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GLOW TUBE RECTIFIER

2,473,831

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2 Sheets-Sheet 1

FIG. 1.

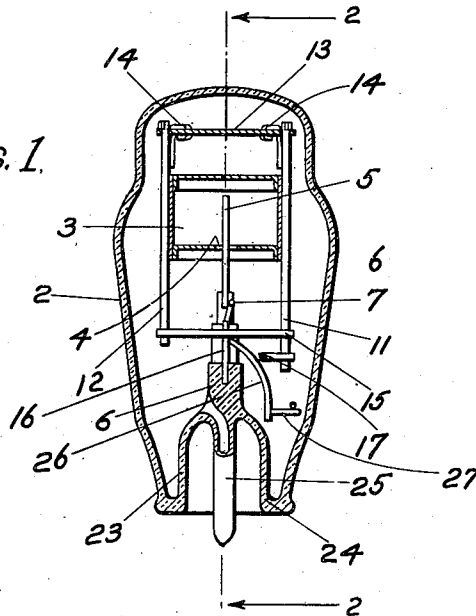
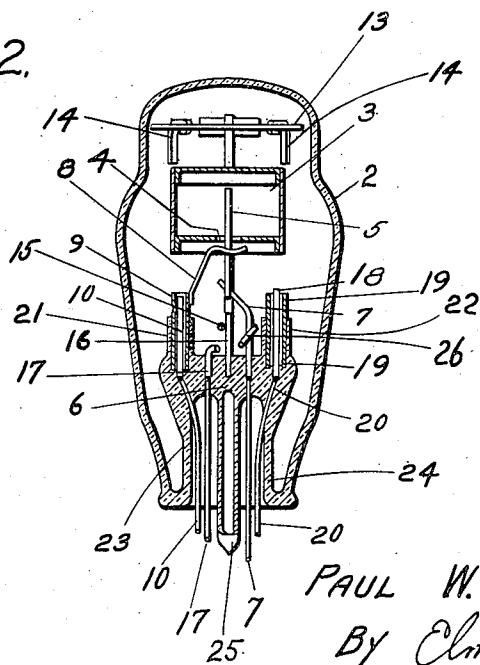


FIG. 2.



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FIG. 3.

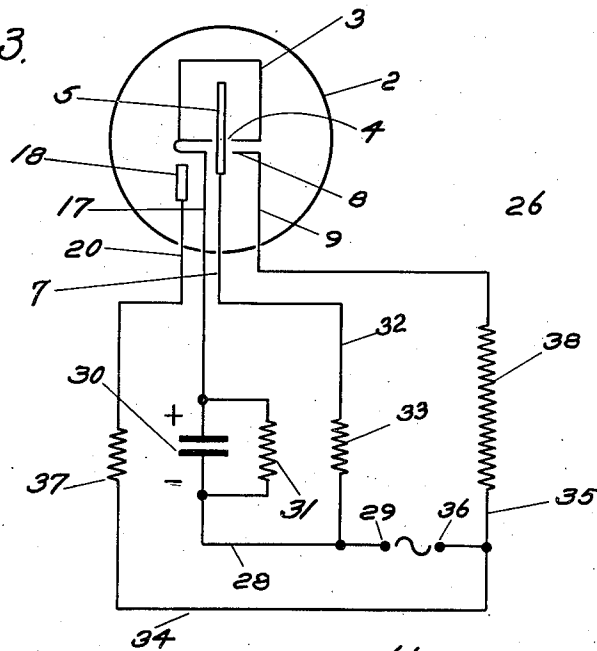
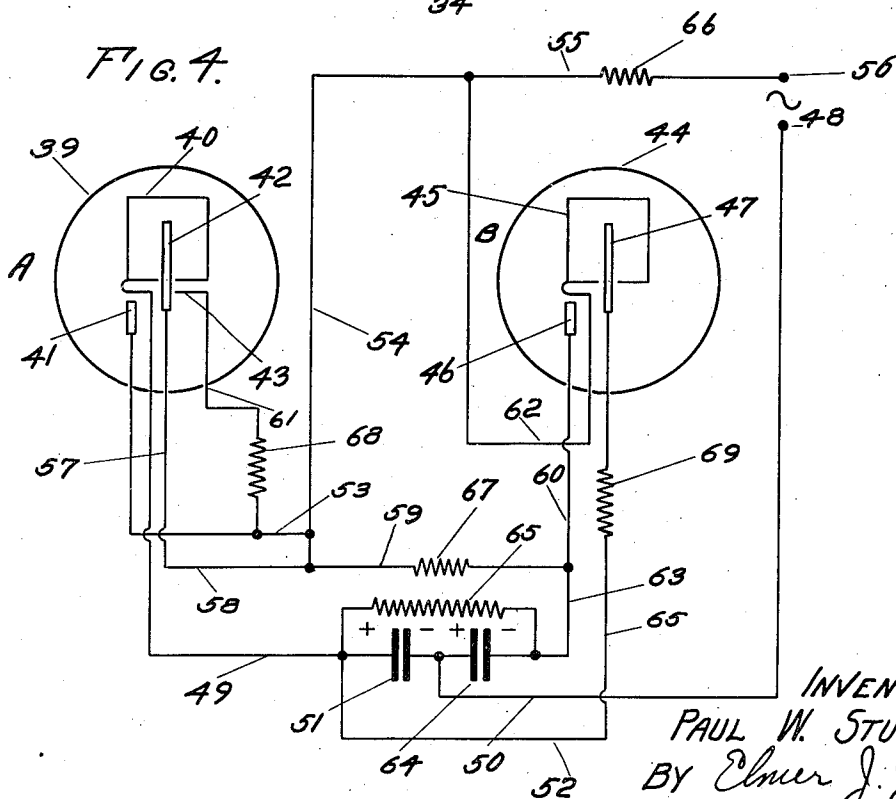


FIG. 4.



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GLOW TUBE RECTIFIER

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This invention relates to improvements in electric rectifying systems.

One of the objects of the present invention is to provide an electric rectifying system comprising an improved rectifier glow discharge tube and adapted to deliver a markedly high D. C. voltage for any A. C. voltage supplied to said system.

Another object of the invention is to provide an electric rectifying system comprising an improved rectifier glow discharge tube, and characterized by low ripple and low pick-up voltage.

A further object of the invention is to provide an electric rectifying system using an improved rectifier glow discharge tube, and characterized by consistent firing.

These and such other objects of the invention as may hereinafter appear will be readily understood from the following description, taken in connection with the accompanying drawing, of embodiments of the invention herein presented for illustrative purposes.

In the drawing:

Fig. 1 is a longitudinal cross-section of an improved rectifier glow discharge tube that may be used in an electric rectifying system embodying the present invention;

Fig. 2 is a longitudinal cross-section on line 2—2 of Fig. 1;

Fig. 3 represents diagrammatically an electric rectifying system embodying one illustrative form of the present invention; and

Fig. 4 represents diagrammatically an electric rectifying system embodying another illustrative form of the present invention.

Referring more particularly to Figs. 1 and 2, the tube illustrated comprises a glass envelope 2 containing an ionizable gas and an electrode assembly including a main glow cathode 3 in the form of a hollow metal cylinder closed at the top and bottom except for a relatively small central opening 4 in its bottom wall. An auxiliary wire glow cathode 5 extends upwardly through said opening 4, well within said main glow cathode 3. Its lower end is connected to a conductor 7, sealed through the press 6 of the tube. An auxiliary or igniter anode 8 is located near said opening 4 and is connected to a tubular metal conductor 9 sealed in the glass press 6 of the tube and connected to a conductor 10 sealed through said press 6. The glass of said press covers the lower part of said tubular conductor 9 in the form of a sleeve 21. The main glow cathode 3 is supported by two wire posts 11 and 12 welded thereto at opposite sides thereof and having their upper ends secured in a spacing member 13 of mica or other

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suitable insulating material. Resilient members 14, suitably spaced about the perimeter of said spacing member, afford yielding bearing for said spacing member against the wall of the tube. Near their lower ends said two posts 11 and 12 are connected by a transverse bracing wire 15, supported centrally by a short post 16 sealed in the press. The posts 11 and 12 serve as conductors for the main glow cathode 3 and for this purpose the post 11 is connected at its lower end to a conductor 17 sealed through the press. The main anode 18 is contained in a tubular metal shield 19 sealed in said press 6, and said anode is connected to a conductor 20 sealed through said press, of which the glass extends upwardly along the lower portion of said shield in the form of a sleeve 22. Said press 6 is formed at the top of a reentrant stem 23, the flare 24 of which is hermetically sealed to the lower edge of said envelope 2 which is filled with a suitable ionizable gas under suitable pressure. An exhaust stem 25 projects downwardly from said press 6. A conductor 26 supports a getter 27 and connects it with the conductor 7.

In Fig. 3 is shown diagrammatically an electric rectifying system embodying the improved tube as above described and illustrated in Figs. 1 and 2, and an illustrative circuit for operation of said tube. Referring to said Fig. 3, the main glow cathode 3 is connected by conductors 17 and 28 to one terminal 29 of a source of alternating current, through an electrical energy storage device, such as a condenser 30, a suitable resistance 31 forming the load across said condenser. The auxiliary cathode 5 is connected by conductors 7 and 32 to the same terminal through a current limiting resistance 33. The main anode 18 and igniter anode 8 are connected as shown by conductors 20 and 34 and 9 and 35, respectively, to the other terminal 36 of the alternating current source. A ballast resistance 37 may be inserted in said main anode circuit and a resistance 38 for limiting the igniter current will preferably be inserted in the igniter anode circuit.

In operation, if the terminals 29 and 36 be connected to a suitable source of A. C. voltage, a voltage will be impressed between the main cathode 3 and the ignition anode 8. When this voltage reaches the ignition voltage, which may be quite high in tubes of this type as compared to the running voltage of the tube, a discharge will be started between said main cathode and said ignition anode. Owing to the ionization thus produced of the space within said main cathode 3 and of the space between said main cathode and

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the main anode 18, a main discharge will be initiated between said main anode and said main cathode and the condenser will charge. When the voltage on the condenser rises substantially to the voltage of the source 29—36 less the drop through the tube and through the resistance 37, the charging current will fall to zero and the discharge between the cathode 3 and the main anode 18 extinguishes. It will be noted that the condenser is charged to such a polarity that it makes the auxiliary cathode 5 negative with respect to the main cathode 3. This initiates a discharge between the inner surface of said main cathode 3 and the auxiliary cathode 5 surrounded by said surface. This discharge persists as long as the condenser remains charged and thus as long as the system remains in operation. This auxiliary discharge persisting during the normally non-conductive half of the supply voltage cycle maintains ionization within the main cathode 3, and thus enables a discharge between said main cathode 3 and said main anode 18 to be initiated in the next half cycle when the voltage between the electrodes 3 and 18 has risen to only a few volts above the normal tube drop. The condenser now recharges, and so on through subsequent cycles, the discharge between said main cathode 3 and auxiliary cathode 5 continuing uninterruptedly to ensure reignition of the tube after each extinction and thus keep the tube in continuous operation as long as may be desired.

In the embodiment of the invention diagrammatically shown in Fig. 4, the system comprises two rectifier glow discharge tubes designated generally by A and B, respectively. The rectifier glow discharge tube comprises an envelope 39, containing an ionizable gas and electrode assembly comprising a cylindrical main cathode 40, closed at top and bottom except for a small hole in the bottom wall, a main anode 41, an auxiliary cathode 42 extending into said main cathode through said hole in the bottom thereof, and an igniter anode 43 substantially as shown in Figs. 1 and 2. Tube B of said system comprises an envelope 44, containing an electrode assembly comprising a cylindrical main cathode 45, similar to that of tube A, a main cathode 46 and an auxiliary electrode 47 extending into said main cathode. In some cases the electrode 47 need not project into the cathode 45 but may be external thereto.

The main cathode 40 of tube A is connected to terminal 48 of a source of alternating current by conductors 49 and 50 having in circuit a voltage storage device, for example, a condenser 51, and to the auxiliary electrode 47 of tube B by said conductor 49 and a conductor 52. The main anode 41 of tube A is connected by conductors 53, 54 and 55 to the other terminal 56 of said alternating current source. The auxiliary cathode 42 of tube A is connected to the main anode 46 of tube B by conductors 57, 58, 59 and 60, and to the terminal 56 of said source by said conductors 57, 58, and 54 and 55. The igniter anode 43 of the tube A is connected by conductor 61 and conductors 53, 54 and 55 to terminal 56 of said source.

The main cathode 45 of tube B is connected by conductors 62 and 55 with terminal 56 of said source and by conductors 62, 54 and 53 with the main anode 41 of tube A. The main anode 46 of tube B is connected with the terminal 48 of said source by conductors 60, 63 and 50 having in circuit a voltage storage device, for example, a condenser 64. A resistance 65 constitutes a load across both condensers 51 and 64. The auxiliary

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electrode 47, which in this embodiment acts as an auxiliary anode B, is connected to the main cathode 40 of tube A by conductors 65 and 49. Suitable current limiting resistances 66, 67, 68 and 69 are inserted in conductors 55, 59, 61 and 65, respectively.

In operation, if the terminals 48 and 56 be connected to a suitable source of alternating current during one-half cycle, a voltage will be impressed between main cathode 40 and igniter anode 43 of tube A, which tends to make the anode 43 positive with respect to the cathode 40. When the voltage thus impressed across said main cathode and igniter anode reaches the igniting potential, a discharge is initiated between said main cathode and said ignition anode, thus igniting the tube. The voltage then falls from the high ignition peak to the lower tube drop and continues substantially uniformly at that lower voltage. Owing to the ionization thus produced in and about said main cathode 40 and in the space between the latter and the main anode 41, a main discharge is initiated between said main cathode and main anode, and the current flowing through the condenser 51 tends to build up the voltage of said condenser. When said condenser voltage reaches a sufficiently high value, the voltage available to support the discharge between said main cathode and said main anode diminishes and said discharge in tube A extinguishes. The voltage across condenser 51 thus built up is now impressed upon the auxiliary electrode 47 of tube B. When this condenser voltage reaches its peak for that cycle, this voltage, added to the positive voltage at terminal 48 during the next half cycle, initiates a discharge between said auxiliary electrode 47 and the main cathode 45 of tube B, said auxiliary electrode acting as an anode. Thereupon the condenser 64 charges and upon reaching its peak voltage for that cycle extinguishes the discharge between the electrodes 45 and 46. It will now be seen that condensers 51 and 64 are charged so as to have their voltages added across the load resistance 65. The main cathode 40 of tube A is connected to the positive terminal of this condenser voltage and the auxiliary cathode 42 of tube A is connected to the negative terminal of this condenser voltage. Thus a discharge is initiated and maintained between the electrodes 40 and 42 as long as the operation is continued. The ionization thus produced enables the main discharge of tube A to be initiated each time the anode 41 becomes positive with respect to its cathode 40 by only a few volts above the normal tube drop. Likewise the main cathode 45 and the auxiliary electrode 47 of tube B are connected respectively to the negative and positive terminals of the condenser voltage. Thus the auxiliary discharge between the electrodes 45 and 47 is maintained as long as the system continues in operation. This auxiliary discharge likewise causes the main discharge of tube B to start each time its anode 46 becomes positive with respect to its cathode 45 by only a few volts above the normal tube drop. Thus tubes A and B operate in alternation as single-phase half-wave rectifiers so long as it is desired to continue the system in operation.

It will be noted that in both of the above-described embodiments of the invention, only one ignition at high voltage, that at the start of the operation, is necessary. As soon as ignition is effected, the voltage drops from the high firing peak to an even, low working voltage which suffices to maintain the discharge between the main

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cathode and auxiliary cathode of the tubes, and thus to maintain ionization and keep subsequent ignition potential low. The operation continues uninterrupted, as above described, at this low voltage as long as desired and without the expenditure of high voltage for further firing. The present invention, therefore, due to the fact that said working voltage is low and that no high voltage is required for repeated igniting as formerly, represents quite a material saving in voltage and a corresponding increase in output voltage and in efficiency. It has been found that an embodiment of the invention shown in Fig. 3 having a tube with a voltage drop of about 60 volts will deliver a D. C. of 80 to 90 volts from an A. C. source of 110 volts R. M. S. For large values of load current and of resistance the output voltage may be less. For the same 110 volt A. C. the embodiment illustrated in Fig. 4 will deliver a D. C. of 90 volts rising to a voltage of about 150 volts as the load resistance is increased to an infinite value. The invention therefore marks a distinct advance in the art.

One large advantage of this invention is that a commercial supply line of 110 volts R. M. S. can be utilized as the power supply without the use of an intervening step-up transformer such as prior systems have inevitably required for satisfactory operation.

Another advantage of the present invention resides in the fact that rectifying systems embodying said invention are characterized by a low ripple. Ripple in systems using glow tubes is usually a function of starting voltage, and, as above explained, once ignition is effected the starting voltage drops to a low level that is maintained substantially constant throughout the remainder of the operation of the system, the ripple thus becoming negligible. Another advantage is the consistent firing. One reason for this is the arrangement of the electrodes whereby the discharge potential between electrodes is maintained at such a level that once ignition is effected, a discharge between two electrodes, namely the main cathode and auxiliary cathode, is always maintained so that any danger of extinction is excluded. A further advantage lies in the low pick-up. This is largely due to the fact that the operation of the igniter furthers ionization of the space between the main cathode and the main anode whereby discharge between these two electrodes is facilitated. In rectifiers embodying applicant's invention, the pick-up voltage is low, it being only slightly higher than the tube drop, that is only by about 3 or 4 volts. This reduces the operating voltage and thus still further increases the output. Other advantages will suggest themselves to those skilled in the art.

I am aware that the present invention can be embodied in other specific forms without departing from the spirit or essential attributes thereof, and I therefore desire the present description to be considered in all respects as illustrative and not restrictive, reference being had to the appended claims rather than to the aforesaid description to indicate the scope of the invention.

What is claimed is:

1. In an electric rectifying system, in combination, a rectifier glow discharge tube including an envelope containing an ionizable gaseous medium, a main cathode, a main anode and an auxiliary electrode, means for initiating a discharge between said main cathode and said main anode, and a condenser connected to be charged

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by said discharge between said main cathode and said main anode, and to deliver voltage for maintaining a continuous discharge between said auxiliary electrode and said main cathode.

2. In an electric rectifying system, in combination, a rectifier glow discharge tube including an envelope containing an ionizable gaseous medium, a main cathode, a main anode and an auxiliary electrode, means for initiating a discharge between said main cathode and said main anode, and means rendered operative during extinction of discharge between said main electrode and said main anode for maintaining a continuous discharge between said auxiliary electrode and said main cathode to maintain ionization and initiate a discharge between said main cathode and said main anode.

3. In an electric rectifying system, in combination, a rectifier glow discharge tube including an envelope containing an ionizable gaseous medium and a main cathode, a main anode and an auxiliary electrode, means for initiating a discharge between said main cathode and said main anode, and electrical energy storage means connected to be charged by said discharge between said main cathode and said main anode, and to be operative during extinction of discharge between said main cathode and said main anode for impressing voltage between said auxiliary electrode and said main cathode and maintaining a continuous discharge between said auxiliary electrode and said main cathode to maintain ionization and initiate a discharge between said main cathode and said main anode.

4. In an electric rectifying system, in combination, a rectifier glow discharge tube including an envelope containing an ionizable gaseous medium, a main cathode, a main anode and an auxiliary electrode, means for initiating a discharge between said main cathode and said main anode, and a condenser connected to be charged by said discharge between said main cathode and said main anode, and to be operative during extinction of discharge between said main cathode and said main anode for impressing voltage between said auxiliary electrode and said main cathode, and maintaining a continuous discharge between said auxiliary electrode and said main cathode to maintain ionization and initiate a discharge between said main cathode and said main anode.

5. In an electric rectifying system, in combination, a first and a second rectifier glow discharge tube, each including an envelope containing an ionizable gaseous medium, a main cathode, a main anode and an auxiliary electrode, means for initiating a discharge between the main cathode and the main anode of said first tube, means operative during extinction of discharge between said main cathode and main anode of said first tube for maintaining a continuous discharge between the auxiliary electrode, acting as an anode, and the main cathode of said second tube to maintain ionization and initiate a discharge between the main cathode and main anode of said second tube, and means operative during extinction of said discharge between the main cathode and said main anode of said second tube for maintaining a continuous discharge between the auxiliary electrode and main cathode, acting as an anode, of said first tube to maintain ionization and initiate a discharge between the main cathode and main anode of said first tube.

6. In an electric rectifying system, in combination, a first and a second rectifier glow discharge tube, each including an envelope containing an

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ionizable gaseous medium, a main cathode, a main anode and an auxiliary electrode, means for initiating a discharge between the main cathode and the main anode of said first tube, electrical energy storage means connected to operate during extinction of discharge between said main cathode and main anode of said first tube to impress a voltage between the auxiliary electrode, acting as an anode, and the main cathode of said second tube and maintain a continuous discharge between said main cathode and auxiliary electrode to maintain ionization and initiate a discharge between the main cathode and main anode of said second tube, and second electrical energy storage means, said two electrical energy storage means being connected to operate during extinction of discharge between the main cathode and the main anode of said second tube to impress a voltage between the auxiliary electrode and main cathode, acting as an anode, of said first tube for maintaining a discharge between said auxiliary electrode and main cathode of said first tube to maintain ionization and initiate a discharge between the main cathode and main anode of said first tube.

7. In an electric rectifying system, in combination, a first and second rectifier glow discharge tube, each including an envelope containing an ionizable gaseous medium, a main cathode, a main anode and an auxiliary electrode, means for initiating a discharge between the main cathode and the main anode of said first tube, a condenser connected to operate during extinction of discharge between the main cathode and main anode of said first tube to impress a voltage between the auxiliary electrode, acting as an anode, and the main cathode of said second tube and maintain a continuous discharge between said main cathode and said auxiliary electrode to maintain ionization and initiate a discharge between the main cathode and the main anode of said second tube, and a second condenser, said two condensers being connected to operate during extinction of discharge between the main anode and main cathode of said second tube to impress a voltage between the main cathode, acting as an

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anode, and the auxiliary electrode of said first tube for maintaining a discharge between said main cathode and auxiliary electrode of said first tube to maintain ionization and initiate a discharge between the main cathode and main anode of said first tube.

8. In an electric rectifying system, in combination, a first and a second rectifier glow discharge tube, each including an envelope containing an ionizable gaseous medium, a main cathode, a main anode and an auxiliary electrode, means for initiating a discharge between the main cathode and main anode of said first tube, voltage impressing means for imposing voltage between the auxiliary electrode, acting as an anode, and the main cathode of said second tube to maintain a continuous discharge between said main cathode and said auxiliary electrode, and initiate a discharge between the main cathode and the main anode of said second tube, and further voltage impressing means, said two voltage impressing means being connected to impress voltage between the auxiliary electrode and the main cathode, acting as an anode, of said first tube for maintaining a continuous discharge between said auxiliary electrode and main cathode of said first tube, thereby to initiate a discharge between the main cathode and the main anode of said tube.

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