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ALTERNATING CURRENT SUPPLY MEANS

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Fig. 1

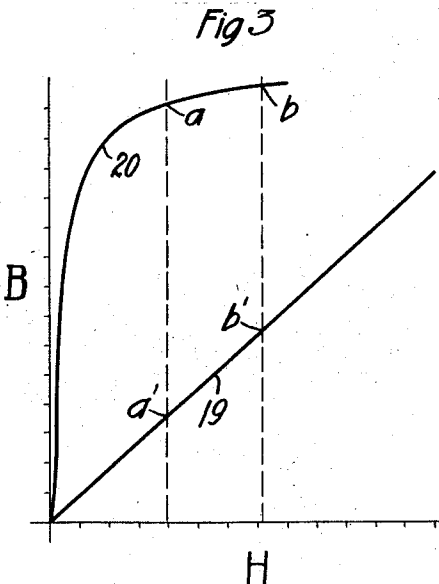
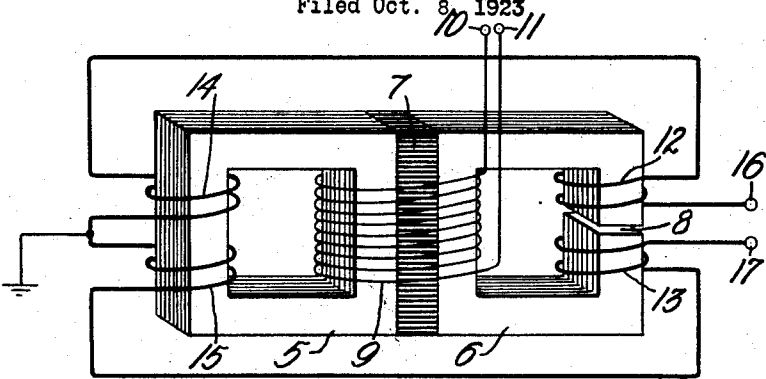
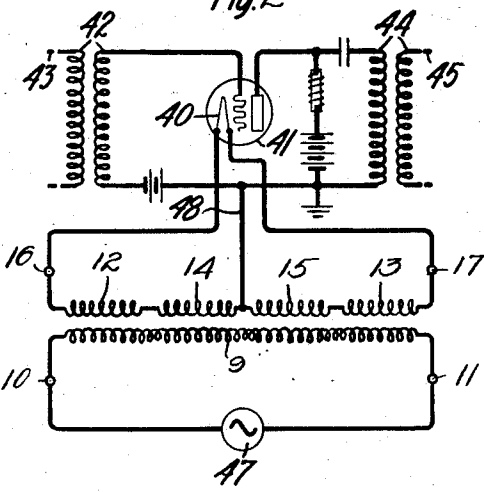


Fig. 2



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ALTERNATING-CURRENT SUPPLY MEANS.

Application filed October 8, 1923. Serial No. 667,248.

This invention relates to alternating current supply means.

One object of the invention is to reduce fluctuations in the voltage across the terminals of the secondary winding of a transformer when a variable voltage is impressed upon the primary winding.

One form of this invention, by means of which the above object is obtained, comprises a constant current transformer having a composite core, one mesh of which has a flux density-magnetization force characteristic different from the flux density-magnetization force characteristic of a second mesh of the core in that the flux for a given change in magnetization force increases much more rapidly in one mesh than in the other. The primary winding may be made common to the two meshes while the secondary winding is in two parts, one part on each mesh. If now, the two parts of the secondary winding are connected so as to be in opposition with the greater potential winding on the mesh having the lesser change of flux with magnetization force, it has been found that the windings on the core may be so adjusted and arranged that the resulting voltage of the two parts of the secondary winding will be substantially constant over a wide range of impressed voltage.

Referring to the drawings, Fig. 1 represents this invention embodied in a transformer having a composite core, each part of which is of the single mesh type. Fig. 2 illustrates the manner in which this invention may be employed in heating a vacuum tube filament with alternating current, and Fig. 3 represents the magnetizing force-flux density characteristics of the separate parts of the composite core of this invention.

Referring to Fig. 1, the transformer disclosed therein comprises a composite core of two sections 5 and 6 separated from each other by a suitable plate 7 of insulating material. The section 5 of the core is of the single mesh type and is composed of a plurality of laminations of magnetic material such as silicon steel. The magnetic circuit in the core section 5 is circumferentially complete without any appreciable air gaps. The core section 6, however, has a magnetic circuit which is circumferentially incomplete due to the presence of an air

gap 8, the purpose of which will be later described. The core section 6 similar to the section 5 is made of laminated magnetic material.

The transformer primary winding 9 surrounds portions of each of the core sections 5 and 6 and is provided with suitable terminals 10 and 11. The transformer secondary winding is composed of four sections, of which sections 12 and 13 are wound on core 6 and sections 14 and 15 are wound on core 5. The terminals for the secondary winding are provided at the points 16 and 17 and the four sections of the secondary winding are shown connected so that sections 14 and 15 are included between sections 12 and 13 with the common terminals of sections 14 and 15 grounded.

The manner in which the transformer arrangement of Fig. 1 may be arranged and adjusted to produce a constant current transformer will be better understood by reference to the curves shown in Fig. 3, in which the curve 19 represents the relation between the magnetizing force and the flux density for a core of the type of section 6 which has an incomplete magnetic path due to the presence of an air gap. Curve 20 represents the same relation for a core such as core section 5 which has a circumferentially complete magnetic circuit. In this figure, the abscissæ represent various values of the magnetizing force H and the ordinates represent the corresponding values of the flux density B . In the regions ab and $a'b'$ of the curves 19 and 20, it will be observed that the increase in flux density for a given increase in magnetizing force is much larger for curve 19 than it is for curve 20. This difference between the two curves may be made the basis of the construction of a transformer having a constant current in the secondary winding regardless of varying line voltage. By the standard methods of transformer design, the primary winding 9 and the core dimensions may be so proportioned that when a line voltage of the minimum value of the range of desired operation is applied to the primary winding, the resulting flux density conditions in the two core parts 5 and 6 correspond, for example, to the points a and a' respectively of the curves 20 and 19. If then, the line voltage is increased, the flux densities must likewise be increased to values such that

the resultant back electromotive force of the primary winding is equal to the line voltage. The points b and b' may be taken to represent such values.

5 As noted before, the relative increase in flux in core 6 in going from a' to b' is much larger than in core 5 in going from a to b . Hence, under the second condition of higher impressed voltage, the fluxes in cores 5 and
10 6 will be increased unequal amounts so that the secondary voltages in windings 12, 13 and windings 14, 15 will be increased by different relative amounts. If, therefore, the windings 12, 13 are so connected that
15 they oppose the voltage in windings 14, 15 and if the voltage in windings 14, 15 is made greater than the voltage in windings 12, 13, these windings may be so proportioned that their resultant difference equals
20 the desired load voltage under conditions of minimum line voltage, while at the same time the effect of any increase in the impressed voltage on the primary winding will be neutralized by a greater percentage increase in the voltage of windings 12, 13 over
25 the increase in the windings 14, 15.

Thus, with windings 14 and 15 delivering a greater voltage than windings 12 and 13 and these two sets of windings opposing each
30 other, the resultant secondary voltage may be adjusted to equal the desired load voltage for minimum line voltage on the primary winding. When the voltage impressed on the primary winding 9 increases, the voltage in the windings 12 and 13 will
35 increase at a more rapid rate than the voltage in windings 14, 15 so that the resulting secondary voltage may be made substantially constant over a wide range of impressed primary voltage.
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The above discussion applies more particularly to conditions of zero secondary load. In operation under load conditions, the effect of the magnetizing force of the secondary current should be taken into consideration. So far as the windings 9, 14 and 15 are concerned, this consideration follows the usual lines of transformer design. In the case of the secondary winding 12, 13, however, somewhat different consideration is
50 required. Due to the fact that the two sets of secondary windings are in opposition, the secondary current is forced through the winding 12, 13 by the superior potential of the winding 14, 15 in a direction opposite to that of the potential of winding 12, 13. Hence its magnetizing effect instead of opposing that of the primary current as in the usual case, aids the magnetizing effect
60 of the primary current and hence the core flux in section 6 is that due to the resultant sum of the primary and secondary currents. The value of this resultant flux must not exceed the value at which the curve 19 ceases to be a substantially straight line, a condi-

tion which is readily assured by the proper value of the air gap length.

A transformer constructed according to the above principles has given the following performance. Operating at a frequency of 60 cycles per second, and delivering an average current of 20 amperes to a non-inductive load of .5 ohm resistance, the applied line voltage was varied from a minimum value of 104 volts to a maximum of 180 volts
75 without causing the secondary current to vary more than 1% from the average value. Over the usual range of voltage variation of commercial 60 cycle current, the secondary current change was even less than the value above noted.
80

Fig. 2 is an illustration of how this invention may be employed for securing substantially constant alternating current for heating the cathode 40 of a vacuum tube 41. The input and output circuits for tube 41 are shown in a conventional manner with the input circuit connected by a suitable input transformer 42 to incoming line 43, while the output circuit by a transformer 44 is
90 coupled to an outgoing line 45. The terminals of the cathode 40 are shown connected to the terminals 16 and 17 of the transformer arrangement of Fig. 1, while the primary winding terminals 10 and 11
95 of the transformer arrangement of Fig. 1 are shown connected to a suitable source 47 of alternating current. The anode and control electrodes of tube 41 are connected to the cathode through the intermediary of a connection 48 which leads to the midpoint of the secondary winding of the current supply transformer. With the current supply transformer arranged on the composite core such as shown in Fig. 1, the alternating
105 current supplied to the cathode 40 will remain substantially constant in value regardless of changes in the voltage impressed by source 47 upon the primary winding 9.

It is, of course, to be understood that the constant current transformer of this invention is of general application and may be employed in various types of circuits in which it is desired to supply a constant current to a load in spite of changes in the line voltage. It is also to be understood that this invention may be employed in forms widely different from those described above without in any wise departing from the spirit of this invention as defined in the
120 appending claims.

What is claimed is:

1. The combination with a load circuit having a plurality of elements, of a source of alternating current, and means for associat-
125 ing said load circuit with said source comprising a transformer having two different magnetic circuits, one having a slow rate of change of flux over a given range of change of magnetizing force and the other having
130

a more rapid rate of change over said range, a primary winding connected to said source and surrounding a portion of both of said magnetic circuits to supply magnetizing force thereto, a secondary winding having terminals connected to one element of said load circuit, said secondary winding comprising a plurality of sections some of which link one of said magnetic circuits and the rest of which link the other of said magnetic circuits, and connections to other elements of said load circuit from the point of mid-potential of said secondary winding to maintain said other elements at the average potential of said one element of said load circuit, said sections and magnetic circuits being arranged and adjusted so that the resultant current supplied to said load circuit by the combined action of the sections of said secondary winding changes less on a percentage basis than the variable voltage impressed on said primary winding.

2. A transformer circuit for supplying an electron discharge device including a cathode, an anode and a control electrode, with voltage from a source of alternating current, said transformer having two different cores, one of said cores having a slow rate of change of flux over a given range of change of magnetizing force and the other of said cores having a more rapid rate of change over said range, a primary winding connected to said source and having turns linking both of said cores to supply magnetizing force thereto, a secondary winding having terminals connected to said cathode, said secondary winding comprising a plurality of sections, certain of said sections being mounted on one of said cores and certain other of said sections being mounted on the other of said cores, and connections from the point of mid-potential of said secondary winding to said anode and said control electrode, the secondary sections mounted on one core being connected in opposition

to the secondary sections mounted on the other core and being so proportioned that the resultant current supplied by said sections to said cathode is substantially constant over a wide range of voltage impressed on said primary winding.

3. A transformer circuit for supplying an electron discharge device having electrodes including a cathode, an anode and control electrode, with voltage from a source of alternating current, said transformer comprising two magnetic circuits one having a slow rate of change of flux over a given range of change of magnetizing force and the other having a more rapid rate of change over said range, a primary winding connected to said source and having a turn linking both of said magnetic circuits to supply magnetizing force thereto, and a secondary winding having terminals connected to said cathode, said secondary winding comprising four equal sections two of which are wound on the first mentioned magnetic circuit and two of which are wound on the second mentioned magnetic circuit, and connections from a mid-point between the sections of said secondary winding wound on one of said magnetic circuits to said anode and to said control electrode, the secondary sections on one magnetic circuit being connected in opposition to the secondary sections on the other of said magnetic circuits, the sections of said secondary winding wound on the first mentioned magnetic circuit developing voltage always greater than the voltage developed by the sections of said secondary winding wound on the second mentioned magnetic circuit for a wide range of voltage impressed on said primary winding.

In witness whereof, I hereunto subscribe my name this 27th day of September, A. D., 1923.

WILLIAM J. SHACKELTON.