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APPARATUS FOR THE SUPPLY OF HIGH-VOLTAGE UNIDIRECTIONAL
CURRENTS FROM A RELATIVELY LOW-VOLTAGE
ALTERNATING CURRENT SOURCE

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2 SHEETS—SHEET 1

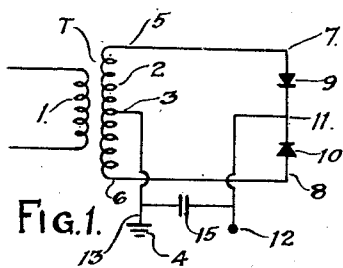


FIG. 1.

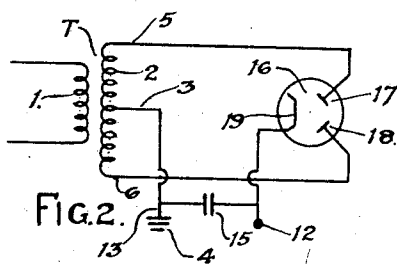


FIG. 2.

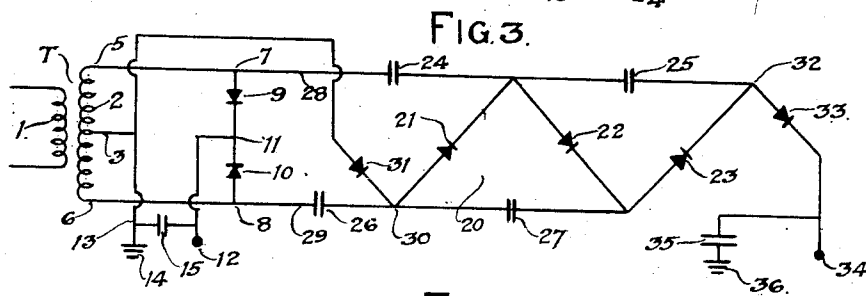


FIG. 3.

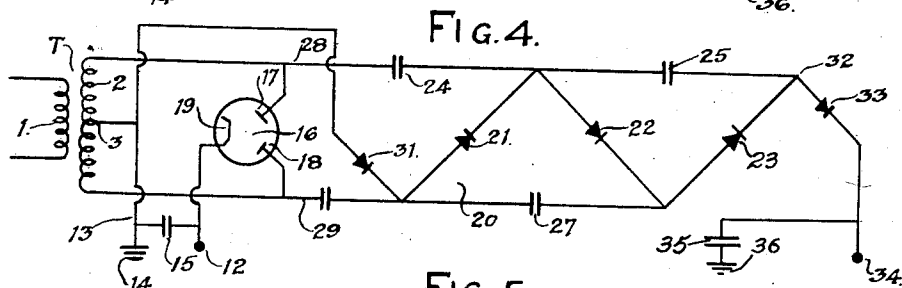


FIG. 4.

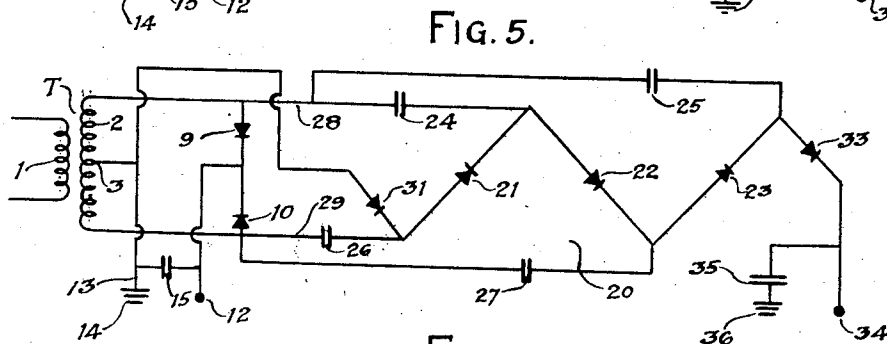


FIG. 5.

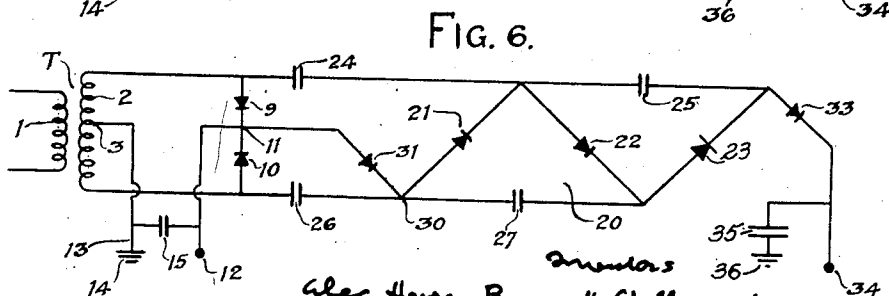


FIG. 6.

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2 SHEETS—SHEET 2

FIG. 7

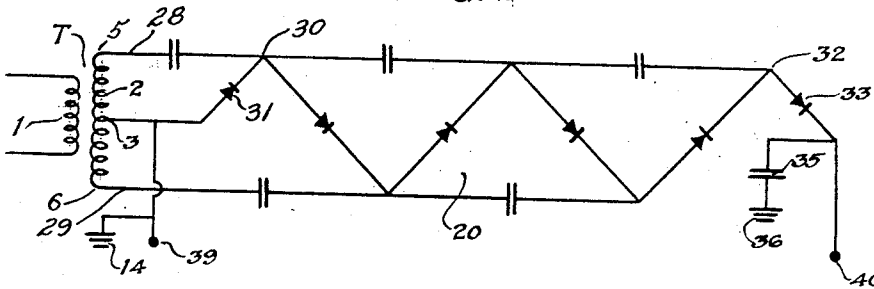
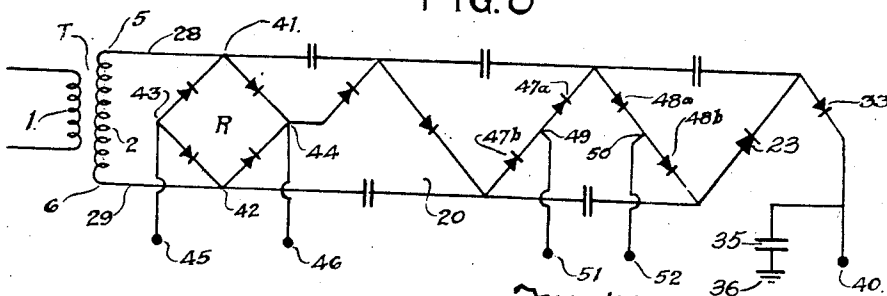


FIG. 8



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UNITED STATES PATENT OFFICE

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APPARATUS FOR THE SUPPLY OF HIGH-VOLTAGE UNIDIRECTIONAL CURRENTS FROM A RELATIVELY LOW-VOLTAGE ALTERNATING CURRENT SOURCE

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6 Claims. (Cl. 307-110)

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This invention relates to apparatus for the supply of high voltage uni-directional current from a relatively low voltage alternating current source and has for its object to provide improved apparatus of this character.

The invention is more particularly applicable to cathode ray tube equipment of the kind employed in television receiving sets for the provision of the high uni-directional voltage (hereinafter referred to as the E. H. T. voltage) required for the cathode ray tube.

Television receiving sets and the like apparatus usually comprise in addition to a cathode ray tube, thermionic valves the anode circuits of which are arranged to be supplied with the necessary uni-directional voltage (hereinafter referred to as H. T. voltages) from a centre-tapped transformer and rectifier system of well known type and in certain particularly advantageous forms of the invention the E. H. T. voltage is derived directly from the centre-tapped transformer winding providing the H. T. voltages thereby avoiding the necessity of providing separate and relatively costly high tension transformer or other apparatus for this purpose.

According to the invention the apparatus for the supply of a high voltage uni-directional current from a relatively low voltage centre-tapped alternating current source comprises a voltage multiplier system of the kind comprising a chain of series connected rectifiers the points of connection between which are connected through one or more condensers to the outer terminals of the alternating current source, the connections being made in turn first to one outer terminal and then to the other, alternately, the end of the chain further from the source of supply being connected through an auxiliary rectifier to one terminal of the uni-directional high voltage supply, which terminal is connected through a condenser to the mid-point of the alternating current source, the other end of the chain being uni-directional high voltage terminal, which is maintained at the same alternating current potential as the mid-point of the alternating current source. In this manner the full voltage at the charging or energising terminals is utilised for voltage multiplication without superimposing an alternating voltage of the fundamental frequency of the source on the uni-directional voltage derived from the multiplier system.

In a preferred form of the invention as applied to television sets or the like of the kind indicated comprising a centre-tapped transformer and rectifier system for providing the

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H. T. voltage, one of the E. H. T. terminals is connected to the centre tap of the transformer while the other E. H. T. terminal is connected through a rectifier to the condenser and rectifier at the end of the multiplier system remote from the transformer, this terminal being also connected through a condenser to the centre tap of the transformer.

The invention will now be described with reference to the accompanying drawings Figures 1 and 2 of which are diagrammatic views of known centre-tapped transformer and rectifier systems for the supply of unidirectional H. T. voltage from an alternating current source the system of Figure 1 utilising a pair of oppositely connected metal rectifiers and the system of Figure 2 a two anode thermionic valve. Figures 3 to 6 inclusive are similar diagrams illustrating various applications of the invention to the systems of Figure 1 or 2.

Figures 7 and 8 are diagrams similar to Figures 3 to 6 inclusive but illustrating more general forms of the invention not embodying the H. T. system diagrammatically shown in Figures 1 and 2.

Referring now first to Figures 1 and 2, two well known connection systems for obtaining H. T. voltage for the anode circuits of thermionic valves are illustrated comprising a transformer T the primary winding 1 of which is connected to an alternating current supply circuit of a usual relatively low voltage e. g. 230 volts, the secondary winding 2 of the transformer T being designed to have a high terminal voltage e. g. 700 volts. The transformer winding 2 is provided with a centre tap 3 connected to earth at 4 and constituting one of the H. T. voltage terminals.

In the system of Figure 1, the outer terminals 5, 6 of the transformer winding 2 are connected to the terminals 7, 8 of a pair of dry contact rectifiers 9, 10 oppositely connected in series with one another. The point 11 of series connection of the rectifiers 9, 10 is connected to a terminal 12 constituting one of the H. T. terminals of the system, the other H. T. terminal 13 being connected to the centre tap 3 of the transformer winding 2 and is earthed as indicated at 14. The terminals 12 and 13 are cross-connected by a suitable condenser 15, the anode of the thermionic valves (not shown) being connected to the H. T. terminal 12 in any usual manner.

In the alternative system of Figure 2, the pair of rectifiers 9, 10 are replaced by a thermionic rectifying valve 16 having two anodes 17, 18 connected to the outer terminals 5, 6 respectively

of the transformer winding 2, while the cathode 19 of the valve 16 is connected to the H. T. terminal 12.

Figures 1 and 2 are two typical examples of well known transformers and rectifier systems for enabling the required H. T. voltage for a cathode ray tube equipment or the like to be derived from a commercial alternating current supply circuit.

Referring now to Figure 3 the invention is illustrated as applied to the system shown in Figure 1 and comprises a voltage multiplier system indicated as a whole at 20 consisting of a number of rectifiers 21, 22, 23 (preferably as shown diagrammatically of the dry contact type) connected in series so as to provide a continuous low resistance circuit for one direction of current flow together with condensers 24, 25, 26, 27 connected so as to be charged in series from charging terminals 28, 29 connected to the outer terminals 5, 6 of the transformer winding 2.

The point 30 in the multiplier system is connected through a half-voltage rectifier section or stage 31 to the centre tap 3 of the transfer winding 2 while the point 32 at the other end of the multiplier system is connected through a half-voltage rectifier section or stage 33 to one E. H. T. terminal 34, the other E. H. T. terminal being constituted by the terminal 13 common to both the H. T. voltage and the E. H. T. voltage. The centre tap 3 of the transformer is connected to ground at 14 and to E. H. T. terminal 34 through a condenser 35 which is earthed at 36.

In operation the multiplier system 20 functions in the well-known manner to develop a uni-directional voltage between the points 30 and 32 of the system due to the charges stored in the condensers. Between the point 30 and the centre tap 3 of the transformer winding 2 an alternating current voltage exists equal to that between the centre tap 3 and the outer terminal 6 of the winding 2. Similarly between the point 32 and the centre tap 3 of the transformer winding 2 an alternating current voltage exists equal to that between the centre tap 3 and the outer terminal 5 of the transformer winding 2.

By connecting points 30 and 32 to the centre tap 3 in a suitable manner through rectifiers 31 and 33, the above mentioned voltages are added to the E. H. T. voltage produced between those points by the multiplier, the two rectifiers 31 and 33 preventing the injection of an alternating current ripple into that voltage. As rectifiers 31 and 33 have to withstand only half the transformer voltage they may be smaller units than those employed in the multiplier circuit itself and are accordingly herein termed half-voltage rectifiers.

Referring now to Figure 4 a system similar to that of Figure 3 is shown as applied to an H. T. system of the kind illustrated in Figure 2, the anodes 17, 18 of a thermionic valve 16 being connected to the charging terminals 28, 29 respectively of the multiplier system 20 while the cathode 19 of the valve 16 is connected to the H. T. voltage terminal 12.

Referring now to Figure 5 the condensers 24, 25, 26, 27 of the voltage multiplier system 20 are shown as arranged to be charged in parallel with one another from the charging terminals 28, 29 instead of in series as in the system of the preceding figures, but in other respects the system of Figure 5 operates in the same manner as the system of Figure 3.

Figure 6 illustrates a modification of the system

of Figure 3 in which the point 30 is connected through the rectifier section 31 to the point 11 of series connection of the rectifiers 9 and 10 so that the voltage developed across the E. H. T. voltage terminals 13 and 34 is the sum of the H. T. voltage across the terminals 13 and 12 and the voltage developed by the multiplier system 20. The E. H. T. voltage at the terminal 34 is thus increased by the amount of the voltage at the H. T. voltage terminal 12.

It will be understood that in the system of Figures 3, 5 and 6 a thermionic valve may be substituted for the rectifiers 9, 10 as in the system of Figure 4.

Furthermore the voltage multiplier system 20 employed in any of the systems may be of the series-connected condenser type shown in Figures 3, 4 and 6 or of the parallel-connected condenser type shown in Figure 5.

It will also be understood that the rectifier 31 in the systems of Figures 3, 4 and 5 may be connected to the H. T. voltage terminal 12 as in the systems of Figure 6 if desired.

It will be seen that the forms of the invention above described enables the required E. H. T. voltage to be obtained in a particularly simple and efficient manner without interfering with the standard H. T. voltage centre-tapped transformer and rectifier system. Furthermore no special transformer or transformer winding, pulse generator or oscillator system is required for obtaining the E. H. T. voltage as has hitherto been usual, with a corresponding saving in cost and complexity.

Referring now to Figures 7 and 8 the invention is illustrated as applied in a more general form to systems in which an existing centre tapped transformer and rectifier system is not available.

In Figure 7 the charging terminals 28, 29 of the voltage multiplier system 20 are connected to the outer terminals 5, 6 of the secondary winding 2 of a transformer T the primary winding 1 of which is connected to an alternating current source of supply. The winding 2 is provided with a centre tap 3 which is connected to one of the E. H. T. terminals 39, the centre tap 3 being also connected through a half voltage rectifier section 31 to the point 30 in the voltage multiplier system 20. The latter comprises condensers and rectifier connected in a similar manner to that of the preceding figures the outermost point 32 of the multiplier system 20 being connected to the other E. H. T. terminal through a half-voltage rectifier section 33. The terminal 40 is connected to earth at 36 through a condenser 35 the E. H. T. terminal 39 being also connected to earth at 14.

In the system of Figure 8, the terminals 5, 6 of the secondary winding 2 of the transformer T are connected to the input terminals 41, 42 of a bridge rectifier system R the output terminals 43, 44 of which are connected to the terminals 45, 46. The terminal 45 constitutes the common H. T. and E. H. T. terminal, the terminal 46 constituting a terminal from which a voltage may be derived corresponding to the rectified uni-directional voltage of the transformer winding 2.

The other E. H. T. terminal 40 is connected to the voltage multiplier system in the same manner as in the previous figures, being connected to earth through a suitable condenser 35.

In Figure 8, certain of the rectifiers of the voltage multiplier system 20 are shown as subdivided into sections 47a, 47b, and 48a, 48b the points 49, 50 of series connection of these sections being connected to intermediate E. H. T.

terminals 51, 52 from which corresponding uni-directional voltages may be derived.

The condensers of the voltage multiplier system shown in Figures 7 and 8 may if desired be arranged to be charged in parallel with one another by utilising connections similar to those of the voltage multiplier of Figure 5.

In either of the systems above described with reference to Figures 7 and 8 or the modifications thereof above indicated the charging terminals of the voltage multiplier system may be connected through one or more blocking condensers to the alternating current supply circuit directly instead of through a transformer, the neutral or earthed point of this circuit constituting the negative uni-directional current terminal.

It will be understood that by reversing the connections of the rectifiers of the voltage multiplier system in any of the arrangements above described the polarity of the E. H. T. and H. T. terminals will be transposed.

It will be seen from the above description that the invention enables the full transformer or supply circuit voltage to be utilised for charging the voltage multiplier systems the charging terminals of which are however at a voltage to earth which is only one half of this full transformer or supply circuit voltage.

The invention is evidently not limited to the particular circuit connections above described and illustrated by way of example.

Having thus described our invention, what we claim is:

1. An apparatus for the supply of high voltage uni-directional current comprising in combination a relatively low voltage alternating current source, a transformer having a primary winding connected to said source, and a secondary winding having a center tap, a voltage multiplier system including condensers, rectifiers connected in cascade and energised from said secondary winding, a first uni-directional current terminal connected to said center tap of said secondary winding, a rectifier connecting said first uni-directional current terminal to one of the energising terminals of said multiplier systems, a second uni-directional current terminal, a rectifier connecting said second uni-directional current terminal to the end of said multiplier system remote from said transformer, and a connection including at least one condenser between said uni-directional current terminals.

2. An apparatus for the supply of high voltage unidirectional current comprising in combination a relatively low voltage alternating current source, a transformer having a primary winding connected to said source and a secondary winding having a center tap, a full wave rectifier having the input terminals connected to said secondary winding, two uni-directional voltage terminals connected respectively to said center tap in said transformer secondary winding and to an output terminal of said full-wave rectifier, a voltage multiplier system including condensers and rectifiers connected in cascade and having its energising terminals connected to said transformer secondary winding, a connection including a rectifier between one of said energising terminals and one of said uni-directional voltage terminals, a third uni-directional voltage terminal, a rectifier connecting said third uni-directional voltage terminal to the end of said voltage multiplier system remote from said transformer, and at least one condenser connecting said third uni-directional voltage terminal to said center tap.

3. An apparatus for the supply of high voltage uni-directional current comprising in combination, a relatively low voltage alternating current source; a transformer having a primary winding adapted to be connected to said source and a secondary winding having a center tap; a voltage multiplier including a plurality of rectifiers and condensers connected so as to form a plurality of stages, each of said stages comprising a pair of said rectifiers of said voltage multiplier connected with like polarity in series across one of said condensers of said voltage multiplier, successive stages being connected with the condensers thereof in series and with the rectifiers of one of said stages being connected with like polarity in series with the rectifiers of the succeeding stage, the middle point of the pair of said rectifiers of one of said stages being connected to the middle point of the pair of said rectifiers of the succeeding stage through one of said condensers; a first condenser connected between one end of said secondary winding and one side of the first rectifier of the first of said stages; a second condenser connected between the other end of said secondary winding and the other side of said first rectifier; a first uni-directional high voltage terminal connected to the center tap of said secondary winding; a rectifier connected with like polarity in series with said first rectifier between same and said first terminal; a second uni-directional high voltage terminal; a rectifier connected with like polarity in series between the last rectifier of the last stage of said voltage multiplier and said second terminal; and a condenser connected between said second terminal and center tap of said secondary winding.

4. An apparatus for the supply of high voltage uni-directional current comprising in combination, a relatively low voltage alternating current source; a transformer having a secondary winding having a center tap; a full wave rectifier connected across said secondary winding; a direct current output terminal forming part of said full wave rectifier; a condenser connected between said output terminal and said center tap of said secondary winding; a voltage multiplier system including a plurality of half-wave rectifiers connected in series including a first rectifier, and a plurality of condensers connected one across each two successive ones of said rectifiers; condensers connecting said first rectifier, respectively, to the ends of said secondary winding; a half-wave rectifier connected in series between said first rectifier and said center tap; a high voltage uni-directional terminal; a half-wave rectifier in series with and connecting said plurality of half-wave rectifiers to said high voltage terminal and a condenser connected between said high voltage terminal and said center tap.

5. An apparatus for the supply of high voltage uni-directional current comprising in combination, a winding of an alternating current transformer; a plurality of rectifiers connected in series; condensers connecting, respectively, the two ends of each of said rectifiers to the two ends of said transformer winding; a center tap in said transformer winding; a rectifier connected between said center tap and the first of said plurality of rectifiers and in series therewith; a high uni-directional current voltage terminal; a rectifier connected in series with said plurality of rectifiers between the last one of said plurality and said terminal; and a condenser connected between said terminal and said center tap.

6. An apparatus for the supply of high voltage

uni-directional current, comprising in combination, a relatively low voltage alternating current source having a center tap; a voltage multiplier system including a plurality of condensers and rectifiers connected in cascade and adapted to be energized from said source; a first output terminal connected to said center tap of said source; a second output terminal connected to the end of said multiplier system remote from said source; a rectifier connected between said center tap and the end of said multiplier adjacent said source; a rectifier interposed between said second output terminal and said remote end of said multiplier system; and a condenser connected between said second output terminal and said center tap of said source.

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LESLIE HURST PETER.

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