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HIGH VOLTAGE SUPPLY CIRCUIT FOR TELEVISION SYSTEMS

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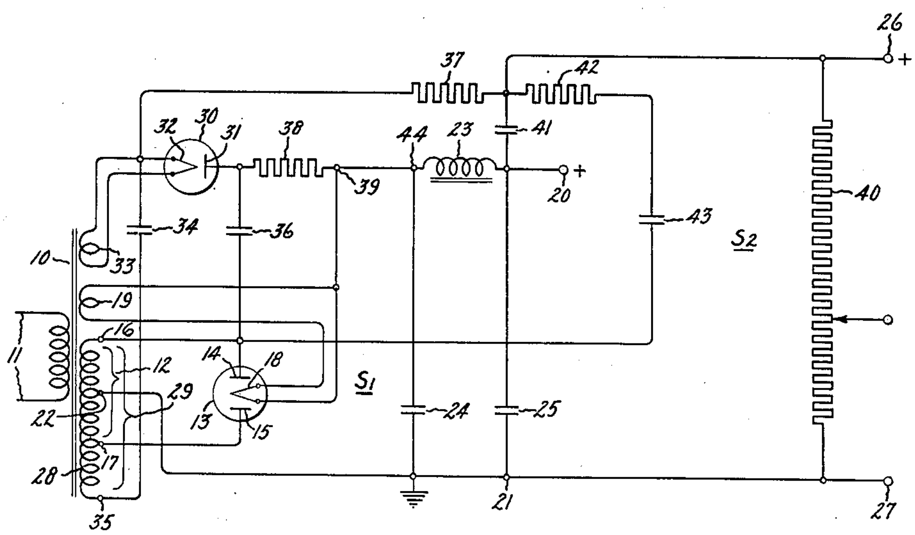

Inventor:
Robert B. Dome.
by Harry E. Dunham
His Attorney.

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HIGH VOLTAGE SUPPLY CIRCUIT FOR TELEVISION SYSTEMS

Robert B. Dome, Bridgeport, Conn., assignor to General Electric Company, a corporation of New York

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5 Claims. (Cl. 171—97)

My invention relates to high voltage power supply circuits and particularly to power supply circuits for cathode-ray tubes used in television systems.

This application is a continuation-in-part of my application, Serial No. 237,785, filed October 29, 1938.

In television receivers power is required to be supplied to the cathode-ray tube at a relatively high voltage. It has been suggested heretofore to supply this power by providing a special high voltage winding arranged to be energized by the usual transformer which supplies power to amplifier or other tubes of the system. The above arrangement, suggested heretofore, entails the disadvantages that this special winding is of relatively high cost.

It is an object of my invention to provide a high voltage power circuit for television cathode-ray tubes which adds relatively little to the cost of the system.

It is a further object of the invention to utilize as a voltage source for the cathode-ray tube the secondary winding of the power transformer which supplies the usual amplifier or other tubes of the receiver.

It is another object of the invention to provide, for the energizing of the cathode-ray tube, a voltage which is the sum of the voltage produced by a secondary winding of the power transformer and the voltage, including that due to the drop through a filter reactor, supplied to a circuit connected to the power transformer for the supply of power to the amplifier or other tubes of the system.

It is a still further object to provide a low cost filter system for the high voltage cathode-ray tube supply circuit.

The novel features which are characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation together with further objects and advantages may best be understood by reference to the following description taken in connection with the accompanying drawing, the single figure of which is a diagrammatic representation of a portion of a television receiver in which my invention has been embodied.

In the single figure of the drawing the television system illustrated therein is similar in general to the television system illustrated in my above mentioned prior application, Serial No. 237,785. The present system includes a usual rectifier circuit for the supply of power for the operation of conventional radio receiver tubes. This usual supply circuit, designated generally by S_1, comprises a transformer 10 having a primary 11 connected to a current source (not shown) and a secondary 12; a rectifier apparatus or tube 13 having anodes 14 and 15 connected to the opposite terminals 16 and 17 of secondary 12 and a cathode 18 supplied with heating current from a secondary winding 19 of transformer 10; output terminals 20 and 21 connected respectively to the cathode 18 and to the mid-tap 22 of secondary 12; and a filter means including a filter reactor 23 and capacitors 24 and 25.

In the television system illustrated in the above mentioned prior application, in order to provide the high unidirectional voltage required for the cathode-ray tube (not shown) and which is to be supplied thereto through the output terminals 26 and 27 of the cathode-ray tube supply circuit designated generally by S_2, the relatively high voltage secondary winding 12 is utilized as part of the voltage source, this secondary 12 being already provided on transformer 10 and being designed for the supply of voltage for the conventional radio receiver tubes (not shown), or for other purposes, through the output terminals 20 and 21. It has been found, however, that the voltage supplied by my above-mentioned system utilizing secondary 12 as part of the cathode-ray tube voltage source is insufficient for the efficient operation of a certain cathode-ray tube which is larger than the tube for which the prior system was designed. In accordance with my present invention I have provided the additional voltage required for the larger tube, while at the same time retaining secondary 12 as part of the voltage source for this tube, by extending one end of secondary 12, additional turns 28 being provided to obtain this additional voltage. For the purpose of utilizing the total secondary winding 29, thus constituted by the original secondary 12 and the additional winding 28, as a part of the voltage source for the cathode-ray tube supply circuit, an auxiliary rectifier tube 30 is provided, as in my above-mentioned prior system, having an anode 31, and a cathode 32 heated from a secondary winding 33 on transformer 10. Rectifier 30 is then supplied with alternating voltage from the total secondary winding 29 through a capacitor 34 connected between one terminal 35 of the winding 29 and the cathode 32 of the tube 30, and through a capacitor 36 connected between the other terminal 16 of the winding 29 and the anode 31 of the tube 30. Cathode 32 of auxiliary rectifier 30 is connected to the high voltage terminal 26 of the cathode-ray tube supply circuit through a connection including a resistor 37. The anode 31 of tube 30 is connected, as in the above-mentioned prior system, through a resistor 38 to the connection 39 between cathode 18 of tube 13 and filter reactor 23, the latter reactor and the output terminals of circuit S_1 thus being included in the cathode-ray tube circuit S_2. A voltage divider 40 is preferably provided connected between the cathode-ray tube supply circuit output terminals 26 and 27 to permit the obtaining of additional voltages as for focus voltage for the cathode-ray tube.

Filter means for the cathode-ray tube circuit S_2 comprise a filter capacitor 41 connected between output terminal 26 of the cathode-ray tube supply circuit S_2 and output terminal 20 of supply circuit S_1; the resistor 37 in series with the capacitor 34; and a resistor 42 in series with a capacitor 43. Capacitor 34 and resistor 37 are connected in series between terminal 35 of the total secondary winding 29 and terminal 26 of circuit S_2. Resistor 42 and capacitor 43 are connected in series between terminal 16 of the total secondary winding 29 and the terminal 26. The ratio of the resistance value of resistor 37 to the resistance value of resistor 42 is made substantially equal to the ratio of the alternating voltage from terminal 35 of total secondary winding 29 to tap 22, which is at ground, to the alternating voltage from terminal 16 to tap 22 or ground. Preferably the ratio of the reactance value of capacitor 34 to the reactance value of capacitor 43 is also made substantially equal to the above-mentioned ratio of the alternating voltage from terminal 35 to tap 22 or ground to the alternating voltage from terminal 16 to tap 22 or ground. Such adjustment of the reactance values of capacitors 34 and 43 may or may not be necessary, depending upon the degree of accuracy required in balancing out undesired oscillations.

From the foregoing description of the system illustrated in the drawing it will be seen that the radio receiver tube supply circuit S_1 may be traced from positive terminal 20, through reactor 23, main rectifier tube 13, secondary winding 12 of transformer 10, and mid-tap 22 of secondary 12 to terminal 21 which is preferably at ground. It will also be seen that the cathode-ray tube supply circuit S_2 may be traced from the high voltage terminal 26, through resistor 37, auxiliary rectifier tube 30, resistor 38, filter reactor 23 of circuit S_1, and the load between terminals 20 and 21 of circuit S_1, to terminal 27.

In operation of the system illustrated in the drawing, let it be assumed that the cathode-ray tube supply circuit S_2 is under no-load conditions, no current being drawn from the output terminal 26, and that the supply circuit S_1 is under load conditions. Under these conditions twice the RMS voltage per anode for the main rectifier 13 exists across the secondary winding 12 of transformer 10. But since in accordance with my present invention the total secondary winding 29, which is connected across the auxiliary rectifier 30, comprises the winding 12 and in addition the winding 28 which is an extension of winding 12 at one extremity thereof, therefore the total alternating voltage which is rectified by the auxiliary rectifier 30 is the sum of twice the RMS voltage per anode of main rectifier plus the voltage due to the added winding 28. Also, under the assumed load conditions in circuit S_1 a predetermined unidirectional output voltage exists across terminals 20 and 21 of circuit S_1, and a predetermined unidirectional voltage drop due to the current drain in the supply circuit S_1 exists across the filter reactor 23. A total predetermined unidirectional voltage therefore exists across the capacitor 24 of circuit S_1 which is the sum of the load voltage across terminals 20 and 21 and the voltage drop across the filter reactor 23.

Since the anode 31 of auxiliary rectifier 30 is connected, through resistor 38 and connection 39, to the positive terminal 44 of filter reactor 23, therefore the above-noted sum of unidirectional voltages across capacitor 24 of circuit S_1 is added to the unidirectional voltage produced, by rectification in auxiliary rectifier 30, from the total secondary winding 29 of transformer 10 constituted by the secondary 12, which supplies circuit S_1, and the added winding 28. Therefore under the assumed no-load conditions in cathode-ray tube supply circuit S_2 and load conditions in receiver tube supply circuit S_1, the total unidirectional voltage appearing across terminals 26 and 27 of cathode-ray tube supply circuit S_2 is the sum of

$$\sqrt{2}$$

times the RMS voltage across the secondary 12 which supplies the receiver supply circuit S_1 plus the RMS voltage across the winding 28 added to winding 12 to produce the total exciting secondary winding 29 which is connected across the auxiliary rectifier 30, plus the load voltage across the terminals 20 and 21 of circuit S_1, plus the voltage drop through filter reactor 23 of circuit S_1.

Under load conditions in circuit S_2, the relatively small current in this circuit flows through resistors 37 and 38. A certain voltage drop therefore exists in these resistors. The above-noted total no-load voltage impressed across terminals 26 and 27 of circuit S_2 is of such value and the voltage drop due to the resistance introduced in the circuit S_2 by the resistors 37 and 38 is of such value that under load conditions in circuit S_2 the resultant voltage which is supplied to the cathode-ray tube is of a predetermined desired value.

The hereinabove-described filter means for the cathode-ray tube supply circuit S_2 constitute together with the winding 29, which energizes the auxiliary rectifier 30, a partial bridge circuit. Two adjacent arms of the bridge are constituted, respectively, by the section of winding 29 between terminal 16 and tap point 22, and by the section between terminal 35 and tap point 22. The other pair of bridge arms are constituted, respectively, by capacitor 34 and resistor 37 in series between winding terminal 35 and terminal 26 of circuit S_2, and capacitor 43 and resistor 42 in series between winding terminal 16 and the terminal 26. The load circuit from which the undesired oscillations are to be filtered is constituted by cathode-ray tube supply circuit S_2, which is connected across the bridge corners constituted by the tap 22 of winding 29 and the terminal 26 of circuit S_2. The filter capacitor 41 and filter capacitor 25, which are in series connection, are connected in shunt with the cathode-ray tube supply circuit S_2, between the corner 22 and corner 26 of the bridge.

In operation of this partial bridge circuit the alternating voltages across filter capacitor 41 come from two sources, one from the terminal 35 of winding 29 through capacitor 34 and resistor 37, and the other from terminal 16 of winding 29 through capacitor **43** and resistor **42**. These two voltages are in opposition, and the ratio of the voltage in arm **22**, **35** to that in arm **22**, **16** is equal to the ratio of the resistance of resistor **37** to the resistance of resistor **42**, and preferably also to the ratio of the reactance of capacitor **34** to the reactance of capacitor **43**. Therefore, because of the resulting balancing of opposed voltages across filter capacitor **41** only a small ripple voltage remains across this capacitor. Since the remaining ripple to be filtered from circuit S_2 is thus small, capacitor **41** need be only of relatively small capacity.

In a practical system constructed in accordance with my present invention and designed to provide approximately 1800 volts output in cathode ray tube supply circuit S_2 under load conditions in this circuit, the voltage across terminals **20** and **21** of supply circuit S_1 is 265 volts and the load current drain from this circuit is 180 milliamperes. In filter reactor **23**, five watts are consumed and the voltage drop thereacross is

$$E=\frac{W}{I}=\frac{5}{.18}=28 \text{ volts}$$

Therefore, the sum of the voltage in supply circuit S_1, across capacitor **24** is 265+28=293 volts.

The RMS voltage per anode in main rectifier **13** is approximately 315 volts and therefore the RMS voltage across secondary **12** is 2×315=630. The RMS voltage added to secondary **12** by the turns **28** which with winding **12** make up the total winding **29**, is 540 volts, and the total RMS voltage across winding **29** is 1170 volts.

The rectified voltage produced by auxiliary rectifier **30** under no-load conditions in circuit S_2 is

$$\sqrt{2}\times 1170=1657 \text{ volts D. C.}$$

The total voltage at the output terminals **26** and **27** of the cathode-ray tube supply circuit S_2 under no-load conditions in the latter circuit is E_t=1657+293=1950 volts.

Under load conditions in circuit S_2 the output current may be approximately 500 microamperes. This current flows through resistors **37** and **38**. The total resistance of these resistors in order to obtain approximately 1800 volts across terminals **26** and **27** of circuit S_2 is

$$R=\frac{E}{I}=\frac{1950-1800}{500\times 10^{-6}}=300{,}000 \text{ ohms}$$

The constants for resistance and capacitance elements employed in the foregoing fractional system in supplying the desired high voltage in the cathode-ray tube circuit S_2 and in accomplishing the required degree of filtering in the latter circuit are as follows:

	Ohms	Watts
Resistor 37	220,000	3.3
Resistor 38	80,000	1.25
Resistor 42	80,000	1.25

	Microfarads	Volts
Capacitor 41	0.4	2,000
Capacitor 43	0.1	2,000
Capacitor 34	0.03	2,000
Capacitor 36	0.25	400

It will be seen that by providing, as part of the voltage supply source for the cathode-ray tube, a secondary winding **29** for transformer **10** which is constituted by the already existing high voltage secondary **12** to which is added the turns **28**, a required relatively very high A. C. voltage is obtained without entailing the considerable cost of an entirely separate secondary to produce this required A. C. voltage which is rectified by the auxiliary rectifier.

My invention has been described herein in a particular embodiment for purposes of illustration. It is to be understood, however, that the invention is susceptible of various changes and modifications and that by the appended claims I intend to cover any such modifications as come within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, a current source, a load circuit, means including a rectifier and a transformer having an energizing winding connected to said rectifier to supply power to said circuit from said source, a second load circuit, a winding connected in series with said energizing winding to form with said energizing winding an energizing winding for said transformer of a greater number of turns than said first-named energizing winding, and means including a rectifier connected in series in said second circuit and across said second-named energizing winding to supply power to said second load circuit from said source.

2. In combination, a load circuit, a rectifier, a transformer winding, means to supply a voltage to said circuit from said winding through said rectifier, a second load circuit, a second transformer winding, means to connect said second winding to said first winding to form with said first winding a transformer winding of a larger number of turns than said first-named transformer winding, a second rectifier connected across said second-named transformer winding, and means to connect said second rectifier in series with said first-named circuit, whereby the voltage supplied to said first-named circuit through said first-named rectifier is added to the voltage supplied to said second circuit through said second rectifier.

3. In combination, a load circuit having a filter reactor in series therewith, a rectifier, a transformer winding, means to supply a voltage to said circuit from said winding through said rectifier, a second load circuit, a second transformer winding, means to connect said first and second windings in series to form a transformer winding of a larger number of turns than said first named transformer winding, a second rectifier connected across said transformer winding of a larger number of turns to supply voltage therefrom to said second circuit, and means to connect said second rectifier in series with said filter reactor and said second circuit.

4. In combination, two load circuits, a transformer winding having a center tap, means to impress a rectified voltage from said winding on one of said circuits, a winding connected to said transformer winding to form a second transformer winding having a larger number of turns than said first transformer winding, means to impress a rectified voltage from said second transformer winding on the other of said circuits, a filter capacitor connected across said other circuit, and means to connect the opposite terminals of said second transformer winding each through a capacitor and a resistor to the high tension side of said filter capacitor, the ratio of the voltages in said second transformer winding between one

of said terminals and said center tap and between the other of said terminals and said center tap being equal to the ratio of the resistance of the resistor corresponding to said one of said terminals and the resistance of the other resistor.

5. In combination, two load circuits, a transformer winding having a center tap, means to impress a rectified voltage from said winding on one of said circuits, a winding connected to said transformer winding to form a second transformer winding having a larger number of turns than said first transformer winding, means to impress a rectified voltage from said second transformer winding on the other of said circuits, a filter capacitor connected across said other circuit, and means to connect the opposite terminals of said second transformer winding each through a capacitor and a resistor to the high tension side of said filter capacitor, the ratio of the voltages in said second transformer winding between one of said terminals and said center tap and between the other of said terminals and said center being equal to the ratio of the resistance of the resistor corresponding to said one of said terminals and the resistance of the other resistor and also equal to the ratio of the reactance of the capacitor corresponding to said one of said terminals to the reactance of the capacitor corresponding to the other of said terminals.

ROBERT B. DOME.