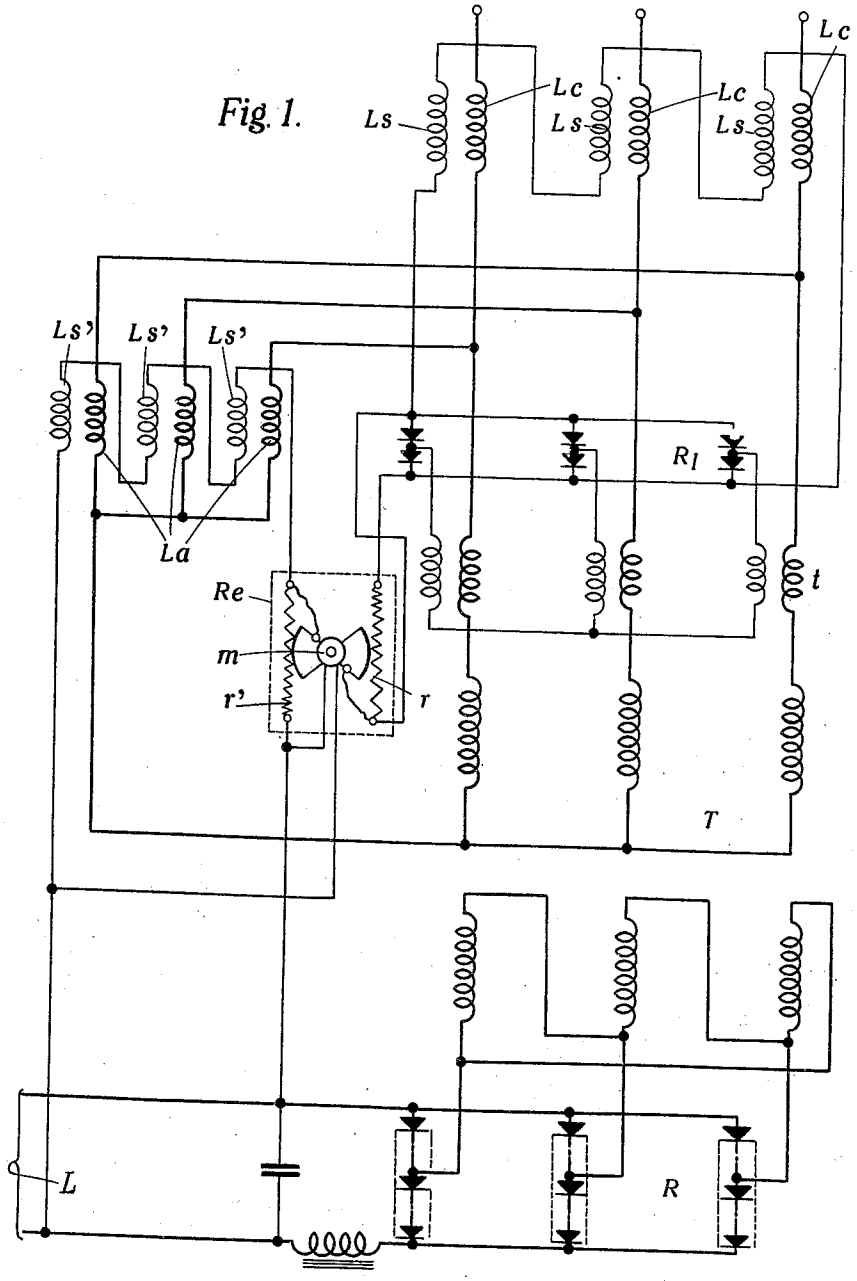
Aug. 20, 1940. H. E. GIROZ 2,212,229

TENSION CONTROL DEVICE

Filed March 11, 1939 2 Sheets-Sheet 1

Fig. 1.



Inventor
H. E. Giroz
by E. O. Thurmey
Attorney

Aug. 20, 1940. H. E. GIROZ 2,212,229

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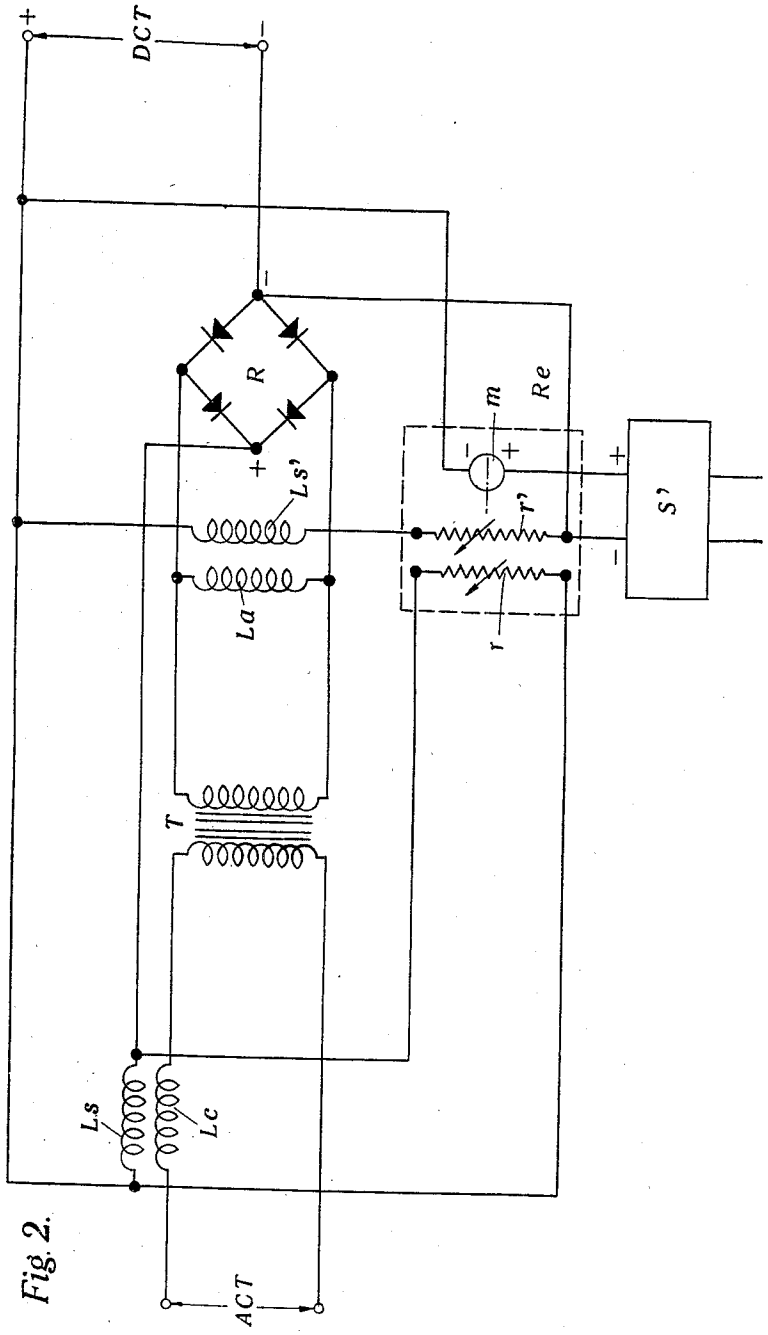


Fig. 2.

Inventor
H. E. Giroz
by E. O. Shinney
Attorney

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UNITED STATES PATENT OFFICE

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TENSION CONTROL DEVICE

Henri Edmond Giroz, Boulogne-Billancourt, France, assignor to International Standard Electric Corporation, New York, N. Y.

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5 Claims. (Cl. 175—363)

The present invention relates to devices for control of rectified voltage derived from an alternating current by means of a rectifier.

Known control devices of this kind comprise inductances inserted in series in the circuit of the alternating current and having saturation windings traversed by the rectified current, the drop of potential across these inductances being thus varied as a function of the load current alone, or the load current and the rectified voltage.

This drop of potential is equal to the product of two factors, viz. the impedance of the variable series inductance or set of inductances employed, that is Z, and the effective value of the alternating current passing through the alternating windings of said inductance, that is I.

It is obvious that in all such devices the value of I (the input alternating current through the variable series inductance) inherently tends to vary with the output current I_c because this output current must inherently be derived directly or indirectly from the input current. In many such known devices, however, a drainage inductance is connected in shunt to the alternating current system at a point subsequent to the series inductance so as to draw a parasitic current of substantially wattless phase, thus artificially increasing the input current I. If such a shunt inductance is arranged to be varied in dependance on some selected characteristic X of the output circuit, the input current I will be artificially caused to vary as a function of such selected characteristic X (in addition to the inherent variation of I as a function of I_c).

Various control means employing inductances of this type have already been suggested in which a variation of the drop of potential ZI is obtained as a function of the output or rectified current I_c, and of the output or rectified potential U in such a direction that whatever the variations of the load and the potential on the alternating side, the value of the rectified voltage U remains substantially constant. In one known device of this type, for example, one or more inductances, with saturating winding have been arranged in series with one of the windings of the feed transformer in such a way that the impedance of the series inductance, or set of inductances, is a function of the output or rectified current I_c, and of the output or rectified potential U, whereas the current I is not artificially varied at all but is subject only to its natural dependence upon I_c:

$$Z=f(I_c,U)$$
$$I=f^1(I_c)$$

In a second known arrangement of this type the series inductances are arranged in such a way that their impedance Z is solely a function of the rectified current, while only the current I which passes through their saturation winding is a function of the rectified potential (in addition of course to its inherent dependence on I_c):

$$Z=\varphi(I_c)\,;\ I=\varphi'(U,I_c)$$

The present invention provides, in accordance with certain of its characteristics, systems for the control or regulation of a rectified potential employing one or more impedance elements inserted in the alternating feed circuit such that the impedance of said elements is a function both of the rectified current and of the rectified potential, and such that the current passing through their windings is artificially controlled as a function of the rectified potential (in addition to its inherent dependence on I_c)

$$Z=\psi(I_c'U)\,;\ I=\psi'(U,I_c)$$

In another aspect, the invention provides systems for the control or regulation of an electrical magnitude, for example, a potential, such that the variations of the drop of control potential across the above mentioned inductance caused by a given variation of the potential at the output of the control system do not decrease in proportion as the current on the output of the control system approaches its maximum or full loading value.

In practical operation, in the two known control systems mentioned above an increase of the output current I_c reduces the value of the impedance of the control elements, and the saturation of said inductances approaches its maximum value. In the first system, the same variation of U will obviously involve a less variation of the impedance Z in the vicinity of saturation, than it will at a distance from the saturation point; and in the second system a given variation of U will give (by varying I) a variation of ZI which is smaller when Z is low.

In a general manner, consequently, the present invention has as its object the provision of means so that a system of control or adjustment of an electrical magnitude employing impedance elements with saturation winding maintains the same efficiency independent of the loading on the output side.

In accordance with certain characteristics of the invention a device for controlling an electrical magnitude such as a potential is essentially composed of a regulator, the control element or member of which influenced by the potential to be adjusted, and which is capable of simultaneously varying two control elements, or members, such for example as two resistances inserted respectively in two separate saturation circuits of the regulator.

In accordance with one characteristic of the invention the inductances employed are such

that their alternating windings cannot induce any flux in the saturation winding.

In accordance with one aspect of the invention a device for the control of a rectified potential may comprise a rectifier device supplied with alternating current by a network through a feed transformer, a first inductance in series with the winding of the said transformer, and having a saturation winding, and a second inductance in parallel with the winding of the transformer, and also having a saturation winding, a regulating device influenced by the potential to be adjusted, and simultaneously controlling two elements such as two resistances, one of which is inserted in shunt to the saturation winding of the first inductance, and the other in series with the saturation winding of the second inductance.

However, in such a device, as the current passing through the saturation winding of the first mentioned inductance is sometimes of a very different order of magnitude from the current passing through the saturation winding of shunt inductance, the practical realisation of a double regulator controlling these two currents may offer certain difficulties. Consequently, in accordance with a still further characteristic, the invention provides for this purpose means to produce a similar order of magnitude of the two currents. In a given example, the saturation winding of the series inductance, instead of being connected directly in series with the load circuit, is fed by means of series transformers which develop on the terminals of their secondaries a potential substantially proportional to that supplied to the rectifiers connected to the load and these secondaries feed an auxiliary rectifier which itself feeds the saturation winding of the inductances. By such an arrangement an adjustment of the transformation ratio of the series transformers can easily be carried out so that the current discharged by the auxiliary rectifier in the saturation winding of the series inductances is of the same order of magnitude as the current passing through the saturation winding of the shunt inductances.

In another way, and in accordance with another feature of the invention, the auxiliary series transformers may be eliminated and the resistances or impedances chosen in such a way that one of the resistances is an element with high output, and low potential, and the other an element with low output and a potential of the order of the potential across the load.

The invention will be explained in detail in the following description of some non-limiting embodiments shown in the attached drawings, in which:

Fig. 1 shows an example of an application in the case of a tri-phase feed network; and

Fig. 2 shows an example of an application employing a mono-phase feed.

In the arrangement of Fig. 1, T represents the main transformer, R the rectifier device, fed by the alternating current network, through the transformer T, Lc the inductances in series with the primary windings of the transformer T, and the saturation windings Ls of which are fed by means of the series transformer t supplying the auxiliary rectifier device R1, La the inductances in shunt on the primary of the transformer T, of which the common saturation winding Ls′ is fed by the potential on the load side of the rectifier R, Re the double regulator devices comprising a control member or element m, and two control resistances r and r', the first being connected in shunt to Ls and the second in series with Ls′.

The regulator Re is provided so that the resistances r and r' both decrease when the potential to be adjusted on the rectified side tends to increase. This is easily obtained by means of the connections of the resistances shown in Fig. 1. When the potential on the rectified side begins to increase, the resistance r decreasing, the current passing through the saturation winding Ls tends to decrease and consequently the impedance Z of the inductance Lc tends to increase. Moreover, the resistance r' decreasing, the current in the saturation winding Ls′ of the inductance La tends to increase, which also increases the current absorbed by the inductances La. Under these conditions an increase of the impedance Z on the inductance Lc, and a simultaneous increase of the current I passing through them are obtained. The result is that the drop of potential ZI through the inductance Lc has a double reason for increasing, which is opposed to the increase of the rectified potential.

If the rectified potential began to decrease the operation which has just been described would be reversed.

It is, however, clear that if the rectifier R discharges with full charge, the respective variations of Z and of I will not need to be so great, as if one or other of these two factors were modified. For example, in order to obtain a variation of ZI from the single to the double, it would be sufficient, instead of merely varying either Z or I in the ratio of 1:2 to vary them simultaneously in the ratio of 1 to $\sqrt{2}$.

The variations of the resistance r on no load have no action of the adjustment of the potential, the current in the inductance Ls being zero. The adjustment is thus completely ensured by the action of r' on the ringing inductances La, which then have a maximum efficiency since Z has its maximum value.

On the other hand, on full load the action of the resistance r is added to that of the resistance r' in order to compensate the reduction of efficiency of the inductances La, the variations of the current through La being multiplied in the product ZI by the variation of the impedance Z of the compounding inductances.

The arrangement described comprises the use of series transformers for the feeding of the saturation winding Ls of the compounding inductances Lc, but this feeding may be ensured in any other suitable way dependent, moreover, on the type of regulator Re employed. In the example given, this method of supply permitted for large outputs a more convenient execution and more exact adjustment of the saturation winding of the compounding inductances.

As mentioned above, the inductances with saturation winding are such that the alternating windings develop no flux through the saturation windings.

Fig. 2 to which I will now refer, represents another embodiment incorporating characteristics of the invention, in which the feed network is shown monophased for the sake of simplicity in the drawings. The alternating current supply is effected on the terminals ACT and the utilisation circuit of the rectified current is tapped on the terminals DCT. The alternating current feeds a transformer T through a compounding inductance Lc in series, and the secondary of transformer T is shunted by an inductance La. These two inductances respectively have saturation windings Ls and Ls′. A rectifier device such as a

rectifier bridge R is supplied by the secondary of the transformer T. A resistance r is connected in shunt to the saturation winding Ls and a resistance r' is connected in series with the saturation winding Ls'. The regulator Rc shown is such that the control member m causes the two resistances r and r' to vary in the same sense, but in this case the resistance r is a resistance with large output and low potential and the resistance r' is a resistance with a small output and with a potential equal to, or of the order of magnitude of the potential across the rectifier bridge R. In order that the resistances r and r' may increase when the potential on the terminals of the motor member m increases, a potential proceeding from an auxiliary source S' of constant tension is opposed to the potential to be adjusted. The potential on the terminals of the source S' may be maintained constant by means of suitable arrangements of valves with luminescent discharge, saturated and non-saturated transformers, etc. Its potential, maintained constant, is determined so as to be greater than the utilisation potential, and in opposition to the latter. In this way when the utilisation potential increases, the potential on the terminals of the motor member or device m decreases and the resistances r and r' are modified consequently in order to bring this utilisation potential to the desired value.

It is clear that the arrangements shown have only been shown by way of example, and that other arrangements incorporating characteristics of the invention may be obtained without departing from the scope of the invention.

It is also clear that such arrangements may be applied to the regulation and control of an alternating potential proceeding from the transformation of another feed alternating potential. In this case the rectifier device R should only have a reduced power and should only be used as source of reference potential.

What is claimed is:

1. A system for supplying to a load regulated direct current voltage derived from an alternating current power supply, comprising a transformer, a rectifier, a first line connected to transmit alternating current from the power suply to said rectifier, said line being divided into two sections coupled together through said transformer, a second line connected to transmit direct current from said rectifier to the load, a shunt inductance connected across said first line, a series inductance connected in series in said first line ahead of said shunt inductance and ahead of said transformer so as to be traversed by current components corresponding to currents drawn by said shunt inductance as well as by current components corresponding to currents drawn by said rectifier, and means for simultaneously oppositely varying the impedances of both said series and shunt inductances responsive to variations of the potential across said second line.

2. A system for supplying to a load regulated direct current voltage derived from an alternating current power supply, comprising a rectifier, a first line connected to transmit alternating current from the power supply to said rectifier, a second line connected to transmit direct current from said rectifier to the load, a shunt inductance connected across said first line, a series inductance connected in series in said first line ahead of said shunt inductance so as to be traversed by current components corresponding to currents drawn by said shunt inductance as well as by current components corresponding to currents drawn by said rectifier, and means for simultaneously oppositely varying the impedances of both said series and shunt inductances responsive to variations of the potential across said second line.

3. In combination an alternating current supply source, a transformer having primary and secondary windings and having said primary winding connected to said source, a rectifier connected to said secondary winding, a load circuit connected to said rectifier, series inductance connected in series with the primary of said transformer, shunt inductance connected in shunt to said transformer, a saturating winding for varying said series inductance and a resistance in shunt thereto, a saturating winding for varying said shunt inductance and a resistance in series therewith and means for simultaneously varying both said resistances in the same direction in dependence upon the voltage across said load circuit.

4. In combination an alternating current supply source, a first transformer having primary and secondary windings and having said primary winding connected to said source, a first rectifier connected to the secondary winding of said first transformer, a load circuit connected to said first rectifier, a first inductance connected in series between said source and the primary winding of said transformer, a second inductance connected in shunt across said transformer, a second transformer having a primary and secondary winding and having its primary winding connected to said source and its secondary winding to a second rectifier, windings connected to said second rectifier for varying the value of said first inductance, a first resistance connected in shunt to said windings, windings for varying the value of said second inductance and connected across said load circuit, a second resistance connected in series with said last mentioned windings and means dependent upon the voltage across said load circuit for varying said first and second resistance simultaneously in the same direction.

5. In combination an alternating current supply source, a transformer having primary and secondary windings and having said primary winding connected to said source, a rectifier connected to the secondary winding of said transformer, a load circuit connected to said rectifier, a first inductance in series between said source and said primary, a winding for varying the value of said inductance, a resistance having large output and low potential in shunt to said winding, a second inductance in shunt to said transformer, a winding for varying the value of said second inductance connected across the said load circuit in series with a resistance of small output and a potential of the order of the potential across the said rectifier and means for varying both said resistances simultaneously in the same direction in dependence upon the potential across the load circuit.

HENRI EDMOND GIROZ.