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LIMITING DEVICE FOR ELECTRIC REGULATORS

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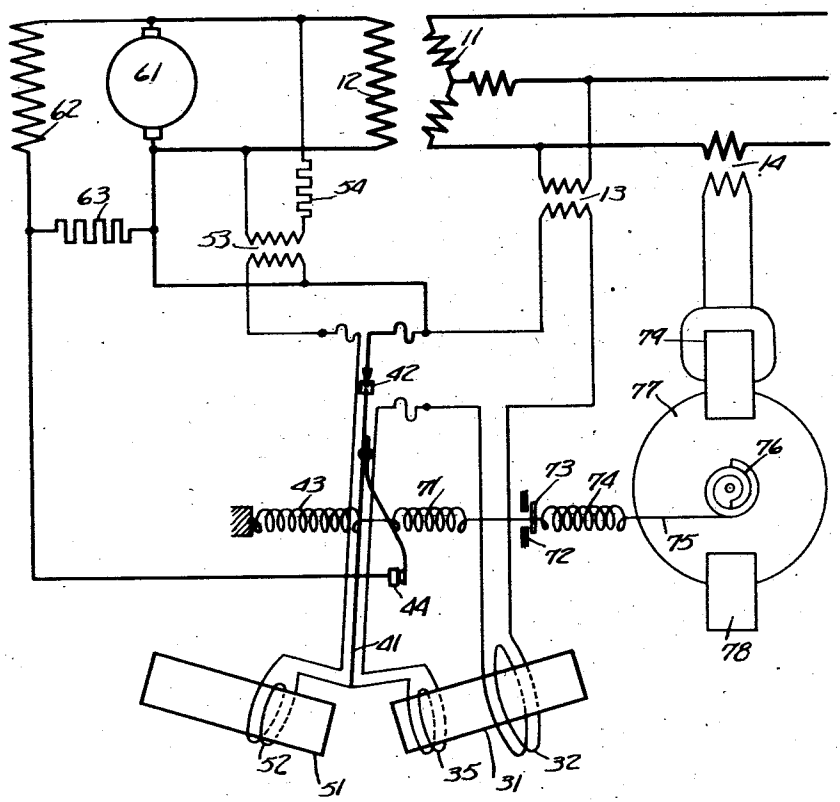

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LIMITING DEVICE FOR ELECTRIC REGULATORS.

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In automatically operating regulators which are intended to keep a certain quantity constant, it happens sometimes, that exceptional circumstances necessitate the withdrawal of such condition in order to maintain another, viz, that some other quantity, more or less dependent on the former, shall not exceed reasonable limits. For instance, in the case of automatic voltage regulators for dynamo-electric machinery, it is not desirable that the voltage shall be kept constant even on the occasion of a short-circuit, but in this case it should rather be lowered sufficiently to limit the current to a moderate value. A regulator operating to keep the current constant, for instance for arc welding, should on the other hand limit the voltage, if the resistance should rise considerably over the normal value, etc.

Earlier devices for the aforesaid purpose have generally been so arranged, that a member, responsive to the value of the quantity to be limited to a certain value, normally has been inactive, but suddenly has been active, as soon as the critical value has been exceeded, and then once for all has been thrown over to another position in which it alone takes charge of the regulation. According to my present invention, on the contrary, the arrangement is such that the member responsive to the value of the quantity to be limited has more than two positions of equilibrium. In all these positions except the original one, the member actuates the regulator in cooperation with the member which is responsive to the value of the quantity which shall normally be kept constant. In this way, the transition from the one mode of regulation to the other is made more smoothly than with the means earlier employed, whereby a dangerous "hunting" of the mechanism and of the machines is avoided.

A form of the invention is diagrammatically illustrated in the accompanying drawing.

Referring to the drawing, a three-phase generator having an armature winding 11 and an exciting winding 12 is fed from a direct current machine having armature 61 and exciting winding 62. A resistor 63 in series with the latter is intermittently short-circuited by the contacts 44 of a regulator having an oscillating member 41. Member 41 is actuated by fluctuations in the voltage across the exciting winding 12 in such a manner that the constant portion of the voltage across said winding is "filtered away". This may be done in different ways, but the preferred embodiment is shown in the drawing, wherein a transformer 53 is employed, the primary of which is connected to the terminals of the winding 12 over an ohmic resistor 54, while the secondary is connected to the vibrating coil 52, which is acted upon by a unidirectional magnetic field, for instance, from a permanent magnet 51. The voltage of the machine is raised and lowered cyclically by the intermittent opening and closing of the contacts 44, and the variations of the voltage are communicated through the transformer 53 to the coil 52, with the result that the member 41 is oscillated in resonance with the electrical impulses. The movements of member 41 are also influenced by a pair of coils 35, 32, which have a core 31 and are fed from a voltage transformer 13, with a unidirectional force which varies with the voltage of the three-phase generator. Coils 52 and 35 are carried by the member 41, but are of light weight, so that their inertia does not prevent the member 41 from swinging at a frequency comparable with that of a Tirrill regulator (5 to 10 cycles per second).

The force of coils 35 and 32 is exerted to move member 41 to break the contact at 44, and this force is ordinarily counterbalanced only by the tension of the spring 43 which is so dimensioned, that equilibrium prevails at normal voltage on the generator 11, 12, the member 41 then only oscillating in its knife-edge bearing 42 under the influence of the variable force in the coil 52.

To the member 41 is, however, connected also a spring 71, which under normal circumstances is only under little tension, and which counteracts the spring 43, so that strictly speaking only the difference between the tensions of these two springs counteracts the force between the coils 32, 35. The other end of the said spring is connected to a piece 73 normally bearing against a fixed stop 72. A spring 74 will however under certain circumstances pull the piece 73 away from the stop 72 and stretch the spring 71. These circumstances arise when

the quantity to be limited to a certain value—in the example shown the current from the generator 11, 12—reaches or slightly exceeds the said value. The said current, through the intermediary of a current transformer 14, actuates a relay, shown as an induction relay with induction disc 77, driving electromagnet 79 and braking magnet 78. The disc 77 is provided with a spirally shaped winding core for a string or the like 75 connected to the spring 74. The arrangement is preferably such that for all tensions of the spring 74 up to a certain limit the disc 77 is actuated by substantially the same torque from the spring, thus it is in neutral equilibrium anywhere between two limiting positions. It may, however, have only one or several intermediate equilibrium positions between the said limits.

For lower values of the current than the critical one, the string 75 bears upon a cylindrical portion of the core 76 and is gradually stretched, as the current rises. The piece 73 still rests against the stop 72. The operation under these conditions is substantially that described in U. S. application Serial No. 103,695, filed by myself and another, the essential thing being that the member 41 will swing freely only as long as there is equilibrium between the force acting on the coil 35 and the difference between mean tensions of the springs 43 and 71. When the current reaches the critical value, the string 75 passes over on the spiral portion of the core 76 and at the same time the piece 73 leaves the stop 72 and stretches the spring 71. The force which balances that acting on the coil 35 will then be the combined tension of the springs 43, 71 and 74. By reason of the spiral shape of the core 76, the force exerted by the current may now equilibrate different tensions of these springs. There may thus be different forces acting on the coil 35 (corresponding to different voltages of the generator 11, 12), and the regulator may still swing in equilibrium. Thus the current is always limited to the critical value, independent of the voltage required to maintain it, (which depends on the impedance of the circuit and thus cannot be foreseen). The passing over from one state of regulation to the other goes very smoothly.

If in three-phase or other polyphase systems the current relay should be responsive to the current in several phases, there may be arranged either several induction or corresponding members acting for instance each on one pair of springs 71, 74, or several driving magnets acting on a common induction disc or member. The manner of operation will be slightly different for these different modifications, and one may be preferred in some cases, one in others. Several induction members may also be arranged on the same shaft.

I claim as my invention:

1. In electric regulators, a movable member carrying contacts, electromagnetic means actuating said member, other electromagnetic means resiliently connected to said movable member, a stop normally preventing the action of said other means on said movable member, and equalizing means associated with said connection and permitting said other electromagnetic means to be in equilibrium in several positions.

2. In electric regulators, a normally swinging member carrying contacts, electromagnetic means actuating said member, other electromagnetic means resiliently connected to said movable member, a stop normally preventing the action of said other means on said movable member, and equalizing means associated with said connection and permitting said other electromagnetic means to be in equilibrium in several positions.

3. A control system for an electric machine comprising a control member responsive to a characteristic of the machine, a second control member, means for causing said second control member to be responsive to another characteristic of the machine, and a connection between said control members, said connection being so constructed and arranged that movement of the second control member within a predetermined range has no effect on the first mentioned control member.

4. A control system for an electric machine comprising a control member responsive to a characteristic of the machine, a second control member, means for causing the second control member to be responsive to another characteristic of the machine, a yielding connection between said control members, and a stop member normally engaging said connection to prevent movement of said second control member within a predetermined range from affecting the movement of said first mentioned control member.

5. A control system for an electric machine comprising a control member responsive to a characteristic of the machine, a second control member, means for causing the second control member to be responsive to another characteristic of the machine, a yielding connection between said control members, a stop member normally engaging said connection to prevent movement of said second control member within a predetermined range from affecting the movement of said first mentioned control member, and equalizing means associated with said connection and with said second control member to permit said second control member to remain in neutral equilibrium over a predetermined range of movement.

In testimony whereof I have signed my name to this specification.

ARLE YTTERBERG.