May 24, 1932. H. K. KOUYOUMJIAN 1,860,102

ELECTRIC CONTROLLING APPARATUS

Filed Sept. 6, 1930

Fig. 1.

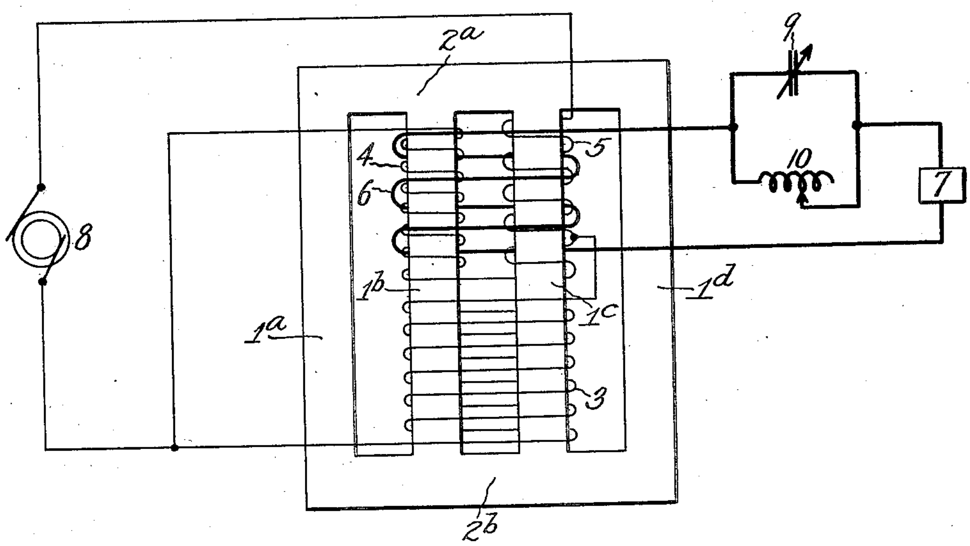
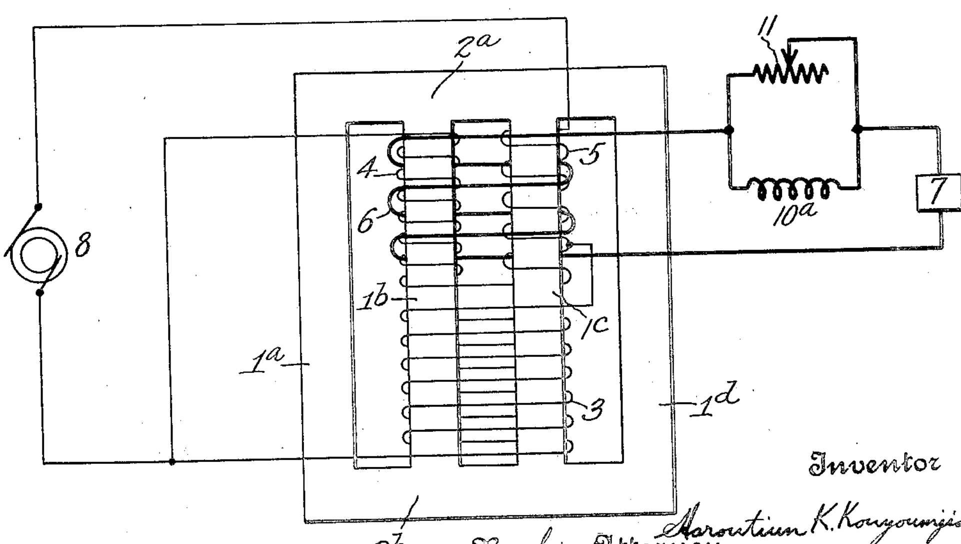


Fig. 2.



Inventor

Haroutiun K. Kouyoumjian

By his Attorney

Lawrence K. Sager

Patented May 24, 1932 1,860,102

UNITED STATES PATENT OFFICE

HAROUTIUN K. KOUYOUMJIAN, OF PROVIDENCE, RHODE ISLAND, ASSIGNOR TO WARD LEONARD ELECTRIC COMPANY, A CORPORATION OF NEW YORK

ELECTRIC CONTROLLING APPARATUS

Application filed September 6, 1930. Serial No. 480,086.

This invention relates particularly to alternating current voltage regulators and transformers wherein the output voltage is maintained approximately constant, or controlled as desired, regardless of variations of voltage in the supply line.

The present invention is an improvement over the inventions disclosed in my prior pending applications, Serial Number 306,259, filed September 15, 1928, and Serial Number 344,333, filed March 5, 1929.

In many cases of use of my improved controlling apparatus, the load remains substantially constant throughout its use; sometimes the load is variable, in which case special forms of construction are desirable, as disclosed for example, in my pending application Serial Number 404,537, filed November 4, 1929. But there are many applications of my improved controller, or transformer, where the load is constant for comparatively long periods of use and where it is desirable, however, to provide means for changing the relationship of the inter-actions, so that when the load is changed and it is desired to continue the operation with a different load, or different character of load, adjustments may be made to compensate for such change in load. After such adjustment, the controller, or transformer, will then operate to maintain the output voltage approximately constant regardless of changes in the supply voltage, or as long as the character or amount of the load continues the same.

The main object of the present invention is to provide improved apparatus whereby a change in the character of the load or amount thereof, insofar as it affects the action of the controller, may be counteracted so that under the new load conditions, the controller will function to control the output voltage as desired, regardless of variations in the supply voltage, or in the frequency thereof. A further object is to obtain these results by a simple and inexpensive form of construction, which will also be durable and dependable. Other objects and advantages of this invention will be understood by those skilled in the art and by the following description and accompanying drawings.

Fig. 1 is a diagram showing one embodiment of the invention; and Fig. 2 is a similar diagram illustrating a modification.

Referring to Fig. 1, the laminated iron, or steel, core is shown as having four legs 1*a*, 1*b*, 1*c* and 1*d*. The legs are joined together at their upper and lower ends by cross-pieces 2*a* and 2*b*. Ordinarily, the cross-sections of the different parts of the core will be about the same, although in some cases, for particular purposes, the cross-sections of the different parts may be modified relatively to each other. It will also be understood that instead of the core being made of the form indicated in the drawings, it may have various other conformations such, for example, as those disclosed in my said prior applications. The inner legs of the core carry a number of windings indicated diagrammatically, but it will be understood that the number of turns of the different windings will be made such as the particular conditions require, and that the location of the windings may be modified from that indicated, and that some of the windings instead of being superimposed with reference to each other, may be located side by side, or may be more or less distributed or sandwiched with each other to meet particular requirements.

The main, or primary, exciting winding 3 is shown as enveloping the lower end portions of the two inner legs. Another exciting winding 4 is shown enveloping the upper portion of the leg 1*b* and is cumulatively acting with reference to the winding 3 as regards the flux tending to be set up in the leg 1*b*. Another exciting winding 5 is shown located on the upper portion of the leg 1*c* and is so wound and connected as to act in opposition to the winding 3, as regards magnetic flux tending to be set up in the leg 1*c*. A secondary, or output, winding 6 is shown enveloping the upper portion of the legs 1*b* and 1*c*, and also enveloping the windings 4 and 5. The winding 6 is shown as supplying a translating device 7 which may be of any form or character.

The alternating current source of energy 8 supplies current to the windings described, the windings 4 and 5 being connected in series with each other across the supply lines, and the primary winding 3 being shown connected in parallel with the winding 4 and in series with the winding 5 across the supply lines or, more strictly stated, in series with a portion of the winding 5. The particular point in the winding 5 to which one terminal of the winding 3 is connected may be varied in order to obtain the desired results. In some cases, the primary winding may be connected in series with all of the bucking winding 5, or it may be connected in series with it and in series with more or less of the cumulative winding 4. In some cases, the primary winding may be connected directly across the line, and in parallel with the other two windings which may be in series with each other, or in some cases in parallel with each other.

In series with the secondary or load circuit, there is connected adjustable means for controlling its power factor, such as the condenser 9 and the inductive device 10. These devices are indicated as being adjustable and are shown connected in parallel with each other in the load circuit, but it will be understood that, according to the character of the load changes and to its amount, these devices may be of any suitable form or character and connected as desired to give the required range of adjustment for the particular conditions to be dealt with. In some cases, it may be necessary to use an inductive device only, or a capacitive device only.

Fig. 2 is a reproduction of Fig. 1, except that the controlling means in the secondary circuit is a fixed inductive device 10*a* in shunt with an adjustable resistance 11. This gives a desirable form of adjustable means from a practical viewpoint and will, ordinarily, meet the usual requirements.

The cross-section of the leg 1*b* and number of ampere turns of the windings enveloping this leg are such that under normal conditions, this portion of the core is worked near, or just below, the knee of the saturation curve, although in some cases, for particular requirements, this core may be normally worked at a different part of the saturation curve. The cross-section of the leg 1*c* and the net ampere turns of the windings enveloping this leg are such that it is normally worked on the so-called straight part of the saturation curve below the knee of the curve, although for particular purposes, the normal condition of this leg of the core may be such as to be normally worked at a higher or lower portion of the straight part of the saturation curve, according to the results desired.

Assuming that the load remains fixed, and that the windings and core have been made to give the particular results desired as to ratio of transformation, capacity and the like, the operation in a general way may be understood by first assuming that the supply voltage falls below normal. The decreased amount of excitation of the leg 1*b*, whether it be small or comparatively large in amount, will be offset by a corresponding increase in the amount of flux in the leg 1*c*, owing to the fact that the bucking winding 5 becomes less effective in its opposition and, as this leg is operating on the straight part of the saturation curve, there will be a resulting increase in the flux in this leg. It will be appreciated furthermore, that the bucking winding is in series with the cumulatively acting winding, and that upon change of voltage, owing to the fact that the leg enclosed by the cumulative winding is near saturation, a larger proportionate change in the value of the current takes place in the cumulative and bucking windings than in the main winding. Thus, upon decrease of supply voltage, there is a proportionately greater decrease in value of the current in the bucking winding than in the main winding. Thus the change in flux to which the output winding 6 is subjected, is not materially changed with a decrease in the supply voltage and permits the output voltage to remain substantially unchanged. Similarly, when the supply voltage increases, the increase in resultant flux in the leg 1*b* is offset by a corresponding decrease in the flux in the leg 1*c*, because the bucking winding then exerts increased bucking action. This results in the flux to which the output winding 6 is subjected remaining approximately the same and in not materially affecting the output voltage.

If, however, the amount of the load, or character of the load, be changed, the relationship and magnitude of the flux set up, or tending to be set up, by the output, or secondary, winding is modified and, unless compensated for by other means, or unless controlled, will have such effect upon the resultant flux, that the output voltage will not be maintained at the required value.

An increase in load does, of course, cause the flux tending to be set up by the secondary winding to be increased and it obviously follows that if the relationships were such as to give a constant voltage output before the change in load, such a change would result in decreasing the output voltage, because the magneto-motive force of the secondary current is in opposition to that of the primary to a greater or lesser extent. If, however, means are provided for controlling the power factor of the secondary circuit, upon change in load, in such a manner that the component of the magneto-motive force of the secondary which is in opposition to that of the primary, be caused to have the proper value, then the apparatus will continue to maintain the output voltage at the required amount under the new load conditions.

The change in power factor is accomplished by adjustment of one or both of the devices 9 and 10 in Fig. 1, or by adjustment of the resistance 11 in Fig. 2. When the load is changed to a smaller value, adjustments are made to decrease the power factor of the secondary circuit, and when the load is increased, the power factor of the secondary circuit is caused to increase; and these adjustments are made in such amounts that the required relationships are maintained for obtaining a constant voltage output. In other words, when the load is changed, the power factor of the secondary circuit is correspondingly adjusted, as regards the amount of change in load, or character of change in load, so that the effect of the flux tending to be set up by action of the secondary current in opposition to the main flux will be caused to have such value as may be necessary to compensate for the change in load.

My invention may be embodied in various forms of construction and in various relationship of parts without departing from the scope thereof.

I claim:

1. Alternating current controlling apparatus comprising a core, an alternating current exciting winding on a portion of said core, a second alternating current exciting winding on another portion of said core acting in opposition to said first-named winding, an output circuit subjected to the resultant flux of said core, and means for adjusting the power factor of said output circuit to compensate for changes in the load.

2. Alternating current controlling apparatus comprising a core, an alternating current exciting winding on a portion of said core, a second alternating current exciting winding on another portion of said core acting in opposition to a portion of the main flux of said first-named winding, an output winding subjected to the combined magnetic effects of said windings, and means for adjusting the power factor of the circuit of said output winding to compensate for changes in the load.

3. Alternating current controlling apparatus comprising a core, an alternating current exciting winding on a portion of said core, a second alternating current exciting winding on another portion of said core acting in opposition to said first-named winding, a third alternating current exciting winding acting cumulatively with said first-named winding on another portion of said core, an output circuit subjected to resultant magnetic effects, and means for changing the power factor of said circuit to compensate for changes in the load.

4. Alternating current controlling apparatus comprising a core, an alternating current exciting winding on a portion of said core, a second alternating current exciting winding on another portion of said core acting in opposition to said first-named winding, a third alternating current exciting winding acting cumulatively with said first-named winding on another portion of said core, an output winding subjected to the combined magnetic effects, and means for changing the power factor of the circuit of said output winding to compensate for changes in the load.

5. Alternating current controlling apparatus comprising a core, an alternating current exciting winding on a portion of said core, a second alternating current exciting winding on another portion of said core acting in opposition to said first-named winding, a third alternating current exciting winding acting cumulatively with said first-named winding on another portion of said core, an output winding enveloping portions of said core also enveloped by said second and third windings, and means for changing the power factor of the circuit of said output winding to compensate for changes in the load.

6. Alternating current controlling apparatus comprising a core, an alternating current exciting winding on a portion of said core, a second alternating current exciting winding on another portion of said core acting in opposition to said first-named winding, an output circuit subjected to the resultant flux of said core, and means for adjusting the power factor of said output circuit to compensate for changes in the load, said portion of the core enveloped by said second winding being normally below saturation.

7. Alternating current controlling apparatus comprising a core, an alternating current exciting winding on a portion of said core, a second alternating current exciting winding on another portion of said core acting in opposition to said first-named winding, a third alternating current exciting winding acting cumulatively with said first-named winding on another portion of said core, an output circuit subjected to resultant magnetic effects, and means for changing the power factor of said circuit to compensate for changes in the load, said portion of the core enveloped by said second winding being below saturation.

8. Alternating current controlling apparatus comprising a core, an alternating current exciting winding on a portion of said core, a second alternating current exciting winding on another portion of said core acting in opposition to said first-named winding, a third alternating current exciting winding acting cumulatively with said first-named winding on another portion of said core, an output circuit subjected to resultant magnetic effects, and means for changing the power factor of said circuit to compensate for changes in the load, said portion of the core enveloped by said second winding being below saturation, and said portion of the core enveloped by said third winding being saturated.

9. Alternating current controlling apparatus comprising a core, an alternating current exciting winding on a portion of said core, a second alternating current exciting winding on another portion of said core acting in opposition to said first-named winding, a third alternating current exciting winding acting cumulatively with said first-named winding on another portion of said core, an output winding enveloping portions of said core also enveloped by said second and third windings, and means for changing the power factor of the circuit of said output winding to compensate for changes in the load, said portion of the core enveloped by said second winding being below saturation.

10. Alternating current controlling apparatus comprising a core, an alternating current exciting winding on a portion of said core, a second alternating current exciting winding on another portion of said core acting in opposition to said first-named winding, a third alternating current exciting winding acting cumulatively with said first-named winding on another portion of said core, an output winding enveloping portions of said core also enveloped by said second and third windings, and means for changing the power factor of the circuit of said output winding to compensate for changes in the load, said portion of the core enveloped by said second winding being below saturation, and said portion of the core enveloped by said third winding being saturated.

11. Alternating current controlling apparatus comprising a core, an alternating current exciting winding on a portion of said core, a second alternating current exciting winding on another portion of said core acting in opposition to a portion of the main flux of said first-named winding, said first-named winding being in series with at least a portion of said second-named winding, an output winding subjected to the combined magnetic effects of said windings, and means for adjusting the power factor of the circuit of said output winding to compensate for changes in the load.

12. Alternating current controlling apparatus comprising a core, an alternating current exciting winding on a portion of said core, a second alternating current exciting winding on another portion of said core acting in opposition to said first-named winding, said first-named winding being in series with at least a portion of said second-named winding, a third alternating current exciting winding acting cumulatively with said first-named winding on another portion of said core, an output winding subjected to the combined magnetic effects, and means for changing the power factor of the circuit of said output winding to compensate for changes in the load.

13. Alternating current controlling apparatus comprising a core, an alternating current exciting winding on a portion of said core, a second alternating current exciting winding on another portion of said core acting in opposition to said first-named winding, said first-named winding being in series with at least a portion of said second-named winding, a third alternating current exciting winding acting cumulatively with said first-named winding on another portion of said core, an output winding enveloping portions of said core also enveloped by said second and third windings, and means for changing the power factor of the circuit of said output winding to compensate for changes in the load.

HAROUTIUN K. KOUYOUMJIAN.