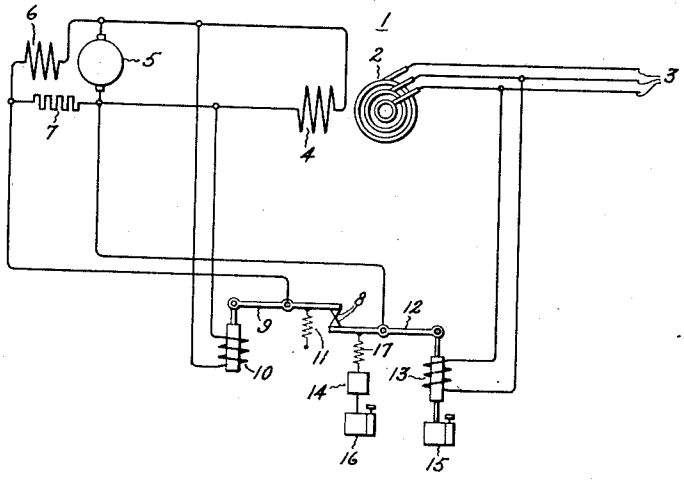
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ELECTRICAL REGULATOR

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# UNITED STATES PATENT OFFICE

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## ELECTRICAL REGULATOR

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My invention relates to electrical regulators and particularly to electrical regulators of the vibratory contact type.

In most electrical regulators, having a main control element whose movement initiates the regulating change, there is a tendency to over regulate. This is due to the fact that the regulating change almost always takes place slower than the speed at which the control element moves because of the relatively large inductance of dynamo-electric machine field windings. It is therefore customary to provide the movable main control means with damping means, such as a dash pot, so as to check the tendency toward hunting. However, when the regulated machine is a large one, so that its field has a high inductance, this damping means must be so strong that it materially decreases the speed of operation of the regulator.

In order to overcome this difficulty it has, heretofore, been proposed to connect the control element to the damping means through a resilient connection, such as a spring. This is a satisfactory solution for regulators other than those of the vibratory contact type. In the latter type there is a tendency for the main control contact, and consequently for its associated elements, to vibrate. This is due to the varying contact pressure on this contact which is produced by the vibratory anti-hunting contact. Under these circumstances a vibratory contact regulator will not operate at its best.

In accordance with my invention I provide the main control assembly of a vibratory contact regulator with two damping elements, one of which is weak and which is rigidly connected to the assembly while the other is strong and is resiliently connected to the assembly. In this manner the weak damping element prevents vibration due to the periodically varying contact pressure while the resiliently connected strong damping arrangement permits a quick and temporary over regulation of the regulator, even for small changes in the regulated quantity, while preventing a hunting action.

An object of my invention is to provide an improvement in regulators and especially in quick acting regulators of the vibratory contact type.

Another object of my invention is to provide a new and improved damping arrangement for the main control assembly of a vibratory contact regulator.

My 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 I have shown a preferred embodiment of my invention as applied to a vibratory contact electrical regulator of the Tirrill type, 1 is a regulated dynamo electric machine comprising an armature 2, connected to an electric circuit 3, and a field winding 4. Machine 1 may be of any type and is illustrated as a three phase synchronous generator. Field winding 4 is connected across the armature 5 of an exciter whose shunt field winding 6 contains a series regulating resistance 7. The terminals of regulating resistance 7 are connected to the contacts 8 of a regulator of the Tirrill type, which differs from the conventional regulator of this type only in the damping means for the main control assembly.

The regulator has the usual anti-hunting assembly comprising pivotally mounted anti-hunting lever 9, anti-hunting coil 10 which is connected across the field winding 4 of the regulated machine and spring 11 for opposing the pull of anti-hunting coil 10. The main control assembly of the regulator includes the usual pivotally mounted main control lever 12, main control coil 13 and counterweight 14. The novel damping means for this latter assembly comprises a relatively weak adjustable damping element 15, which is preferably a dash pot, connected substantially rigidly to this assembly and a relatively strong adjustable damping means 16, which is also preferably a dash pot, connected to the main control assembly through a resilient connection, such as a spring 17.

The operation of the arrangement illustrated in the drawing is as follows. Ignoring for the time being the function and opera-

tion of the special damping means for the main control assembly, the operation of the ordinary Tirrill type regulator, which is well understood by those skilled in the art, is briefly as follows: Assume that machine 1 is supplying energy at normal voltage to circuit 3, that exciter 5 is operating at rated speed and that the main control assembly is stationary. Under these circumstances the anti-hunting assembly will be vibrating rapidly due to the following action. With the contacts 8 separated all of resistance 7 will be in the shunt field circuit of the exciter. Consequently the excitation of the exciter will be low and as a result its voltage will fall. As soon as the voltage of the exciter falls the energization of the anti-hunting magnet 10 decreases with the result that spring 11 overpowers the pull of magnet 10 and causes contacts 8 to engage. As soon as these contacts engage, resistance 7 is short circuited with the result that the field current of the exciter 6 increases and consequently its voltage increases until anti-hunting magnet 10 overpowers spring 11 and again separates the contacts 8. The above-described action is extremely rapid and results in holding an average exciter voltage which, due to the large inductance of field winding 4, results in a constant voltage being generated by machine 1.

If now the main control contact should move upwardly because of a decrease in the excitation of main control coil 13, through a fall in voltage on circuit 3 for example, the ratio of time open to time closed of contacts 8 will decrease with the result that the average excitation of the exciter increases and consequently the voltage of machine 1 will increase. Likewise if the voltage on circuit 3 rises the energization of coil 13 increases and the main control contact will move away from the anti-hunting contact thereby increasing the ratio of time open to time closed of these contacts with the result that the average excitation of the exciter and consequently of machine 1 will decrease until the voltage returns to normal. It should be noted that although I have shown the regulator as a voltage regulator, in that main control coil 13 is connected to be responsive to the voltage of the circuit 3, the regulator may equally well control any one of the other electrical conditions of circuit 3 without departing from my invention in its broader aspects.

The operation of the damping elements for the main control assembly of the regulator is as follows: For best operation of the regulator during normal voltage conditions the main control assembly should be stationary. Therefore, the rigidly connected damping means 15 is adjusted so as to just prevent the movement of this assembly which would otherwise be caused by the intermittent engagement of contacts 8 due to the vibratory action of the anti-hunting assembly. In practice this adjustment is so weak as to not appreciably interfere with the speed of action of the main control assembly due to small changes in voltage on circuit 3. Due to the comparatively large inductance of the field winding circuits of the exciter and main regulated machine the regulator acts more rapidly than changes can take place in the condition to be regulated. This in itself is beneficial in that the temporary over-regulation increases the speed of action of the regulator. However, due to the inertia of the main control assembly itself this tendency to over-regulate, unless damped out, produces an objectionable periodic voltage fluctuation. However, by the addition of damping means 16 and resilient connections 17 the benefits of a temporary and rapid over-regulation are retained while at the same time a periodic swinging back and forth of the main control assembly is quickly damped out by the dash pot 16. Thus if a temporary or transient voltage fluctuation occurs on circuit 3 the main control assembly may respond quickly due to the resiliency of connection 17 and then return to its original position without disturbing damping means 16. On the other hand, if the conditions causing the change in voltage on circuit 3 are permanent necessitating new adjustments or positions of the main control assembly the resilient connection 17 allows a certain over-regulation which increases the speed of action of the regulator while the damping means 16 gradually follows the change in position of the main control assembly and checks any tendency for this assembly to oscillate.

Although I have shown my invention as applied to an electrical regulator it will at once occur to those skilled in the art that my invention is not so limited and that it is equally applicable to any regulator having a main control assembly and a vibration producing anti-hunting assembly without departing from my invention in its broader aspects.

While I have shown and described a particular embodiment of my invention it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention and I, therefore, aim in the appended claims to cover all such changes and 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. In a vibratory contact regulator, a vibratory contact, a main control assembly having a non-vibratory contact cooperating with said vibratory contact, a damping element rigidly connected to said assembly, a second damping element resiliently connected to said assembly, said first damping element being weak with respect to said second damping element.

2. The combination with a vibratory contact regulator, a vibratory contact, a main control assembly having a non-vibratory contact cooperating with said vibratory contact, a damping element rigidly connected to said assembly, a second damping element, means comprising a resilient element and a weight for tensioning said element connecting said second damping means to said main control assembly, said second damping element being strong with respect to said first mentioned damping element.

3. The combination with the main control-assembly of a vibratory contact electrical regulator, of damping means for just preventing movement of said assembly due to variable contact pressure during normal operation, a second damping means for preventing hunting of the assembly as the result of a regulating change, and a resilient connection between said second damping means and said assembly for permitting quick action of said assembly.

4. In combination, an electric circuit, a dynamo electric machine connected to said circuit, a vibratory contact regulator connected to said machine, a main control assembly for said regulator, a dash pot rigidly connected to said assembly, said dash pot being adjusted so as to just prevent motion of said assembly due to the normal variations in contact pressure, a second dash pot, a spring connection between said second dash pot and said assembly, the damping strength of said second dash pot being stronger than that of the first dash pot.

In witness whereof, I have hereunto set my hand this 22 day of December, 1930.

KARL H. MAY.