

Jan. 11, 1949.

J. EVANS

2,458,577

HIGH POTENTIAL POWER SUPPLY

Filed July 2, 1945

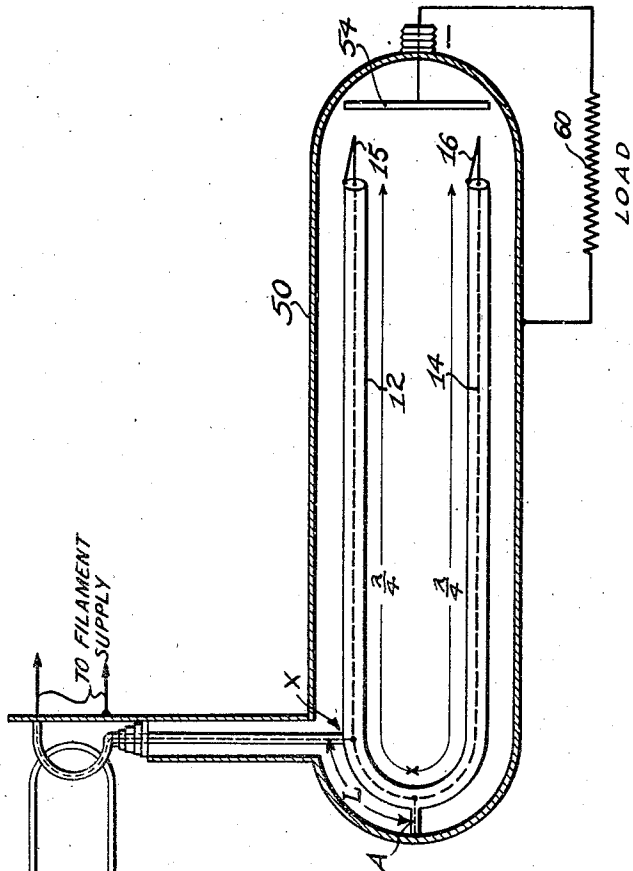


Fig. 2.

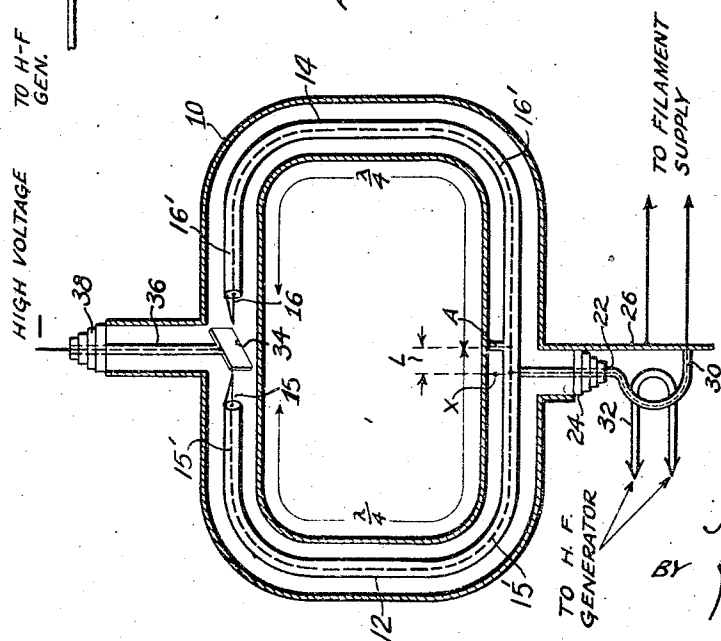


Fig. 1.

INVENTOR.
JOHN EVANS

BY

H. Brown
ATTORNEY

UNITED STATES PATENT OFFICE

2,458,577

HIGH-POTENTIAL POWER SUPPLY

John Evans, Hightstown, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application July 2, 1945, Serial No. 602,814

15 Claims. (Cl. 315—39)

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The present invention relates to high potential power supplies and, more particularly, to such systems adapted for use with a load having low current requirements.

An object of the present invention is the provision of means for obtaining a high unidirectional voltage.

Another object of the present invention is the provision for a power supply suitable for use with cathode ray tubes, linear accelerators, electron microscopes and the like.

A further object of the present invention is to provide a rectifier system for a high potential power supply operating at ultra high radio frequencies.

The foregoing objects and others which may appear from the following detailed description can be obtained by providing a rectifier circuit utilizing coaxial transmission lines, each having an effective length equal to one-quarter of the operating wavelength of the radio frequency oscillator to which it is connected and each short circuited at one end.

Still a further object of the present invention is the provision of a high voltage power supply which is not dangerous to life.

A shorted quarter wave transmission line acts as a voltage transformation circuit, providing a voltage step-up proportional to the "Q" of the line. The term "Q" is an expression of the quality of the line, that is, the ratio of its resonant impedance to its resistance. Since it is entirely feasible to attain a "Q" of several thousand in a coaxial transmission line, a substantial voltage step-up may be obtained without difficulty. Since current drain of the anode circuit of a cathode-ray tube or electron microscope is low, the oscillator supplying the rectifier of present invention need be capable of supplying only a small amount of power.

A high voltage power supply, constructed according to the present invention, presents less danger to the unwary operator than conventional power supplies since the power supply is incapable of supplying appreciable current. Accidental contact with the high voltage terminal of the power supply presents such a drain on the system that the voltage drops to a value no longer dangerous to life.

The present invention will be more fully understood by reference to the following detailed description which is accompanied by a drawing in which Fig. 1 illustrates in cross section an embodiment of the invention while Fig. 2 illustrates a modification of the invention shown in Fig. 1.

Referring now to Fig. 1 there is shown an annular evacuated casing 10. Within the casing 10 and coaxially arranged with respect to the outside walls of the casing are a pair of inner conductors 12 and 14. Conductors 12 and 14, together with the outer casing 10, form sections of

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coaxial transmission lines each short circuited at one end. The lengths of conductors 12 and 14 are so chosen as to be one-quarter wave in length from point A where they are connected to the outer casing 10 to their other ends where they are terminated in electron emitting means which may be filamentary cathodes 15 and 16. One side of each of the filamentary cathodes is directly connected to the conductors 12 and 14 while the other side is connected to filament leads 15' and 16' running within the conductors 12 and 14. Near point A a hollow branch conductor 22 extends through a vacuum tight seal 24 to the exterior. The filament lead extends through branch conductor 22 to the exterior of the system. The distance, L, between the point of connection, X, of conductor 22 to conductor 12 and point A on the conductors 12 and 14 is so chosen as to match the characteristic impedance of the transmission line formed by conductor 22 and the outer surrounding shell 26. At the outer end of conductor 22 are arranged means for coupling the system to a source of high frequency oscillations which include a coupling loop 30 formed in conductor 22, said coupling being arranged to lie in inductive relationship with a tank circuit 32. The tank circuit may be connected to a high frequency generator means (not shown) of an appropriate frequency for operation with the rectifier system of the invention. Since one end of coupling loop 30 may be directly grounded or connected to the outer casing 26 of the input transmission line, the filament lead passing therethrough is effectively isolated from the high voltage system and may be connected to a conventional low voltage filament supply as indicated by the arrows. No elaborate insulation system is required for the filament supply system.

The entire system within casing 10 is connected to a vacuum system and exhausted to a pressure commensurate with the voltages involved.

Between the filamentary cathodes 15 and 16 is located an anode 34 which may be supported in position by a support rod 36 passing through a vacuum tight bushing 38 to the exterior of the system where it is available as the high voltage negative terminal of the system. Supplementary or alternative anode supporting means may be employed as required. Also transformation conductors 12 and 14 may be supported by coaxial cable spacers or such similar means as may be required.

Since the device as so far described has, in effect, two one-quarter wave lines connected end to end, a total phase shift of 180° is obtained between cathodes 15 and 16. Thus, a full wave rectifier is obtained from an unbalanced alternating current source.

The voltage step-up obtained in the rectifier circuit using one-quarter wave lines being proportional to the "Q" of the lines, it is desirable

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that the "Q" be made as high as possible. This is attained by an appropriate dimensioning of the ratios of the inner and outer conductors to obtain a high characteristic impedance, however always bearing in mind the additional provision that the inner conductor diameter should be fairly large so as to minimize the ohmic resistance of the conductor itself. This necessarily follows since the "Q" of the line is proportional to the quantity

$$\frac{2\pi Z_0 f}{Rc}$$

where Rc is the resistance of the conductor and Z_0 is the characteristic impedance of the line.

A modified form of the invention shown in Fig. 2 utilizes the same arrangement of inner conductors 12 and 14 as in Fig. 1. However, the conductors are more closely adjacent and are contained within a cylindrical evacuating casing 50 instead of an annular casing as in Fig. 1.

The electron emission means or cathodes 15 and 16 are in this modification more closely adjacent than those in Fig. 1 and the anode 54 need not therefore be placed between the cathodes but may be positioned at one side thereof.

The filament heating arrangement, the means for supplying high frequency energy to the rectifier and for withdrawing rectified direct potentials across load circuit 60 are the same as Fig. 1 and need not again be described.

While I have illustrated a particular embodiment of the present invention, it should be clearly understood that it is not limited thereto since many modifications may be made in the several elements employed and in their arrangement and it is therefore contemplated by the appended claims to cover any such modifications as fall within the spirit and scope of the invention.

What is claimed is:

1. A power supply system including means for coupling high frequency energy at low potential to said system, an evacuated casing having therein a pair of transmission line sections, each including a conductor having an electrical length equal to one quarter of the operating wavelength of a source of high frequency energy, with which said system is adapted to be operated, said line sections each being short circuited at one end, said coupling circuit introducing said energy into said lines near said one end, said conductors each carrying an electron emitting cathode at their free ends, and an anode structure in operative association with said cathodes.

2. A power supply system including means for coupling high frequency energy at low potential to said system, an evacuated casing having therein a pair of transmission line sections, each including a conductor having an electrical length equal to one quarter of the operating wavelength of a source of high frequency energy, with which said system is adapted to be operated, said line sections each being short circuited at one end, said coupling circuit introducing said energy into said lines near said ends, said conductors each carrying an electron emitting cathode at their free ends, said ends being closely adjacent, and an anode in operative association with said cathodes.

3. A power supply system including a coupling circuit for coupling high frequency energy at low potential to said system, a pair of transmission line sections, each including a conductor having an electrical length equal to one quarter of the operating wavelength of a source of high

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frequency energy, with which said system is adapted to be operated, said line sections each being conductively connected to the other end, said coupling circuit coupling said energy into said lines near said one end, said conductors each carrying an electron emitting cathode at their free ends, said ends being closely adjacent, and an anode structure in operative association with said cathodes, said system being contained within an evacuated casing.

4. A power supply system including means for coupling high frequency energy at low potential to said system, a pair of transmission line sections, each including a conductor having an electrical length equal to one quarter of the operating wavelength of a source of high frequency energy with which said system is adapted to be operated, one of the ends of said line sections being connected to a common point, means for coupling said energy into said lines near said ends, said conductors each carrying an electron emitting cathode at their free ends, said ends being closely adjacent, and an anode in operative association with said cathodes, said system being contained within an evacuated casing, said casing serving as an outer shell for said transmission line sections.

5. A power supply system including means for coupling high frequency energy at low potential to said system, a pair of transmission line sections, each including a conductor having an electrical length equal to one quarter of the operating wavelength of a source of high frequency energy, with which said system is adapted to be operated, said line sections being conductively connected each to the other at one end, means for coupling said energy into said lines near said one end, said conductors each carrying an electron emitting cathode at their free ends, said free ends being closely adjacent, an anode in operative association with said cathodes and a connection for energizing said cathodes passing through said transmission line sections.

6. A power supply system including means for coupling high frequency energy at low potential to said system, a pair of transmission line sections, each including a conductor having an electrical length equal to one quarter of the operating wavelength of a source of high frequency energy with which said system is adapted to be operated; one of the ends of said line sections being connected to a common point, means for coupling said energy into said lines near said one end, said conductors each carrying an electron emitting cathode at their free ends, said free ends being closely adjacent, and an anode in operative association with said cathodes, said system being contained within an evacuated casing, said casing serving as an outer shell for said transmission line sections and a connection for energizing said cathodes passing through said transmission line sections.

7. A power supply system including a hollow annular casing, a pair of inner conductors within said casing and coaxially arranged with respect to the wall of said casing, each of said conductors having a length equal to one quarter of the wavelength of high frequency energy with which said system is adapted to be operated, said conductors having their ends closely adjacent, one pair of adjacent ends being connected together and to said casing, the other ends bearing electron emissive cathodes, an anode between said cathodes, a coaxial line section having an inner conductor connected to one of said conduc-

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tors near the end which is connected to said casing and an outer shell of said line section being connected to said casing.

8. A power supply system including a hollow annular casing, a pair of inner conductors within said casing and coaxially arranged with respect to the wall of said casing, each of said conductors having a length equal to one quarter of the wavelength of high frequency energy with which said system is adapted to be operated, said conductors having their ends closely adjacent, one pair of adjacent ends being connected together and to said casing, the other ends bearing electron emissive cathodes, an anode between said cathodes, a coaxial line section having an inner conductor connected to one of said conductors near the end of which is connected to said casing, an outer shell of said line section being connected to said casing, and means for energizing said cathodes including a connection passing through each of said inner conductors from said cathodes to the exterior of said system.

9. A power supply system including a hollow annular casing, a pair of inner conductors within said casing and coaxially arranged with respect to the wall of said casing, each of said conductors having a length equal to one quarter of the wavelength of high frequency energy with which said system is adapted to be operated, said conductors having their ends closely adjacent, one pair of adjacent ends being connected together and to said casing, the other ends bearing electron emissive cathodes, an anode between said cathodes, a coaxial line section having an inner conductor connected to one of said conductors near the end which is connected to said casing, an outer shell of said line section being connected to said casing, and means for energizing said cathodes including a connection passing through each of said inner conductors from said cathodes to the exterior of said system, said casing being hermetically sealed and evacuated.

10. A power supply system including a hollow cylindrical casing, a pair of parallel hollow conductors having a length equal to a quarter of the wavelength of high frequency energy with which said system is adapted to be operated, said conductors being connected together and to said casing at one end, the other ends bearing electron emissive cathodes, an anode in operative relationship with said cathodes, an input circuit for said system including a coaxial line section having an outer shell branched from said casing and a hollow inner conductor connected to one of said pair of conductors near their connection to said casing and means for energizing said cathodes including connections from the exterior of said casing passing through said hollow conductors to said cathodes.

11. A power supply system including a hollow cylindrical casing, a pair of parallel hollow conductors having a length equal to a quarter of the wavelength of high frequency energy with which said system is adapted to be operated, said conductors being connected together and to said casing at one end, the other ends bearing electron emissive cathodes, an anode in operative relationship with said cathodes, an input circuit for said system including a coaxial line section having an outer shell branched from said casing and a hollow inner conductor connected to one of said pair of conductors near their connection to said casing and means for energizing said cathodes including connections from the exterior of said cas-

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ing passing through said hollow conductors to said cathodes, said casing being evacuated.

12. A power supply including a coupling circuit for coupling high frequency energy at low potential to said system, an evacuated casing having therein a pair of transmission line sections each including a conductor having an electrical length equal to one quarter of the operating wavelength of a source of high frequency energy with which said system is adapted to be operated, said line sections each being short circuited at one end, said coupling circuit introducing said high frequency energy into said lines near said one end, said conductors each carrying an electron emitting cathode at their free ends, and an anode in operative association with said cathodes.

13. A power supply system including a coupling circuit for coupling high frequency energy at low potential to said system, an evacuated casing having therein a pair of transmission line sections each including a conductor having an electrical length equal to one quarter of the operating wavelength of a source of high frequency energy with which said system is adapted to be operated, said line sections each being short circuited at one end, said coupling circuit introducing said high frequency energy into said line sections near said one end, said conductors each carrying an electron emitting cathode at their free ends, said free ends being closely adjacent, and an anode in operative association with said cathodes.

14. Apparatus for producing high uni-directional voltage from relatively low voltage alternating current including, an evacuated container, rectifier electrodes including an anode and a cathode within said container, a two-conductor transmission line of an electrical length substantially equal to one quarter of the wave length of said alternating current within said container, a coupling between one conductor of said line and said cathode, a coupling between the other end of said one conductor extending through the wall of said container, and excited by said alternating current and an output lead extending from said anode through the wall of said container.

15. Apparatus for producing high uni-directional voltage from relatively low voltage alternating current, including, an evacuated container, rectifier electrodes including an anode and two cathodes within said container, two transmission lines of an electrical length equal to one quarter of the operating wave length of said alternating current within said container, a coupling between one end of each of said lines and a different one of said cathodes, a coupling between the other ends of said lines extending through the wall of said containers and excited by said alternating current and an output lead extending from said anode thru the wall of said container.

JOHN EVANS.

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