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OSCILLATORY HIGH-VOLTAGE SUPPLY

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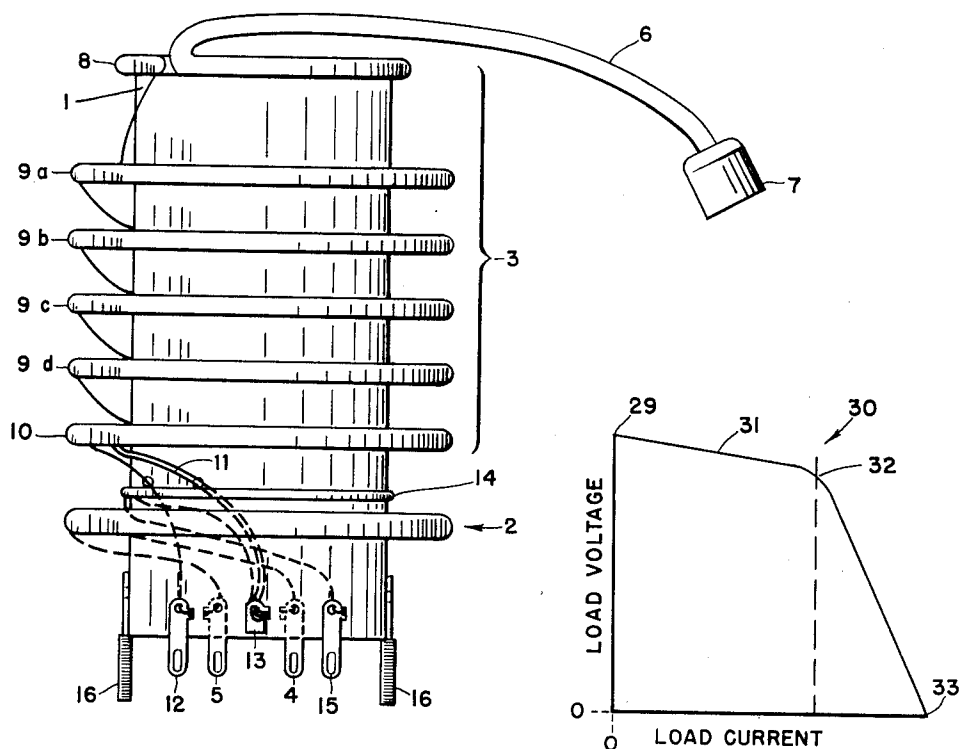


Fig. 1

Fig. 3

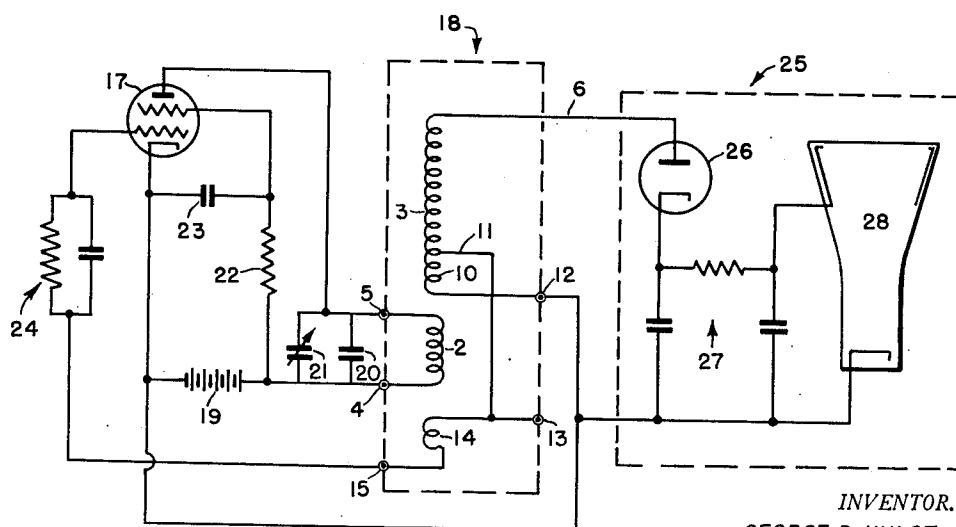


Fig. 2

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OSCILLATORY HIGH-VOLTAGE SUPPLY

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4 Claims. (Cl. 250—36)

This invention relates to high voltage low power direct current supply circuits of the radio frequency oscillator type and more particularly to a high voltage supply particularly adapted for use in television apparatus.

In the prior art (U. S. Patent No. 2,276,832) an oscillator circuit has been utilized to provide direct current for a cathode ray tube such as is used in television apparatus. In these circuits, it has been customary to use a transformer having primary, secondary, and tertiary windings, these windings being connected to the plate of the oscillator tube, the high voltage rectifier, and the grid of the oscillator tube, respectively.

It has been found that, to obtain good regulation from such a supply, the primary and secondary circuits must be reasonably tightly coupled (U. S. Patent No. 2,374,781). It has also been found in practice that the spacing between the high voltage winding and other windings must not be less than a certain amount dependent upon voltage, in order to avoid corona and high voltage flashover, which if present would generate noise in the amplifiers associated with the cathode ray tube and might result in damage to the coil itself.

It is an object of this invention to provide a high voltage supply having good regulation, high efficiency, and low short circuit current.

A second object is to provide a high voltage supply which is free of corona, compact, and inexpensive to manufacture.

These objects are accomplished in part by the incorporation of a high voltage transformer which has certain novel constructional features.

The objects and features of my invention can best be understood by referring to the accompanying drawings, in which:

Figure 1 is a side elevational view showing a high voltage transformer incorporating the novel features of this invention;

Figure 2 is a schematic drawing of a circuit in accordance with one embodiment of my invention incorporating the transformer of Figure 1; and

Figure 3 is a graph illustrating the performance obtainable from my invention.

Referring to Figure 1, the high voltage transformer comprises a coil form upon which are wound a primary winding 2, a high voltage secondary winding 3, and a tertiary winding construction in accordance with the invention, to be explained in more detail hereinafter.

The start or inside end of the primary winding 2 is soldered to a connecting lug 4. The finish or outside end of the primary winding 2 is soldered to a second connecting lug 5. The start or high voltage end of the high voltage winding 3 is connected to a high voltage wire 6 which has a large diameter insulating covering to insure against corona. A connector 7 having a smooth rounded outside contour is used to terminate the high voltage wire 6 and to connect it to the high voltage rectifier tube (shown in Figure 2). In the preferred form shown, one turn of the high voltage wire 6 is affixed to the top end of the coil form 1 to form a corona shield 8 for the coil form. The secondary winding 3 is wound continuously in the form of five separate pies or coils 9a, b, c and d, and 10, in a manner known to the art, in order first to keep the potential difference between adjacent turns of wire to a safe value and second to keep the distributed self-

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capacitance of the high voltage winding to a low value. The last pie 10 of the secondary winding 3 is provided with a tap 11, the purpose of which will be explained. The finish of the secondary winding is soldered to a connecting lug 12.

The tertiary winding is composed of two parts, one part being the portion of the secondary winding between the tap 11 and the finish, the manner of connection being that of an autotransformer. This portion of the secondary winding, in the embodiment shown, thus serves two purposes. The two wires resulting from the tap 11 of the secondary winding 3 may be soldered as a matter of convenience, to a dummy lug 13. To this dummy lug 13 also is soldered the start of the second part 14 of the tertiary winding, the finish being soldered to a fourth connecting lug 15.

The purpose of the special form of the tertiary winding is as follows. Since it is desirable to keep all the low voltage windings away from the high voltage end of the secondary winding, and since there must be more than a certain critical amount of mutual inductance between the secondary winding and both the primary and the tertiary windings, both primary and tertiary windings are located near the low potential end of the secondary winding. Hence it follows that there will be high mutual inductance between primary and tertiary windings. This in turn if present, would result in poor operation of the high voltage supply.

The manner of minimizing mutual inductance between primary and tertiary windings in my invention may be described in this way. One winding, preferably the tertiary winding, is wound in two parts, one part being in close proximity to the secondary winding and one part being more distant therefrom. The two parts of the tertiary winding are then so connected that the mutual inductance between the primary winding and one part of the tertiary winding is opposite and preferably approximately equal to the mutual inductance between the primary winding and the other part of the tertiary winding. If this condition holds, the mutual inductance between secondary and each part of the tertiary will in general also be opposing, but since one part of the tertiary winding is closer to the secondary winding than the other, the mutual inductances will be unbalanced, and adequate coupling will obtain between secondary and tertiary windings.

In the preferred form shown, the nearer portion of the tertiary winding is a part of the secondary winding in autotransformer connection to the tap, rather than being a separate coil. The reasons for this are those of economy, rather than of principles. In the first place, one less winding position of the coil is required in manufacture. In the second place, if a separate coil were used it would have to be spaced as far away from the low potential pie 10 as the coil 14 in order to have a sufficiently low potential gradient along the surface of the coil form. In the third place an autotransformer connection requires less wire than a separate coil if the latter has the same mutual inductance.

In Figure 2 is shown a preferred circuit in which the coil of Figure 1 may be used. An oscillator tube 17 preferably of the beam power type has its plate connected to a primary winding 2 of a high voltage transformer 18, of the type shown in Figure 1. The other end of the primary winding 2 is connected to a source 19 of direct current. In parallel with the primary winding 2 of the transformer and of such a value to resonate therewith are a fixed capacitor 20 and an adjustable capacitor 21. The screen grid of the oscillator tube 17 is connected through a resistor 22 to the source 19, the screen grid being bypassed to the cathode of the oscillator tube 17 by means of a condenser 23. The grid of the oscillator tube is connected to the parallel combination 24 of a resistor and a capacitor, for the purpose of providing grid bias, the combination 24 in turn being connected to the lower portion 14 of the tertiary winding by means of a terminal 15. The cathode of the oscillator tube 17 is connected to the low potential end of the secondary winding 3 by means of a terminal 12. The upper and lower portions of the tertiary

winding are connected together by means of a dummy lug 13. The secondary winding 3 of the transformer is connected to a load 25 which in the preferred form contains a high voltage rectifier 26, a resistance-capacitance filter 27, and a cathode ray tube 28, said combination being well known to the art.

The amount of voltage obtainable from the supply can be controlled by means of the oscillator plate tuning condensers 20 and 21. An increase of capacitance results in a lower no-load voltage.

In Figure 3 is shown a curve representative of the performance obtainable from the preferred circuit of Figure 2. When the picture on the face of the cathode ray tube is completely black, i. e. when the selection beam is not exciting the screen, the high voltage supply draws no current and its operation is represented by the intersection 29 of the performance curve 30 and the zero current line. As the subject matter portrayed on the picture tube becomes brighter, current is drawn from the supply and the voltage drops slightly as represented by the flat portion 31 of the performance curve 30. With an extremely bright picture full rated current flows. In the preferred form of the supply, the full load current coincides with a flexure point 32 on the performance curve. It is desirable that the voltage between no-load and full load operation remain fairly constant, this condition being known as good regulation. Stated another way, the slope of the flat portion 31 of the performance curve is the internal resistance of the supply over its operating range, which slope should be low. In the preferred circuit a supply adjusted to give 17.5 kilovolts at no load has approximately 3.5 megohms internal resistance between no load and a full load of 700 microamperes.

Beyond the operating range it is desirable that the performance curve drop quickly to zero, so that the maximum current that can be drawn from the supply is low. If this condition exists accidental contact of personnel with the supply will not represent a hazard. In view of the dual need for good regulation and low maximum current it becomes apparent that the flexure point must preferably be sharp and well defined at approximately the desired full load or a little above it. It has been found in practice that this condition exists only when the mutual inductance between the primary and tertiary windings is very small. This invention makes possible the desired regulation while confining the maximum current represented by point 33 well below the limit set by insurance underwriters.

It has been found that the improved performance of the described supply results in part from the low self capacitance of the high voltage winding which in turn results from the complete removal of all low voltage windings from the proximity of the high voltage end of the high voltage winding, as has been described.

The efficiency of the supply usually increases with the size of the transformer, higher Q in the windings being obtainable. Since the low voltage windings are grouped together, in a given amount of space, the secondary winding may be made larger than in the transformer used heretofore, resulting in unusually high efficiency.

In the preferred circuit the components have the following values:

Tube 17—6L6G

Transformer 18:

Primary winding, .00034 henry

Secondary winding, .24 henry

Tertiary winding, .00034 henry

Mutual inductance, primary to secondary, .0019 henry

Mutual inductance, secondary to tertiary, .0012 henry

Mutual inductance, primary to tertiary, none

Supply 19, 425 volts

Capacitor 20, .0028 microfarad

Capacitor 21, .005 to .0015 microfarad

Resistor 22, 33,000 ohms

Capacitor 23, .05 microfarad

Combination 24, 47,000 ohms and .00047 microfarad

Rectifier 26, 1B3

Filter 27, 100,000 ohms and .0005 microfarad

Cathode ray tube 28, 20AP4

Although the above components gave excellent results for the particular application for which they were used, the values selected are not critical. The value of fixed

capacitor 20 should be selected for the particular output voltage desired. For many applications, the adjustable condenser 21 may be omitted. In all cases, however, the mutual inductance between primary and tertiary winding should be small.

In the claims, a low voltage winding signifies that transformer winding connected to the input voltage supply source while high voltage winding signifies that winding connected to an output or utilizing load requiring a voltage greater than the input voltage. Specifically applying the terms when utilizing an electronic oscillator, the low voltage windings are connected to the oscillator voltage supply while the high voltage winding is connected to the utilizing electronic tube such as a cathode ray tube.

It should be understood that although a specific embodiment of my invention has been shown and described, other embodiments suitable for other desired conditions can readily be devised by those skilled in the art. The extent of these embodiments can best be ascertained from the following claims.

What is claimed is:

1. A device for supplying electrical power to a load, said device comprising an oscillator tube having input and output circuits, and a transformer comprising a first winding connected in one of said circuits, a second winding mutually inductively coupled to said first winding and electrically connected to said load, and a third winding adjacent said first winding and connected electrically to the other of said circuits, said third winding having separate parts, each of said parts being positioned to couple inductively in unequal magnitude to said second winding and in equal magnitude to said first winding, and being electrically connected together in coupling opposition with respect to said first winding.

2. A device for supplying electrical power to a load, said device comprising an oscillator tube having input and output circuits, and a transformer comprising a first winding connected in one of said circuits, a second winding positioned near said first winding and connected to said load and having high and low potential ends and a tap intermediate said ends, and a coil positioned adjacent and inductively coupled to said first winding, and connected in the other of said circuits in series with the portion of said second winding between said low potential end and said tap in coupling opposition with respect to said first winding, said coil and said portion of said second winding being inductively coupled to said first winding in equal magnitude.

3. A device for supplying electrical power to a load, said device comprising an oscillator tube having a grid, a plate, and a cathode, and a transformer comprising a first winding connected in series with a direct voltage source between said plate and said cathode, a second winding connected to said load and having high and low potential ends and a tap intermediate said ends and a coil positioned adjacent to and inductively coupled to said first winding, and connected in series with the portion of said second winding between said low potential end and said tap between said grid and said cathode in coupling opposition to said first winding, said coil and said portion of said second winding being inductively coupled to said first winding in equal magnitude.

4. A transformer comprising a first winding, a second winding positioned to be inductively mutually coupled to said first winding and having high and low potential ends and a tap intermediate said ends, and a third winding positioned adjacent and inductively coupled to said first winding and connected electrically to said tap in coupling opposition to the portion of said second winding between said tap and one of said ends, said third winding being inductively coupled solely to said second winding.

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