever 39 away from the stop 48 and the contact member 32 from engagement with the contact member 28. This operation permits the reversing switch 23 to be deenergized and dropped to its circuit interrupting position after the time interval provided by the condenser 63, which time interval insures sufficient operation of the rheostat motor 15 to cause the rheostat arm 14 to move from engagement with one rheostat button to the next adjacent button in a well known manner. If the drop in voltage of the generator armature 1 is very large, the contact member 28 may engage the contact member 32 in its lower position until the increase in voltage of the generator armature 1 has progressed sufficiently to cause upward movement of the lever 26.

In a similar manner, if the voltage between conductors 2 and 3 increases above the desired value, the increase in the pull of the winding 35 on the core 34 will move the magnet core upwardly against the force of the spring 33 and cause engagement of contact members 28 and 29 to close a circuit from conductor 54 through contact members 28 and 29, conductor 74, auxiliary winding 75 provided about the core 34 of the primary relay, conductor 76, the winding 77 of the reversing switch 24, and conductor 78 to the negative conductor 62. The closing of this circuit causes operation of the reversing switch 24 to its circuit closing position, to close a circuit from one terminal of the battery 22 through the contact members 79 and 82, the motor field winding 19 and armature winding 17 to the other terminal of the battery 22 to energize the motor to operate the rheostat arm 14 in a clockwise direction to thereby insert a greater portion of the resistor 13 in series with the generator field winding 4 to decrease the energization thereof and correspondingly decrease the voltage output of the armature 1. Upon initial engagement of the contact members 28 and 29, the current flowing through the circuit controlled thereby and which includes the winding 75 on the primary relay, causes the winding 75 to aid the pull of the operating winding 35, to increase the upward pull of the core 34 on the lever 26 and increase the contact pressure between the contact members 28 and 29. If, therefore, the pressure of the initial engagement between the contact members 28 and 29 is insufficient to supply the current necessary for actuating the reversing switch 24 to its circuit closing position, the increase in contact pressure caused by flow of current through the winding 75 will assure the building up of current in the winding 77 to a value that will cause operation of the switch 24 to its circuit closing position. A timing circuit consisting of a condenser 63 and a resistor 64 connected in series with each other is provided in shunt relation to the reversing switch winding 77 in the same manner as for the reversing switch 23 to maintain it in its circuit closing position for a predetermined time after interruption of the circuit energizing the winding 77.

Upon operation of the switch 24 to its circuit closing position, a circuit is also closed from conductor 54 through conductor 68, the winding of magnet 53, conductor 69, contact members 83 and 84 and conductor 78 to conductor 62 for energizing the magnet 53 to operate the levers 39 and 38 in the manner above-described to move the contact members 28 and 29 away from each other, thus separating the contact members 28 and 29 to interrupt the circuit through the winding 77 of the reversing switch 24. This provides an anti-hunting action to prevent overtravel of the rheostat arm 14 in either direction.

In the above-described regulator, it will be appreciated that the operation of the regulator is improved by providing means for increasing the contact pressure after initial engagement of the contact members of the primary relay until the associated motor operating switch is operated to a circuit closing position after which the energizing circuit thereof is abruptly interrupted by movement of the outer contact member 29 and 32, thus reestablishing the initial conditions of the regulator. The provision of means for increasing the contact pressure will insure operation of the regulator against high resistance at the contact members of the primary relay that may be caused by dust particles, oil film, mechanical vibration or electrical oscillations which would otherwise impair the proper operation of the regulator. The means for increasing the primary relay contact pressure does not alter the calibration of the contact making voltmeter,

since the windings 56 and 75 are not energized during the normal operation of the relay, which is under the control of the winding 35. The winding 56 or 75 is deenergized immediately upon energization of the coil of the anti-hunting magnet 53 as above-described, the closed reversing switch being held in its circuit closing position for a short time thereafter by operation of the associated capacity timing circuit.

Many modifications in the apparatus and circuits illustrated and described will be apparent to one skilled in the art, and I do not wish to be limited otherwise than by the scope of the appended claims.

I claim as my invention:

1. In a regulator system wherein an electric motor and means actuated thereby are employed for varying a quantity to be regulated, in combination, a pair of electrically operated reversing switches actuated to their circuit closing positions when energized, a primary relay having an operating coil and floating contact means actuated thereby adapted to engage the one or the other of two cooperating contact members for controlling circuits for energizing the one or the other of said reversing switches, means energized in response to engagement of said cooperating primary relay contact members with light pressure for causing a sufficient increase in contact pressure to assure operation of the associated reversing switch, said means comprising a pair of coils, one of said coils being effective to oppose the operating coil when the floating contact means engages one of said cooperating contact members, and the other of said coils being effective to aid the operating coil when the floating contact means engages the other of said cooperating contact members.

2. In a regulator system wherein an electric motor and means actuated thereby are employed for varying a quantity to be regulated, in combination, a pair of electrically operated reversing switches actuated to their circuit closing positions when energized, a primary relay for controlling the reversing switches having floating contact means and two cooperating contact members adapted to be separately engaged by said floating contact means for controlling circuits for energizing the one or the other of said reversing switches, means for actuating said floating contact means comprising an electromagnet having an operating coil and a coil in series with each cooperating contact member for modifying the pull of the magnet upon closure of a circuit by said contact member for assuring positive contact pressure, one of said coils in series with a cooperating contact member being arranged to act differentially with the operating coil controlling the floating contact means upon engagement of the floating contact means with said one cooperating contact member, and the other of said coils in series with a cooperating contact member being arranged to act cumulatively with the operating coil controlling the floating contact means upon engagement of the floating contact means with said other cooperating contact member.

3. In a regulator system wherein an electric motor and means actuated thereby are employed for varying a quantity to be regulated, in combination, a pair of electrically operated reversing switches actuated to their circuit closing positions when energized, a primary relay having an operating coil and floating contact means actuated thereby and adapted to engage the one or the other of two cooperating contact members for controlling circuits for energizing the one or the other of said reversing switches, means comprising a pair of coils responsive to engagement of said cooperating primary relay contact members with light pressure for causing a sufficient increase in contact pressure to assure operation of the associated reversing switch, one of said coils being effective to oppose the operating coil when the floating contact means engages one of said cooperating contact members, and the other of said coils being effective to aid the operating coil when the floating contact means engages the other of said cooperating contact members, and electrically actuated means for separating the primary relay contact members, said last-named means being energized through auxiliary contact members on said reversing switches upon operation thereof to circuit closing positions.

4. In a regulator system wherein an electric motor and means actuated thereby are employed for varying a quantity to be regulated, in combination, a pair of electrically operated reversing switches actuated to their circuit closing positions when energized, a primary relay having floating contact members and an electromagnet having an operating coil for actuating said floating contact members, cooperating contact members adapted to be separately engaged by said floating contact members to control circuits for controlling the operation of said reversing switches, electro-responsive means comprising a pair of coils controlled by engagement of said primary relay contact members for increasing the contact pressure to assure operation of said reversing switches, one of said coils being effective to oppose the operating coil when the floating contact means engages one of said cooperating contact members, and the other of said coils being effective to aid the operating coil when the floating contact means engages the other of said cooperating contact members, and electro-responsive means controlled by operation of said reversing switches for causing separation of said primary relay contact members.

5. In a regulator system wherein an electric motor and means actuated thereby are employed for varying a quantity to be regulated, in combination, a pair of electrically operated reversing switches actuated to their circuit closing positions when energized, a primary relay having floating contact means adapted to engage the one or the other of two cooperating contact members for controlling energizing circuits for energizing the one or the other of said reversing switches and a magnet comprising a core and three windings thereon, one of said windings being an operating winding for controlling the operation of said floating contact means and the other windings being auxiliary windings connected in series with the cooperating contact members of the primary relay for increasing the contact pressure upon engagement thereof with light pressure for causing a sufficient increase in contact pressure to assure operation of the associated reversing switch, one of said auxiliary windings being arranged to aid and the other to oppose the operating winding and electrically actuated means for separating the primary relay contact members, said last-named means being energized through auxiliary contact members on said reversing switches upon operation thereof to circuit closing positions.

JOSEPH F. KOVALSKY.