Nov. 14, 1950 H. FORSSELL 2,530,011

MEANS FOR PRODUCING A CONSTANT CURRENT

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Fig. 1

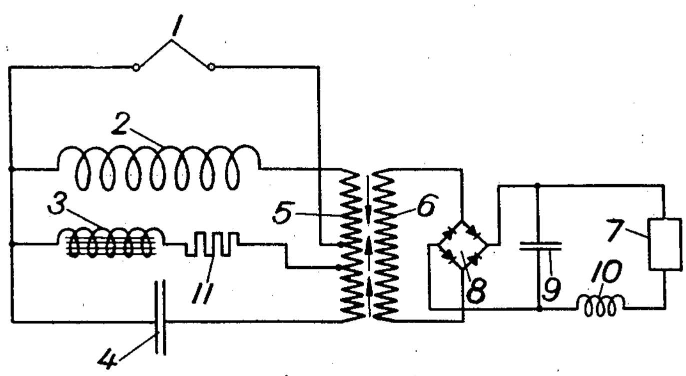
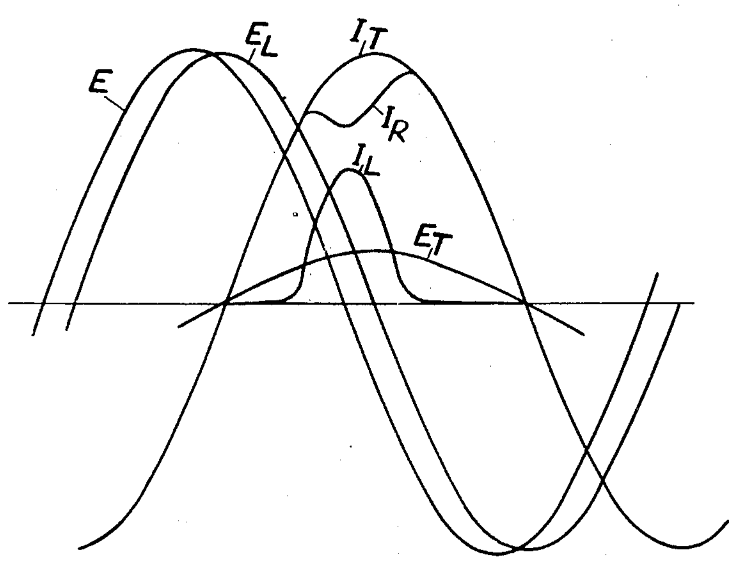


Fig. 2



Inventor
Harry Forssell.
By [signature]
Attorney.

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MEANS FOR PRODUCING A CONSTANT CURRENT

Harry Forssell, Ludvika, Sweden, assignor to Allmänna Svenska Elektriska Aktiebolaget, Västerås, Sweden, a Swedish corporation

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4 Claims. (Cl. 323—6)

1

It is known to derive, from an alternating voltage, a current which is independent, over a rather wide range, of the resistance in the circuit in which it flows, by causing the alternating current source to feed two transformer windings, one through a mainly inductive and one through a mainly capacitive circuit, so as to cause the ampereturns of the said windings to cooperate, the current being taken from the same transformer. Especially if the resistance of the load circuit is mainly of an ohmic character, it has a very little influence on the current, and at the same time the source of current is only little inductively loaded, as the two primary circuits compensate each other in this respect.

As already said, the current obtained by the described means will be rather independent of the resistance in the load circuit, but on the other hand, it will be directly dependent on the voltage of the current source. In order to reduce this dependence to a minimum, a third circuit is, according to the present invention, connected to the source of current, the said circuit containing an inductance with saturable iron and feeding a winding of the same transformer, the ampereturns of which counteract those of the two first-named windings. An ohmic resistance is preferably connected in series with the inductance.

Thorough mathematical investigations have proved that by a suitable proportioning of the third circuit and the transformer winding fed thereby (which preferably may form part of the capacitatively fed winding) an accurate compensation of fluctuations in the voltage and frequency of the source of current can be obtained.

A form of the invention is diagrammatically illustrated in Fig. 1 of the accompanying drawing, which Fig. 2 shows a diagram of its mode of operation.

In Fig. 1, the numeral 1 designates a pair of alternating current terminals, between which a slightly variable voltage is supposed to exist. Between the said terminals, three parallel current paths are connected which contain, next to one terminal, a constant inductance 2, an inductance 3 containing saturable iron in series with an ohmic resistance 11, and a condenser 4 respectively. The constant inductance 2 and the condenser 4 are connected each to one end of a transformer winding 5, the midpoint of which is connected to the other alternating current terminal. If the ohmic resistances in the current paths through 2 and 4 can be neglected, the currents

2

therein are displaced in phase by 180°, and as they are connected to opposite ends of the transformer winding, their ampereturns are in phase and thus cooperate. The transformer has a secondary winding 6 which is connected to a load 7, in the form shown through a rectifier 8 and smoothening members 9, 10. As long as the voltage drop in this load, which is supposed to be purely ohmic and automatically becomes so when the current is rectified, is, reduced to the primary side of the transformer, smaller by a technical order of magnitude than the voltage drops in the inductance 2 and condenser 4, the variation of current in the load 7 will be smaller by still another order of magnitude. Nor does a small variation of the frequency of the alternating current cause any appreciable fluctuation of the current, but on the other hand, the latter becomes essentially proportional to the voltage between the terminals 1.

The third current path containing the inductance 3 added according to the present invention reduces, on the other hand, the voltage dependence of the current materially. An exact description of the operation in this respect necessitates a rather circumstantial mathematical treatment, but a survey of the mode of operation is obtained by the diagram shown in Fig. 2. In the latter, E designates the voltage between the alternating current terminals and E_L and E_T two components thereof, namely, the voltage on the inductance 3 with the resistance 11 and the voltage on the transformer winding connected to the said inductance. It is true that the latter component in reality has not a pure sine shape, but as it is comparatively small, its deviation from such shape can be neglected at this survey. I_T designates the primary current of the transformer dependent on the current paths through 2 and 4. This current is practically in phase with the voltage E_T and 90° behind E_L. Its curve may therefore also represent the flux in the iron core of the inductance 3 during the time intervals when the current through 3 and 11 is negligible. I_L represents the current through 3 and 11.

The more the saturation curve of the said iron core approaches the ideal shape, composed by a straight vertical and a straight horizontal portion, the more the aforesaid condition for the current will be fulfilled during the first part of a semicycle of I_T, when the magnetisation of the iron core rises to nearly the saturation value without requiring any appreciable current. The first part of the curve I_L is therefore nearly horizontal. When the iron core has been saturated, the voltage E_L is essentially absorbed by the resistance 11. The current then approaches phase coincidence with the voltage E_L. The transition is, however, in reality not instantaneous, but the current curve has about the shape shown in Fig. 2. As this current counteracts the currents from the inductance 2 and the condenser 4 in the transformer 5, 6 but traverses a smaller part of the transformer winding than said latter currents, the resultant ampereturns in the primary winding 5 will be represented by the curve I_R where this curve distinguishes from I_T.

If now the voltage E for instance rises somewhat, which makes E_L rise in the same proportion, the part of the said voltage absorbed by the inductance 3 cannot rise appreciably, but the main part of the increase is absorbed by the resistance 11. The current I_L therefore rises more rapidly than the current I_T, and the proportion between the counteracting ampereturns in the transformer winding and the whole winding can always be chosen so as to make the rectified mean value of I_R approximately constant, independent of the fluctuations of I_T. It should however be observed, that a limit is put by the fact that the crest value of I_L may be so high that the depression in I_R extends to the negative side. Its negative portion, in rectification, will then act increasing instead of reducing on the total number of ampereturns, which will thus be incorrect. If the voltage E should sink instead of rise, a similar compensation occurs up to the limit at which the inductance 3 is no more saturated.

The connection illustrated in Fig. 1 may be modified in different manners within the scope of the invention. Thus it is for instance not necessary that the condenser 4 and the inductance 3 be connected directly to one terminal of the voltage source, but they may be connected to one or more intermediary taps on the inductance 2 which then acts as a voltage divider. The members 3, 11, and 4 should then of course be dimensioned with respect to the portion or portions of the inductance 2 lying in parallel thereto. The transformer may of course be built without a separate secondary winding, and inversely, the winding turns fed through the inductance 3 and resistance 11 may form a separate winding.

I claim as my invention:

1. Means for deriving a substantially constant alternating current from a variable voltage comprising alternating current terminals, a transformer winding composed of a plurality of electromagnetically cooperating parts, a substantially inductive current path and a substantially capacitative current path connected in parallel to said terminals and each including one of said parts, and a third current path connected to said terminals and containing a reactor with an iron core in series with a resistor and another of said winding parts, said last winding part acting to oppose the ampereturns of the others of said winding parts.

2. Means according to claim 1, in which said last winding part is also contained in said substantially capacitative current path.

3. Means according to claim 1, in which said substantially capacitative current path is connected to at least one point of said substantially inductive current path different from said alternating current terminals.

4. Means according to claim 1, in which said current path containing a reactor with an iron core is connected to at least one point of said substantially inductive current path different from said alternating current terminals.

HARRY FORSSELL.

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