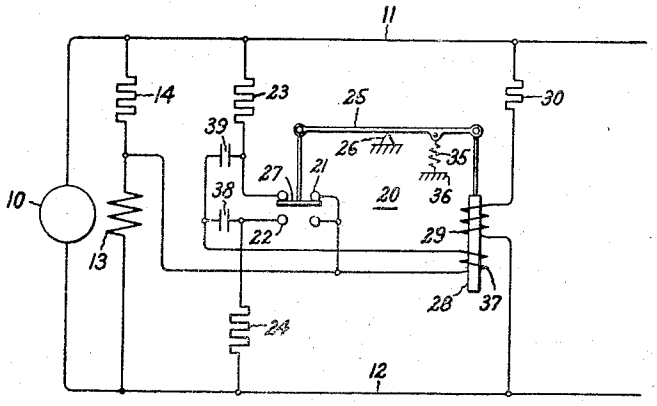
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CIRCUIT CONTROLLER

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CIRCUIT CONTROLLER

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My invention relates to circuit controllers and particularly to an arc suppressing and regulating coil circuit for circuit controlling relays of the vibratory regulating type.

A well known means for the suppression of arcs at circuit making and breaking contacts comprises a condenser and a resistor connected in series across the contacts. Where arc suppression is essential because of frequent contact operation, as in regulating relays of the vibratory type, the above arc suppression circuit is often used. For example, in battery charging generator systems for Diesel-electric locomotives, and the like, the load on the regulator contacts is particularly severe because the generator, being driven by the engine, is subject to wide and very rapid variations in speed.

The principal object of my invention is to provide a circuit arrangement for both suppressing arcing at the contacts and improving the regulating qualities of a vibratory regulator.

It is also an object of my invention to provide a vibratory regulator particularly applicable to engine-driven generator voltage regulation.

It is a further and specific object of my invention to provide an arc suppressing and regulating circuit for a vibratory regulator adapted for an engine driven generator on a Diesel-electric vehicle.

In carrying out my invention in one form I employ a vibratory regulator having a pair of normally closed contacts, a pair of normally open contacts, and an operating winding. To such a regulator I add an additional coil or regulating winding and connect this winding in series with separate reactive energy-storing means such as condensers across each of the pairs of contacts of the regulator. The polarity of the regulating winding is then so related to that of the operating winding that when either of the regulator contacts opens the charging current through the condenser associated with that pair of contacts will pass through the regulating winding in a direction tending to reclose the contacts, while when either of the regulator contacts closes the discharge current from the condensor associated with that pair of contacts will pass through the regulating winding in a directiton tending to reopen the contacts.

For a more complete understanding of my invention reference should now be had to the accompanying drawing, the single figure of which is a simplified circuit diagram showing a regulator circuit embodying my invention applied to the voltage regulation of a direct current generator.

Referring now to the single figure of the drawing, I have shown a direct current generator 10, which may be an axle-driven generator, connected to supply a unidirectional voltage to the supply lines 11 and 12 and provided with a shunt field winding 13, and a field resistor 14 connected in series with the field winding 13.

In order to regulate the output voltage of the generator 10 a vibratory regulator 20 includes a pair of normally closed low limit contacts 21 and a pair of normally open high limit contacts 22. The normally closed contacts 21 are connected to complete a shunt circuit around the field resistor 14 through a shunting resistor 23; while the normally open contacts 22 are so connected that when closed they complete a shunt circuit around the field winding 13 through a shunting resistor 24.

As shown in the drawing, the regulator 20 may comprise a lever arm 25 pivoted on a knife edge 26 and carrying at one end a contact member 27 and at the other end a magnetic armature 28. A voltage responsive operating winding 29 located in attractive relationship to the armature 28 is connected across the supply lines 11 and 12 in series with a resistor 30. In order to bias the relay to a position in which the contacts 21 are normally closed a tension spring 35 may be connected to a portion 36 of the relay frame. In operative relation to the armature 28 and inductively linked with the winding 29 is disposed a regulating winding 37. The regulating winding 37 is connected in series with an energy-storing capacitor 38 across the contacts 22 of the regulator 20 and is connected in series with a capacitor 39 across the contacts 21 of the regulator 20.

In operation, when the generator 10 is at standstill the regulator 20 is biased to close the contacts 21 and complete a shunt circuit around the field resistor 14. Thus as the generator comes up to speed maximum energization is applied to the shunt field winding 13. When the generator reaches approximately its minimum normal operating speed, its voltage will be near the pick-up point of the operating winding 29. At this time the capacitor 38 will be charged since it is connected across the field winding 13 of the generator in series with the resistor 24 and the regulating winding 37. As the generator voltage tends to rise above this point with a further increase in speed, the winding 29 will pick up the armature 28, and the contacts 21 will be opened

to remove the shunt circuit from the field resistor 14. As soon as the contact member 27 leaves the contacts 21 the circuit through the contacts 21 is broken and a charging current flows through the capacitor 39 and the regulating winding 37 in series. The polarity of the regulating winding 37 is such that this charging current sets up a magneto-motive force opposing the magneto-motive force set up by the operating winding 29, thereby tending to weaken the operating force of the relay and reclose the contacts 21. The decrease in generator field excitation due to unshunting of the field resistor also tends to cause the contacts to reclose. Likewise, whenever the generator voltage tends to fall, the contacts 21 will be closed to shunt the resistor.

If, however, the voltage of the generator tends to rise after the contacts 21 have been opened, as due to an increase in speed, the contact member 27 will close the contacts 22 and complete a shunt circuit around the field winding 13 through the shunting resistor 24. The shunting of the field winding 13 will result in such a decrease in the output voltage of the generator 10 that the contact member 27 will tend to separate from the contacts 22. Also, the capacitor 38 having been previously charged, it will discharge when the contacts 22 are closed; and the discharge current will flow through the regulating winding 37 in a direction tending to reopen the contacts 22. As soon as the contact member 27 leaves the contacts 22, however, the circuit through these contacts is broken to remove the shunt from the generator field 13. Upon opening of the contacts 22 a charging current is established through the capacitor 38 and the regulating winding 37 in series. This charging current flows in such a direction through the regulating winding 37 that it sets up a magneto-motive force assisting the magneto-motive force of the operating winding 29, and thereby tends to reclose the contacts 22. The removal of the shunt from the generator field 13 and the consequent increase in generator voltage likewise tends to reclose the contacts 22 by increasing the energization of the operating coil 29 of the regulator 20.

If now, as due to a decrease in generator speed, the contacts 21 are reclosed, the capacitor 39, being charged, will discharge through the regulating winding 37. The flow of discharge current through the winding 37 will be in a direction to set up a magneto-motive force assisting that of the coil 29, whereby the contacts 21 will tend to be reopened.

As has been pointed out, when either of the contacts 21 or 22 is reclosed after the condensers 39 and 38 have been charged, the affected condenser will discharge through the regulating coil. As usual, it is necessary to have a current limiting resistor in this discharge circuit. According to my invention the impedance of the regulating coil 37 may be made sufficient to limit the discharge in a manner similar to the conventional current limiting resistor used in series with a condenser for arc suppression. Thus the impedance of the regulating coil acts to limit the magnitude of the discharge current, while the inductance of the coil is effective to reduce the rate of rise of discharge current.

As described above, a vibrating regulatory action of the contact member 27 will take place on the contacts 21 and 22. The tendency will be to regulate on the contacts 21 when the required field current is relatively high and on the contacts 22 when the required field current is relatively low. Because it increases the frequency of vibration of the regulating contacts, the regulating winding 37 in the capacitor circuits will reduce the magnitude of the slight periodic voltage variations always necessary to operate a vibratory regulator. In operation it is possible to so adjust the regulator that no material voltage difference exists whether the regulatory action occurs upon the contacts 21 or on the contacts 22. Furthermore, the presence of the capacitors shunting the contacts tends to reduce the momentary increase or decrease in generator field current, as do capacitive arc suppressing circuits heretofore known.

It will be observed from the foregoing that one of the most advantageous features of my invention is that the charging current flowing through the regulating winding 37 upon the breaking of either of the regulator contacts not only assists in the regulating action of the device but also suppresses any arcing at the contacts in a manner similar to the well known condenser and series connected charging resistor connected across a pair of regulating contacts.

While I have shown and described but one preferred form of my invention, I wish to have it understood that I do not wish to be limited thereby, and that I, therefore, intend by the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

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

1. A circuit controlling device comprising a switch, means for moving said switch between open and closed circuit positions, a winding operatively associated with said switch for modifying the operation of said switch, and reactive energy-storing means effective upon any movement of said switch from either of said positions to the other for producing a transient current flow through said winding in a direction tending to oppose said movement.

2. A circuit controlling device comprising a switch, means for moving said switch between open and closed circuit positions, a winding operatively associated with said switch for modifying the operation of said switch, a capacitor, connections connecting said winding across said switch in series with said capacitor so that when said switch is moved to an open circuit position said winding is energized momentarily by a charging current through said capacitor in a direction to tend to reclose said switch and when said switch is moved to a closed circuit position said winding is energized momentarily by the discharge of said condenser therethrough in a direction to tend to reopen said switch.

3. A circuit controlling device comprising a switch, an operating winding for moving said switch between open and closed circuit positions in accordance with its energization, a second winding operatively associated with said switch for modifying the operation of said switch by said first winding, a capacitor, connections connecting said second winding across said switch in series with said capacitor so that when said switch is moved by said first winding to an open circuit position said second winding is energized momentarily by a charging current through said capacitor in a direction to tend to reclose said switch and when said switch is moved by said first winding to a closed circuit position said second winding is energized momentarily by the

discharge of said condenser therethrough in a direction to tend to reopen said switch.

4. In combination, an electromagnetic circuit controller comprising co-operating switch contacts, a movable armature operatively connected to move one of said contacts between open and closed circuit positions thereby to control the value of a quantity, an operating winding disposed in attractive relationship to said armature and arranged to be energized in accordance with the value of said quantity, a second winding disposed in inductive relationship to said armature, and reactive energy-storing means effective upon any movement of said one contact from either of said positions to the other for producing a transient current flow through said second winding in a direction tending to oppose said movement.

5. In combination, an electromagnetic circuit controller comprising co-operating switch contacts, a movable armature operatively connected to move one of said contacts between open and closed circuit positions thereby to control the value of a quantity, an operating winding disposed in attractive relationship to said armature and arranged to be energized in accordance with the value of said quantity, a second winding disposed in inductive relationship to said operating winding, and a capacitor connected in series circuit relation with said second winding across said co-operating contacts, whereby said second winding is momentarily energized by the current through said capacitor upon either engagement or disengagement of said contacts, said energization being such as to oppose any change in the operative relation of said contacts.

6. In combination, an electromagnetic circuit controller comprising a plurality of circuit controlling means arranged to control the value of a quantity, a movable armature connected to actuate said circuit controlling means, an operating winding disposed in attractive relationship to said armature and arranged to be energized in accordance with the value of said quantity, a second winding disposed in inductive relationship to said operating winding, a first capacitor connected to be responsive to the actuation of a first of said circuit controlling means thereby to control a transient flow of current in said second winding opposing said actuation, and a second capacitor connected to be responsive to actuation of a second of said circuit controlling means thereby to control a transient flow of current in said second winding opposing the actuation of said second circuit controlling means.

7. In combination, an electromagnetic circuit controller comprising co-operating switch contacts, a movable armature operatively connected to move one of said contacts between closed and open circuit positions thereby to control the value of a quantity, an operating winding disposed in attractive relationship to said armature and arranged to be energized in accordance with the value of said quantity, a second winding disposed in inductive relationship to said operating winding, and reactive energy-storing means connected in series circuit relation with said second winding across said switch contacts for transiently energizing said second winding upon any movement of said one contact from either of said positions to the other, said energization being such as to oppose said movement, whereby said second winding assists in producing a regulating action of said contacts and serves to prevent arcing upon a disengagement of said contacts.

8. In combination, an electromagnetic circuit controller comprising two pairs of co-operating switch contacts actuable between open and closed positions to control the value of a quantity, a movable armature connected to control the position of both of said pairs of contacts, an operating winding disposed in attractive relationship to said armature and arranged to be energized in accordance with the value of said quantity, a second winding disposed in inductive relationship to said operating winding, a first capacitor connected in series circuit relation with said second winding across one pair of said contacts thereby to control transient energization of said second winding upon actuation of said one pair of contacts, and a second capacitor connected in series circuit relation with said second winding across the other of said pairs of contacts thereby to control transient energization of said second winding upon actuation of said second pair of contacts, the energization of said second winding at all times being such as to oppose the actuation of said contacts, whereby said second winding serves both to improve the vibratory characteristics of said circuit controller and to provide a discharge impedance for said capacitors upon actuation of either of said pairs of contacts to their closed position.

9. In combination, an electromagnetic circuit controller comprising two pairs of co-operating switch contacts having open and closed positions to control the value of a quantity, a movable armature connected to control the positions of both of said pairs of contacts, an operating winding and a second winding disposed in attractive relationship to said armature, said operating winding being connected for energization in accordance with the value of said quantity, a first capacitor connected in series circuit relation with said second winding across one of said pairs of contacts, and a second capacitor connected in series circuit relation with said second winding across the other of said pairs of contacts, whereby the opening or closing of either of said pairs of contacts initiates a change in the charge of the capacitor associated therewith through said second winding, said second winding being so disposed in said series circuit that the current therethrough upon the opening of either of said pairs of contacts acts upon said armature with a force tending to reclose the opened contacts and the current therethrough upon the closing of either of said pairs of contacts acts upon said armature with a force tending to reopen the closed contacts.

10. In a control system, the combination of means for increasing and decreasing the value of a quantity, a control device having a pair of low limit and a pair of high limit switch contacts arranged to control said means, a movable armature arranged to effect opening and closing movements of each of said pairs of contacts, an operating winding for said armature connected to be energized in accordance with the value of said quantity, a second winding arranged to influence the action of said operating winding, and reactive energy-storing means connected across each of said pairs of contacts and effective upon either opening or closing movement thereof transiently to energize said second winding in a manner tending to oppose the movement.

11. In a control system, the combination of means for increasing and decreasing the value of

a quantity, a vibratory control device having a pair of low limit and a pair of high limit switch contacts arranged to control said means, a movable armature connected to actuate said contacts, an operating winding disposed in attractive relationship to said armature and arranged to be energized in accordance with the value of said quantity, a second winding disposed in inductive relationship to said operating winding, a first capacitor connected in series circuit relation with said second winding across said low limit contacts thereby to control a transient flow of current in said second winding upon actuation of said low limit contacts, and a second capacitor connected in series circuit relation with said second winding across said high limit contacts thereby to control a transient flow of current in said second winding to oppose actuation of said high limit contacts, whereby said second winding serves to improve the vibratory characteristics of said control device and to provide a discharge impedance for said capacitors.

12. In a control system, the combination of means for increasing and decreasing the value of a quantity, a control device having a pair of low limit and a pair of high limit switch contacts arranged to control said means, a movable armature connected to actuate said contacts, an operating winding disposed in attractive relationship to said armature and arranged to be energized in accordance with the value of said quantity, a second winding disposed in inductive relationship to said actuating winding, a first capacitor connected in series circuit relation with said second winding across one of said pairs of contacts, and a second capacitor connected in series circuit relation with said second winding across the other of said pairs of contacts, whereby the opening of either of said pairs of contacts initiates a charging current and the closing of either of said pairs of contacts initiates a discharge current through the capacitor respectively associated therewith and through said second winding, said second winding being so disposed in said series circuits that said current through said second winding exerts controlling forces in a direction tending to oppose the opening or closing of said contacts.

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