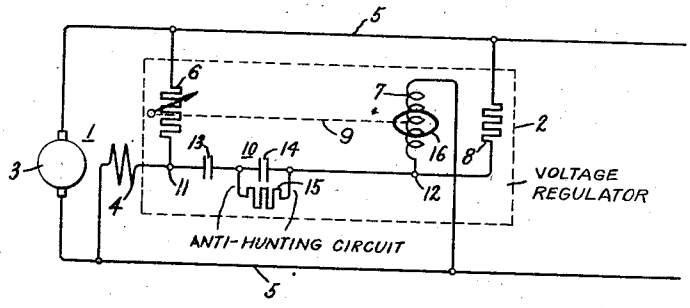
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ANTIHUNTING CIRCUIT

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ANTIHUNTING CIRCUIT

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This invention relates to anti-hunting circuits and more particularly to improvements in such circuits for automatic regulators.

Practically all automatic regulating systems tend to overshoot or hunt because of unavoidable time lags and inertia, either mechanical or electrical or both. These effects prevent the regulator from stopping its regulating action at the exact instant when the regulated quantity is returned to normal and consequently it overshoots and the regulator has to apply counter-correction.

In accordance with the present invention there is provided a very simple, inexpensive and static anti-hunting circuit which is particularly adapted for use with electrical regulators of the direct-acting rheostatic type. Such regulators are suitable for regulating various operating quantities associated with dynamo-electric machines and they usually comprise a variable resistance or rheostatic element whose resistance is controlled by the energization of a primary electroresponsive device, such, for example, as an operating magnet.

An object of the invention is to provide a new and improved anti-hunting circuit.

A further object of the invention is to provide an inexpensive and simple static-anti-hunting circuit for direct-acting rheostatic regulators.

The invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

Referring now to the single figure of the accompanying drawing wherein there has been illustrated diagrammatically an embodiment of the invention, it will be observed that the principal elements of the system are a dynamo-electric machine 1 and a voltage regulator 2. The machine 1 may, for example, be a direct-current shunt-connected generator having an armature 3 and a field winding 4. The armature is connected across an output or load circuit 5.

The voltage regulator comprises a rheostatic element 6, a main or primary control element 7 and a normally fixed resistor 8. The primary control element is an electromagnet whose armature is mechanically attached to the rheostat by means illustrated schematically at 9, the arrangement being such that an increase in energization of the winding 7 will cause an increase in resistance of the rheostatic element 6 and conversely a decrease in energization of the winding 7 will cause a decrease in resistance of the element 6. In most regulators of this type the normal magnetic force or pull of the magnet 7 is counterbalanced by suitable reference means, such, for example, as a spring (not shown). The rheostatic element 6 and the shunt field winding 4 are connected in series with each other across the output circuit 5 and similarly the control element 7 and the normally fixed resistance 8 are connected in series across the output circuit. The resistance 8 has a substantially zero temperature coefficient of resistance and it normally has a resistance which is substantially higher than the resistance of the winding 7 so that most of the circuit voltage is consumed in the drop across the resistance 8 and in this manner the winding need not be wound for high voltage and at the same time the change in its resistance due to changes in temperature will have negligible effect on the current through it. The anti-hunting circuit 10 is connected between the junction point 11 of the shunt field winding 4 and the rheostatic element 6 and the junction 12 of the primary control winding 7 and the resistor 8.

The anti-hunting circuit consists essentially of a capacitor which is divided into two serially-connected parts 13 and 14 with a resistor 15 connected in parallel circuit relation with the capacitor 14.

The series connections between the field winding 4 and the rheostat 6 and between the primary control winding 7 and the resistor 8 are so arranged that the anti-hunting circuit in effect connects the field winding 4 and the control winding 7 in shunt circuit relation and connects the rheostatic element 6 and the resistor 8 in shunt circuit relation.

The operation of the circuit is as follows: During steady state conditions the energization of the winding 7 will be normal and the value of the resistance 6 will be just sufficient to permit the amount of current to flow through the field winding 4 which is necessary to maintain constant voltage on the circuit 5 under the operating conditions of speed, load and temperature which then exist. Any change in one or more of these operating conditions will cause the voltage to depart from normal, thereby producing a proportional change in the energization of the winding 7 whereby the value of the resistance of the rheostatic element 6 is changed in the same direction. For example, an increase in voltage causes an increase in current in the winding 7 which causes an increase in resistance in the element 6, thereby decreasing the current in the field winding 4, and conversely a decrease in voltage on the

circuit 5 will cause the resistance of the rheostat 6 to decrease.

The voltage of the junction 12 stays substantially independent of the operation of the regulator because the relative resistance of the winding 7 and the resistor 8 is not varied as a result of variations in voltage of the circuit 5. However, the winding 4 has a relatively large inductance and therefore it resists changes in current through it so that if the resistance of the device 6 is decreased even slightly there will be a momentary large increase in voltage across the winding 4 because the inductance of this winding in resisting an increase in current therethrough causes it to have a momentary effective resistance or counter-voltage which is substantially equal to that of the main circuit 5. Consequently, the potential of junction 11 rises substantially above the potential of junction 12 whereby a surge of charging current flows through the anti-hunting capacitor and this surge of current will flow through the winding 7 in the same direction as the main current which already exists therein. Consequently, energization of the magnet 7 is strengthened thereby causing it to increase the resistance of the rheostat 6 so as to check the action of the regulator. The strength of the anti-hunting impulse flowing through the capacitor 13—14 will be proportional to the magnitude of the original change in voltage on the circuit.

On the other hand, when the voltage of the circuit 5 increases above normal the action of the regulator in increasing the resistance of the rheostat 6 causes the voltage of the junction 11 to fall momentarily substantially below its normal value. This causes the anti-hunting current surge through the capacitor 13—14 to flow in the opposite direction in an attempt to equalize the voltages of the junctions 11 and 22 and this current surge flows through the winding 7 in the opposite direction to the normal current flow so that it subtracts therefrom and thus decreases the net energization of the winding. Consequently, the regulating action is checked before the system as a whole has a chance to overshoot.

The action of this anti-hunting system is also improved by the addition of a short-circuited coil or turn, such as a single copper ring 16 around the winding 7. It acts to retard or reduce the rate of change of current in the winding 7.

It has been found that if the capacitor 13 has 200 microfarads, the capacitor 14 has 150 microfarads and the resistor 15 has 25 ohms, the regulating system with which my invention has been tested is practically dead-beat and its hunting is reduced to a minimum.

While there has been shown and described a particular embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications can be made therein without departing from the invention and, therefore, it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

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

1. In combination, a circuit whose voltage is to be maintained constant, an automatic voltage regulator comprising a rheostatic element, a primary control electromagnet which is provided with a short-circuited turn and a resistor, means including a winding for varying said voltage, said rheostatic element and said winding being connected in series across said circuit, an anti-hunting capacitor, means for effectively connecting said primary control electromagnet across said winding through said capacitor, and means for effectively connecting said resistor across said rheostatic element through said capacitor.

2. In combination, a circuit whose voltage is to be maintained constant, an automatic voltage regulator comprising a rheostatic element, a primary control element and a resistor, means including a winding for varying said voltage, said rheostatic element and said winding being connected in series across said circuit, an anti-hunting capacitor, a second resistor connected in shunt circuit relation with said capacitor, means for effectively connecting said primary control element across said winding through said capacitor, and means for effectively connecting the first-mentioned resistor across said rheostatic element through said capacitor.

3. In combination, a circuit whose voltage is to be maintained constant, an automatic voltage regulator comprising a rheostatic element, a primary control element and a resistor, means including a winding for varying said voltage, said rheostatic element and said winding being connected in series across said circuit, an anti-hunting unit comprising a pair of serially connected capacitors and a second resistor connected in parallel with one of the capacitors, means for effectively connecting said primary control element across said winding through said anti-hunting unit, and means for effectively connecting the first-mentioned resistor across said rheostatic element through said anti-hunting unit.

4. In combination, a direct-current generator having a shunt field winding, a direct-acting rheostatic voltage regulator for said generator, said regulator having a rheostatic element connected in series with the shunt field winding of said generator, said regulator having a main control element and a normally fixed resistor connected in series across said generator, and an anti-hunting unit comprising a parallel-connected capacitor and a second resistor connected between the junction of said field winding and said rheostatic element on the one hand and the junction of said control element and the first-mentioned resistor on the other hand, said connections being such that the voltage of the capacitor is equal to any difference in voltage between said shunt field winding and said main control element.

5. In combination, a direct-current generator having a shunt field winding, a direct-acting rheostatic voltage regulator for said generator, said regulator having a rheostatic element connected in series with the shunt field winding of said generator, said regulator having a main control element and a normally fixed resistor connected in series across said generator, and an anti-hunting unit comprising a pair of serially-connected capacitors with a second resistor connected in parallel with one of said capacitors, said anti-hunting unit being connected between the junction of said field winding and said rheostatic element on the one hand and the junction of said control element and the first-mentioned resistor on the other hand, said connections being such that the voltage of the anti-hunting unit is equal to any difference in voltage between said shunt field winding and said main control element.

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