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S. J. HARRIS

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VOLTAGE MULTIPLIER CIRCUIT

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FIG. 1

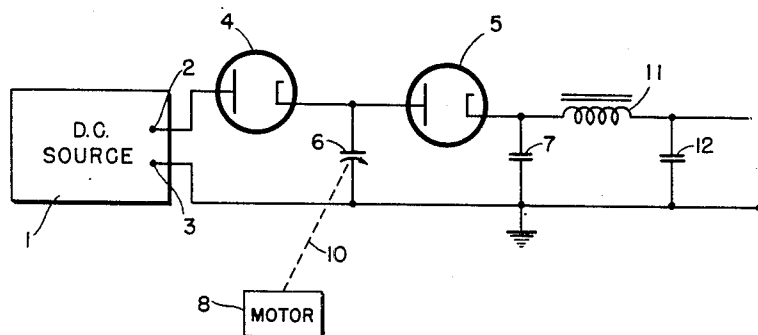
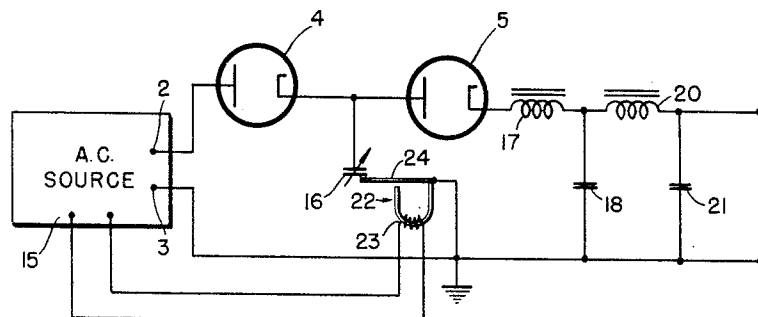


FIG. 2



INVENTOR.

SAMUEL J. HARRIS

BY

Arthur A. Smith

ATTORNEY

UNITED STATES PATENT OFFICE

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VOLTAGE MULTIPLIER CIRCUIT

Samuel J. Harris, Fort Wayne, Ind., assignor, by
mesne assignments, to Farnsworth Research
Corporation, a corporation of Indiana

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This invention relates to transformerless power supplies and particularly to a circuit for multiplying the voltage developed by a source of unidirectional or alternating voltage.

It is conventional practice to provide a rectifier circuit arranged to double the peak voltage developed by an alternating voltage source. It has also been proposed to provide a circuit including a plurality of diodes and condensers arranged in cascade for repeatedly multiplying the voltage of an alternating voltage source. However, a circuit of this type has the drawback that a large number of diodes and condensers is required to obtain an output voltage that is appreciably higher than the input voltage.

In a television receiver, for example, a unidirectional voltage of the order of several thousand volts is required for accelerating the cathode ray of the television image reproducing tube. Thus, for a television receiver a voltage multiplier would be desirable for multiplying the unidirectional anode voltage of the receiver which usually amounts to about 300 volts only thereby to develop a unidirectional voltage of the order of several thousand volts required for the image reproducing cathode ray tube.

It is an object of the present invention, therefore, to provide a novel voltage multiplier circuit which requires a minimum of components.

A further object of the invention is to provide a simple voltage multiplier circuit which permits to multiply the voltage of a unidirectional or alternating voltage source by a large factor.

In accordance with the present invention, there is provided a voltage multiplier circuit comprising a source of voltage. There are provided a first electric storage element such as a condenser variable between a maximum and a minimum capacitance and means for varying the capacitance of the first condenser. There is further provided a second electric storage element which may also be a condenser. Finally unilaterally conducting means are provided for coupling the source of voltage to the two condensers to charge the first condenser from the voltage source when the capacitance of the first condenser is near its maximum value and to discharge the first condenser into the second condenser when the capacitance of the first condenser is near its minimum value. In this manner a voltage is developed across the second condenser which is higher than the voltage of the voltage source. Actually, the output voltage is multiplied by a factor which equals the ratio of the maximum

to the minimum capacitance of the first condenser.

For a better understanding of the invention, together with other and further objects thereof, reference is made to the following description, taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the accompanying drawing, Fig. 1 is a circuit diagram of a voltage multiplier connected to a direct current source and embodying the present invention, while Fig. 2 is a circuit diagram of a modified voltage multiplier in accordance with the invention connected to an alternating current source.

Referring now to Fig. 1, there is illustrated a voltage multiplier comprising direct current source 1 having two output terminals 2 and 3, output terminal 3 being connected to ground as illustrated. Source 1 may develop a positive unidirectional voltage with respect to ground. Two unilaterally conducting devices 4 and 5 are connected in series to output terminal 2 of source 1 and may, for example, consist of diodes as illustrated. Variable condenser 6 connects the junction point of diodes 4 and 5 to ground, that is to terminal 3, while fixed condenser 7 connects the output electrode of diode 5, that is, its cathode to ground.

In accordance with the present invention, variable condenser 6 may be a rotatable condenser which may, for example, be driven through a motor 8 by means of a driving connection indicated at 10. A filter network, which may include series coil 11 and shunt condenser 12, may be coupled to condenser 7 for smoothing out the voltage derived from the voltage multiplier.

The voltage multiplier circuit of Fig. 1 operates as follows. Let it be assumed that, initially, condensers 6, 7 and 12 are discharged. As soon as source 1 is connected to the circuit, diodes 4 and 5 will become conducting and the condensers will charge up to the voltage developed across terminals 2 and 3. Let it be further assumed that the capacitance of variable condenser 6 alternately is increased and decreased to a maximum or minimum value by means of motor 8. It is well known that the voltage V of a condenser depends upon its charge Q and its capacitance C as follows: $V=Q/C$. Accordingly, as the capacitance of condenser 6 decreases, its voltage increases and vice versa.

When the voltage across condenser 6 thus increases, due to a decrease of its capacitance, the cathode of diode 4 will become positive with re-

spect to its anode, and consequently, current conduction through diode 4 ceases. When the capacitance of condenser 6 decreases further, the voltage across condenser 6 will continue to increase until the anode of diode 5 becomes positive with respect to its cathode so that diode 5 becomes conducting to charge condenser 7 to a higher voltage.

It will accordingly be seen that the voltage across condenser 7 will eventually become a multiple of that across terminals 2 and 3. The factor by which the input voltage is multiplied depends upon the ratio of the maximum capacitance of condenser 6 to its minimum capacitance. This ratio could be made as high as 20 to 1 so that, if the voltage across terminals 2 and 3 amounts to 300 volts, the voltage across condenser 7 will eventually increase to 6,000 volts. Since diodes 4 and 5 only conduct when the capacitance of rotatable condenser 6 is near its maximum or minimum value, the capacitance of condenser 6 need not vary continuously, but might abruptly change from a maximum to a minimum value.

The voltage multiplier circuit of the present invention may with advantage be used in a color television receiver where condenser 6 may be driven by the motor that rotates the color wheel of the receiver.

Referring now to Fig. 2, in which like components are designated by the same reference numerals as were used in Fig. 1, there is illustrated a modified voltage multiplier which includes an alternating current source 15 having output terminals 2 and 3. Diodes 4 and 5 are again connected in series to terminal 2 of voltage source 15. The junction point of diodes 4 and 5 is connected to ground through variable condenser 16. The output electrode of diode 5, that is, its cathode is connected through choke coil 17 to shunt condenser 18. Coil 17 and condenser 18 form part of a filter network which further includes series choke coil 20 and shunt condenser 21.

Variable condenser 16 is preferably of the vibratory type. The capacitance of condenser 16 may be varied between a maximum and a minimum value by means of an electromagnet 22 energized by winding 23 which preferably is connected to alternating current source 15 as shown. Electromagnet 22 accordingly will vibrate its armature 24 to which is connected one of the plates of variable condenser 16.

The capacitance of condenser 16 is accordingly varied in synchronism with the frequency of the alternating voltage of source 15 impressed on diodes 4 and 5. The capacitance of condenser 16 should have its maximum value when the alternating input voltage has a positive peak and, therefore, the capacitance will have a minimum when the alternating input voltage has its negative peak.

The circuit of Fig. 2, therefore, operates in substantially the same manner as that of Fig. 1. During the positive peak of the input voltage, diode 4 will become conducting to charge variable condenser 16. When the capacitance of condenser 16 has reached its minimum, diode 5 will become conducting to charge condenser 18. It is preferred to charge condenser 18 through a choke coil such as 17 which may form part of the filter network. Since diode 4 only conducts when the voltage of source 15 has a positive peak, it is to be understood that the voltage multiplier circuit of the present invention will also operate

if source 15 develops positive pulses instead of a sinusoidal wave. The voltage multiplier of the present invention requires a minimum of component elements and at the same time it is able to multiply the input voltage by a large factor.

While there has been described what is at present considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and, it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A voltage multiplier circuit comprising a source of a voltage wave, a first condenser variable between a maximum and a minimum capacitance, means for varying the capacitance of said first condenser in synchronism with the frequency of said wave, a second condenser, and unilaterally conducting means for coupling said source to said condensers to charge said first condenser from said source when the capacitance of said first condenser is near said maximum capacitance and to discharge said first condenser into said second condenser when the capacitance of said first condenser is near said minimum capacitance, thereby to develop a voltage across said second condenser that is higher than the peak voltage of said wave.

2. A voltage multiplier circuit comprising a source of alternating voltage having two output terminals, two unilaterally conducting devices connected in series to one of said terminals and having an output electrode, a first electric storage element connected between the junction point of said devices and the other one of said terminals, means for periodically varying the capacitance of said first element in synchronism with the frequency of said alternating voltage, and a second electric storage element connected between said output electrode and the other one of said terminals, thereby to develop a voltage across said second element that is higher than that across said terminals.

3. A voltage multiplier circuit comprising a source of alternating voltage having two output terminals, two diodes connected in series to one of said terminals and having an output electrode, a first condenser connected between the junction point of said diodes and the other one of said terminals, means for periodically varying the capacitance of said first condenser in synchronism with the frequency of said alternating voltage so that said capacitance is at a maximum when said alternating voltage has a peak, a second condenser connected between said output electrode and the other one of said terminals, and a filter network coupled to said second condenser, thereby to develop a voltage across said second condenser that is higher than that across said terminals.

SAMUEL J. HARRIS.

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