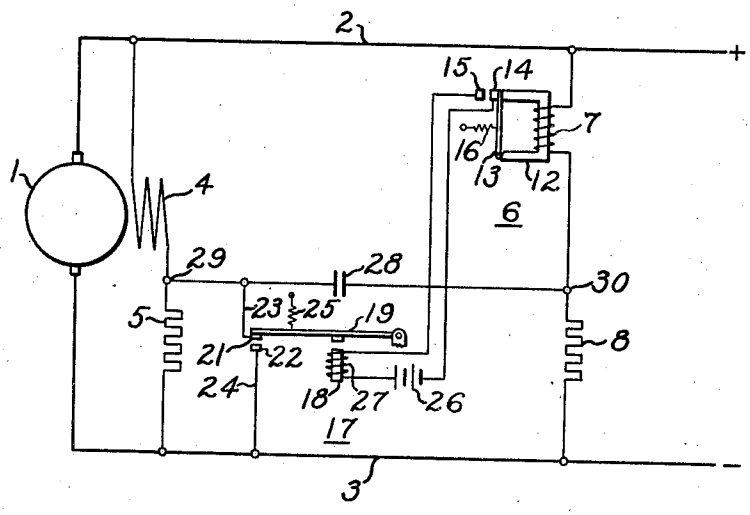
Aug. 23, 1938. J. F. KOVALSKY 2,128,094

VIBRATING TYPE REGULATOR

Filed Nov. 24, 1937



WITNESSES:

James F. Young

Mrs. C. Groome

INVENTOR

Joseph F. Kovalsky.

BY

Ezra W. Savage

ATTORNEY

Patented Aug. 23, 1938 2,128,094

UNITED STATES PATENT OFFICE

2,128,094

VIBRATING TYPE REGULATOR

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

Application November 24, 1937, Serial No. 176,239

6 Claims. (Cl. 171—229)

My invention relates to vibrating regulators, such as are used for governing the excitation of a dynamo-electric machine to maintain an electric quantity, such as voltage, at a predetermined value. In such regulators, a vibrating relay is caused to operate to intermittently short circuit a regulating resistor, or a portion thereof, to vary the resistance in circuit with the field winding of the generator alternately above and below the correct resistance value for maintaining the regulated quantity at the desired value. The effective value of the resistor is determined by the ratio between the intervals of time during which the resistor is short circuited and the intervals of time during which the short circuit is removed.

It is desired to provide such regulators with means for anticipating the corrective action caused by a change in the field excitation of the generator prior to a completion of this action at the terminals of the generator, in order to prevent over-travel in the corrective influence. Such corrective forces or anti-hunting means have in the past been determined in small regulators by the voltage drop across the field resistor which varies as the necessity of different field current value varies, as would be the case when the voltage or load on the generator changes.

It is an object of my invention to provide a generator voltage regulator having anti-hunting means for influencing the primary relay control element to provide the same amount of anti-hunting over the entire load and voltage range to be controlled.

Other objects and advantages of my invention will appear from the following description of one preferred embodiment thereof, reference being had to the accompanying drawing in which the single figure is a diagrammatic view illustrating the same.

Referring to the drawing, a direct-current generator is illustrated having an armature winding 1, connected to supply circuit conductors 2 and 3 and a field winding 4 connected between these conductors in series with a field controlling resistor 5. Means for controlling the field excitation is provided comprising a primary relay 6 having a winding 7, one terminal of which is connected to the supply conductor 2 and the other terminal of which is connected through a control circuit resistor 8 to the supply conductor 3. The primary relay 6 also comprises a core 12 and an armature 13 carrying a movable contact member 14 that is adapted to engage a fixed contact member 15. The armature 13 is biased by a spring 16 to a contact engaging position and upon a predetermined energization of the core 12, sufficient to oppose the pull of the spring 13, the armature is moved to a circuit-interrupting position.

A secondary relay 17 may be provided having a core 18 and an armature 19 carrying a movable contact member 21 that is adapted to engage a fixed contact member 22 to close a circuit through conductors 23 and 24 in shunt relation to the field controlling resistor 5. A spring 25 is provided for biasing the armature 19 to a circuit interrupting position, the armature being moved to a circuit closing position by the magnetizing influence of the core 18 upon engagement of the primary relay contact members 14 and 15 to complete a circuit from the source of energy 26 through the secondary relay winding 27.

An energy storing device, illustrated as a condenser 28, is connected between a junction point 29 in the field winding circuit and a junction point 30 in the primary relay control circuit. The junction point 29 lies between the generator field winding 4 and the field controlling resistor 5, and the junction point 30 is between the primary relay winding 7 and the control circuit resistor 8.

It will be appreciated that the energization of the primary relay core by the winding 7 is a measure of the voltage between the supply conductors 2 and 3. If the voltage between conductors 2 and 3 falls below the desired value, the pull of the spring 16 will be greater than the decreased pull on the relay core caused by energization thereof by the winding 7 and will effect the engagement of the primary relay contact members 14 and 15. This causes operation of the secondary relay 17 to its circuit-closing position to shunt the control resistor 5 from the field winding circuit and apply a voltage thereto corresponding to the voltage between the supply conductors 2 and 3.

The increase in voltage applied to the generator field winding causes the voltage output from the armature winding 1 to increase, thus increasing the voltage between supply conductors 2 and 3 and the energization of the primary relay winding 7, which upon a predetermined value of generator voltage, will move the armature 13 against the bias of the spring 16 to separate the contact members 14 and 15, thus causing the deenergization of the secondary relay 17 to interrupt the circuit through the relay contact members 21 and 22 in shunt relation to the regulating resistor 5 to reintroduce this resistor in series circuit relation with the generator field

winding 4 to again decrease the energization thereof. This intermittent vibratory action continues in a well-known manner to alternately shunt the control resistor 5 from the field winding circuit and reintroduce it into the field winding circuit for short intervals of time, the ratio of time between the exclusion of the resistor 5 from the field winding circuit and the inclusion of the resistor 5 in the circuit determining the effective value of the resistor 5 in controlling the current in the winding 4.

The description of the operation of the regulating system thus far made has neglected the effect of the condenser 28 which is charged to a degree depending upon the voltage impressed across its terminals. If the voltage across the terminals of the condenser 28 is maintained constant for a short interval of time, until the charge on the condenser 28 has adjusted itself to a value corresponding to the terminal potential, no charging or discharging current will flow. If we assume that the conductor 2 is the positive conductor and the conductor 3, the negative conductor, and that for an instant represented by the relay contacts in their illustrated or circuit-opening position, no charging current is flowing to or from the condenser 28, the generator voltage will decrease in the manner above described until the primary relay 6 closes its contacts to cause the secondary relay 17 to connect the junction point 29 to the supply conductor 3 through secondary relay contact members 21 and 22. Upon the closing of the secondary relay contact members the potential between the junction points 29 and 30 is changed by the voltage drop appearing across the resistor 5, thus causing charging current to flow from conductor 2 through the relay winding 7 and the condenser 28 to the supply conductor 3, which charging current starts to flow immediately upon the engagement of the secondary relay contact members 21 and 22 or before an appreciable increase in the generator voltage has had time to result from the increased potential applied to the field winding 4 due to the inherent time lag characteristics of the field winding. This charging current increases the energization of the relay winding 7 to a value sufficient to cause separation of the contact members 14 and 15 prior to the time that this would occur if controlled by the voltage between supply conductors 2 and 3 alone, thus introducing a stabilizing or anti-hunting action into the regulator to limit the amount of over-travel in the voltage between conductors 2 and 3.

The separation of the contact members 14 and 15 causes the separation of the secondary relay contact members 21 and 22, to reintroduce the resistor 5 in circuit with the field winding 4 and, at the same time, to reestablish the potential difference between junction points 29 and 30 which are the terminals of the condenser 28, to their former value, thus causing the charge that has been established on the condenser 28 to dissipate itself by a current flowing in the opposite direction, or from condenser 28 through the relay winding 7 in a direction opposite to the flow of the regulating component of current through that winding between conductors 2 and 3. This causes a decrease in the energization of the winding 7 faster than it would occur were it controlled solely by the decreasing potential between conductors 2 and 3 resulting from the reintroduction of the control resistor 5 in circuit with the field winding 4.

It will thus be seen that the primary relay contact members 14 and 15 and the secondary relay contact members 21 and 22 are brought into engagement and separated from engagement at earlier times in the regulating cycle upon a decrease or increase, respectively, in the voltage of the regulated generator on account of the stabilizing or anti-hunting action of a charging current flowing to the condenser 28 and a discharging current flowing from the condenser 28, as above described. This stabilizing or anti-hunting action is independent of the load on the regulated generator and is the same for all conditions of the circuit within the limits for which the regulator is adjusted.

Many modifications in the arrangement of parts will occur to those skilled in the art within the spirit of my invention 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, a dynamo-electric machine for supplying unidirectional current to circuit supply conductors and provided with a field winding, a field energizing circuit including said field winding and a field controlling resistor connected in series between said supply conductors, a primary relay for intermittently short circuiting said resistor for controlling the effective value thereof, a control circuit including the operating winding of said primary relay and a control circuit resistor, and anti-hunting means comprising a condenser connected from a junction point between the field winding and the regulating resistor and a junction point between the primary relay winding and the control circuit resistor.

2. In a regulator system, a dynamo-electric machine for supplying unidirectional current to supply circuit conductors and provided with a field winding, a field energizing circuit including said field winding connected to one of said conductors and a field regulating resistor between said field winding and the other of said supply conductors, a regulating relay having a winding for intermittently short circuiting said control resistor, a control circuit for connecting said relay winding to the first named of said conductors and including a control circuit resistor between said relay winding and the other of said conductors, and a condenser connected between said field winding and said relay winding.

3. In a regulator system, a dynamo-electric machine for supplying unidirectional current and provided with a field winding, a field energizing circuit including said field winding and a field controlling resistor connected in series between the terminals of said dynamo-electric machine, regulating means including a relay for effecting the intermittent short circuiting of said field controlling resistor, a control circuit including the winding of said relay and a control circuit resistor connected in series between the terminals of said dynamo-electric machine, and energy storing means connected between said field winding and said relay winding that is responsive to a change in the voltage supplied to said field winding for effecting a stabilizing current through the relay winding.

4. In a regulating system, a dynamo-electric machine having a field winding, an energizing circuit for said field winding, means for controlling the energization of said field winding comprising a regulating relay having a winding connected between the terminals of said machine, and anti-hunting means comprising an energy

storing element connected in a loop circuit including said field winding and said relay winding for introducing a component of current into said relay winding upon a change in the voltage applied to said field winding in a direction to stabilize the relay winding current sooner than would be effected by the corrective regulating action alone.

5. In a regulating system, a dynamo-electric machine having a field winding connected in circuit between the terminals thereof, said circuit including a regulating resistor for adjusting the voltage applied to the field winding, a regulating relay for controlling said regulating resistor and having a winding connected in a control circuit between said machine terminals, and energy storing means connected in a loop circuit for causing a stabilizing component of current to flow through said relay winding upon a change in the voltage applied to said field winding.

6. In a regulating system, a dynamo-electric machine having a field winding connected in circuit between the terminals thereof, said circuit including a regulating resistor for adjusting the voltage applied to the field winding, a regulating relay for intermittently short circuiting said regulating resistor having an operating winding connected between the terminals of said machine, a condenser, and means operative upon the short circuiting of said regulating resistor for connecting said condenser in series circuit with said relay winding to effect the flow of charging current to the condenser through the winding.

JOSEPH F. KOVALSKY.