

June 27, 1933.

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1,916,072

AUTOMATIC ELECTRICAL REGULATING ARRANGEMENT

Filed May 11, 1932

Fig. 1.

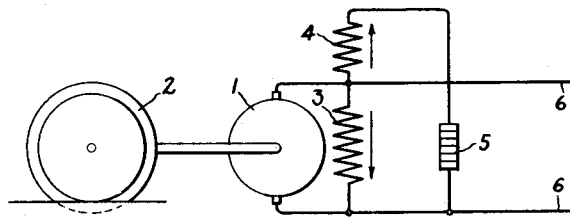
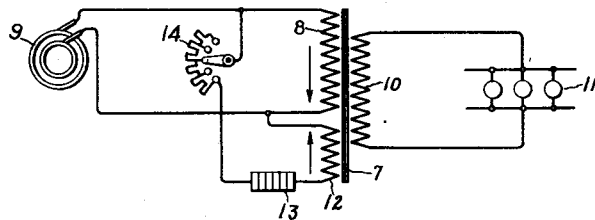


Fig. 2.



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AUTOMATIC ELECTRICAL REGULATING ARRANGEMENT

Application filed May 11, 1932. Serial No. 610,735.

My invention relates broadly to automatic electrical regulating arrangements and more particularly to automatic voltage regulating arrangements which depend for their operation upon negative impedance-current characteristic impedance elements.

The expression "negative impedance-current characteristic" is used here as a short way of designating broadly any impedance which decreases in value with increases in the voltage across it, or the current through it, or both.

Perhaps the most common type of negative impedance-current characteristic impedance is a resistance having a relatively high temperature coefficient of resistance. Materials like boron, and some forms of carbon, have relatively high negative temperature coefficients of resistance, so that, under ordinary conditions, their resistance decreases with increases of current therethrough.

Such materials, however, are relatively sluggish in action as they depend upon a change in temperature. They are also affected by changes in the ambient, or surrounding temperature. As a consequence of these properties these materials are not ideal elements of automatic regulating systems, or circuits, where it is usually desirable that the action be rapid and independent of any condition except the regulating condition.

I have found that a relatively new type of negative impedance-current characteristic element is very well adapted for use in regulating circuits. This is the synthetic resistance material which is described and claimed in Patent No. 1,822,742, granted September 8, 1931, on an application of K. B. McEachron, and assigned to the assignee of the present application. This material has the property of reducing its electrical resistance substantially instantaneously with increases in applied voltage, or increases in current therethrough. Its change in resistance with changes in temperature is relatively insignificant.

Broadly speaking, my invention relates to automatic voltage regulation by means of a main winding and a parallel connected bucking winding, whose net ampere turns control the voltage to be regulated. Automatic con-

trol is secured by a substantially instantaneously acting negative impedance-current characteristic element connected in series with the bucking winding.

An object of my invention is to provide an improved voltage regulating arrangement.

A further object of my invention is to provide a simple, quick acting static type voltage regulating arrangement.

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.

In the drawing, Fig. 1 illustrates an embodiment of my invention as applied to regulating the voltage of a variable speed direct current generator, while Fig. 2 illustrates another embodiment of my invention for regulating the output voltage of a transformer which is connected to a variable voltage source of current supply.

In Fig. 1 of the drawing I have illustrated, by way of example, a direct current generator 1, which is connected to be operated at variable speed by any suitable means, such for example, as by a railway car wheel 2. Generator 1 is provided with a main shunt field winding 3, and a differential shunt field winding 4, connected in series with an instantaneously acting negative impedance-current characteristic resistance 5 of the type which is the subject matter of the above referred to McEachron patent. A load circuit 6 is connected to generator 1.

The operation of the arrangement illustrated in Fig. 1 is as follows: Changes in speed of the car wheel 2 cause the generator to produce corresponding changes in voltage. Assume for example that the speed increases and that consequently the voltage increases. The voltage across the circuit including differential winding 4 and special resistance 5 will therefore increase, thereby decreasing the resistance value of resistance device 5 with the result that the current through the bucking, or differential winding 4 increases. This has the effect of opposing the increase in ampere turns of the field winding 3 due to the increase in terminal voltage of the gen-

erator 1. Resistance device 5 has a substantially hyperbolic impedance-current characteristic with the result that its resistance may be made to decrease extremely rapidly with increases in applied voltage. Thus, with increases in speed of generator 1 the increase in current through the coil 4 may be made so large as actually to cause a decrease in the net ampere turns of the two coils 3 and 4, taken together, with the result that the voltage of generator 1 may be maintained substantially constant over a considerable speed range.

When the speed of generator 1 is again reduced the voltage will drop and the resistance of the element 5 will increase, thereby restoring conditions to their normal relation.

In Fig. 2 I have shown a transformer core 7 having a primary winding 8 connected to a variable voltage source of supply, such as a single phase alternating current generator 9, and a secondary winding 10 connected to supply any suitable load, such for example, as incandescent lamps 11. Transformer core 7 is provided with an auxiliary bucking winding 12 which is connected in circuit with a negative volt-ampere characteristic resistance, or impedance 13, across the primary winding 8. Impedance 13 is preferably made of the resistance material which is described and claimed in the above referred to McEachron patent. An adjustable rheostat 14 is connected in circuit with bucking winding 12 and element 13 for the purpose of adjusting the current therethrough.

The operation of the arrangement shown in Fig. 2 may be described as follows: With a given voltage produced by source 9, the two windings 8 and 12 will produce a resultant flux in the transformer core which will induce a given voltage in the secondary winding 10. Assume, now, that the voltage of source 9 increases. This will cause an increased current to flow in the negative impedance-current element 13, thereby causing this device to reduce its impedance. This causes a disproportionate increase in current through bucking winding 12 which, in effect, increases the magnetic reluctance of the magnetic circuit of the transformer with respect to the

primary winding 8. This in turn increases the ratio of the leakage flux of the primary winding to the core flux which threads the secondary winding. By proper proportioning of the various elements the increase in leakage flux may be made substantially equal to the increase in flux produced by winding 8 alone, when the supply voltage increases, so that substantially constant core flux is maintained.

In connection with Fig. 2 it should be noted that my invention is not necessarily limited to maintaining constant the output voltage of a transformer to which a variable input voltage is applied but that it is applicable to any case where a constant core flux is desired but where the supply voltage, for the exciting winding for the core, is variable.

While I have described what I at present consider preferred embodiments of my invention, it will be obvious to those skilled in the art that various 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 combination, a transformer having a pair of windings, a bucking winding connected in parallel with one of said windings, and a resistance element whose electrical resistance decreases substantially instantaneously with increases in current therethrough connected in series with said bucking winding.

2. In combination, a transformer having a primary winding and a secondary winding, a bucking winding connected in parallel with said primary winding, and a resistance element whose electrical resistance decreases substantially instantaneously with increases in applied voltage, in a manner which is substantially independent of temperature, connected in series with said bucking winding.

In witness whereof, I have hereto set my hand.

WILLIAM K. RANKIN.