Feb. 9, 1932. K. WIEGAND ET AL 1,844,375

GASEOUS ELECTRIC DISCHARGE DEVICE

Filed Feb. 24, 1931

Fig. 1

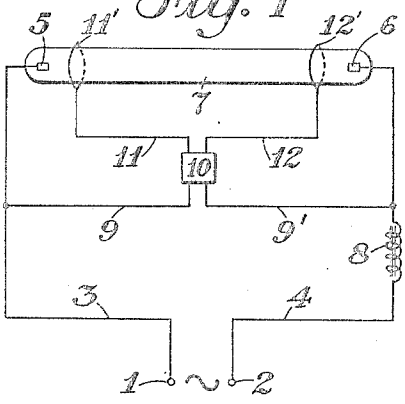


Fig. 2

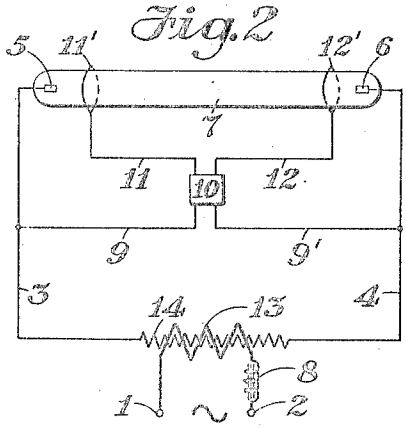


Fig. 3

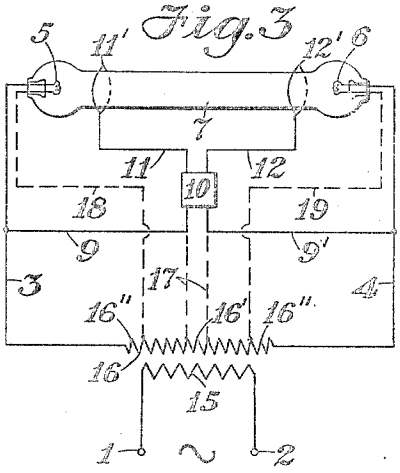


Fig. 4

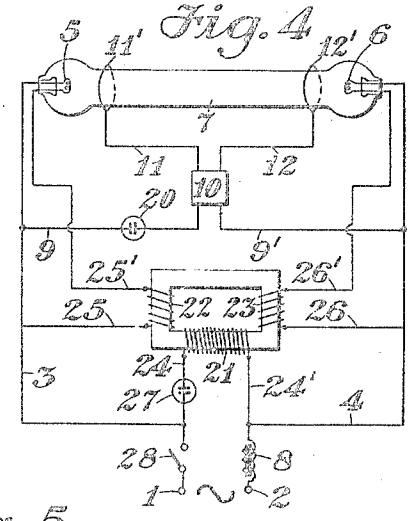
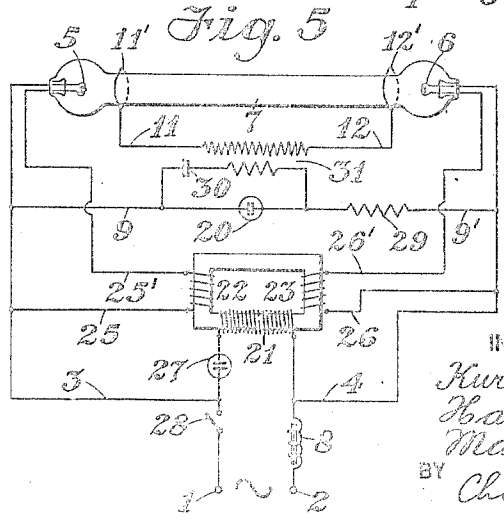


Fig. 5



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Patented Feb. 9, 1932 1,844,375

UNITED STATES PATENT OFFICE

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GASEOUS ELECTRIC DISCHARGE DEVICE

Application filed February 24, 1931, Serial No. 517,994, and in Germany March 7, 1930.

The present invention relates generally to gaseous electric discharge devices and more particularly the invention relates to starting and operating means for such devices.

It is well known in the art that gaseous electric discharge devices may be started into operation by means of high frequency currents suitably applied to said devices, and that a high frequency generator connected in parallel to the discharge device is especially efficacious for this purpose. It is as equally well known in the art that it is not necessary to have the high frequency generator in operation after the start of the gaseous discharge. Hitherto the high frequency generator has been cut out of circuit by various means having movable parts such as a manually operated switch or a time switch. The object of this invention is to provide an arrangement of electric circuits and apparatus in which the high frequency generator ceases functioning on the establishment of the gaseous discharge in the gaseous electric discharge device and without the use of movable parts.

In accordance with this object the high frequency generator used is designed so that the operating potential of the gaseous electric discharge device, which is approximately half of the starting potential of said device, is not sufficient to operate said high frequency generator which is connected to one of the electrode leads at a part of said lead between the electrode and a resistance furnishing a sufficient potential drop for the discharge path. Accordingly the high frequency generator functions during the starting period, while the electrodes are being heated to an electron emitting temperature if this type of electrode is used, during which period the full starting potential is applied to the high frequency generator. Immediately on the establishing of the gaseous discharge in the gaseous electric discharge device the resistance connected into the electrode lead lowers the potential from the starting potential to the operating potential, as is well known in the art, and the high frequency generator, being connected, as stated, in an electrode lead between the electrode and the resistance is supplied only with the operating potential and which is, as heretofore pointed out, insufficient to maintain it in a functioning condition. Thus the high frequency generator is stopped during the operation of the gaseous electric discharge device without the use of any movable parts.

The same result is attained in a still more advantageous manner, when desired, by connecting a gaseous electric discharge device of the negative glow type into the lead connecting the high frequency generator in parallel with the discharge path. Said negative glow lamp has a break down potential less than the starting potential of the gaseous electric discharge device, but higher than the operating potential of said device. During the starting period the starting voltage is applied to the high frequency generator, but on the start of the gaseous electric discharge device the potential drops to the operating potential, as heretofore pointed out, at which potential the negative glow lamp is inoperative causing a positive break in the current flowing to the high frequency generator which ceases to function. In a like manner a transformer for heating the electrodes, where this type of electrode is used, may be made inoperative on the start of the gaseous electric discharge device.

In the drawings accompanying and forming part of this specification several embodiments of the new and novel starting circuit are shown for purposes of disclosure in which,

Fig. 1 is a schematic view of one embodiment of the new and novel starting and operating circuit,

Fig. 2 is a schematic view of another embodiment of the invention,

Fig. 3 is a schematic view of another embodiment of the invention,

Fig. 4 is a schematic view of another embodiment of the invention,

Fig. 5 is a schematic view of another embodiment of the invention.

Like numbers denote like parts in all the drawings.

Referring to Fig. 1 the new and novel starting and operating circuit illustrated thereby comprises electrodes 5 and 6, which are of the

electron emitting type heated by the current flow through the tube, sealed in at both ends of the container of the electric discharge device 7, the container of said device 7 being filled with the usual discharge conducting gases, or vapors, or gas-vapor mixtures. Said electrodes 5 and 6 are connected by leads 3 and 4 to the terminals 1 and 2 of a suitable current source, though they may be, as is well known in the art, connected to a separate heating circuit to heat them to an electron emitting temperature. A choke-coil 8 is connected into electrode lead 4, said choke-coil 8 being provided to reduce the starting potential to the operating potential, and to act as a ballasting reactance or resistance during the operation of said electric discharge device 7 as is well known in the art. Said choke-coil 8 may be replaced by an ohmic resistance, a capacity resistance, or a group of incandescent lamps as desired, and in the latter instance the incandecent lamps add to the general illumination. Leads 9 and 9′ of the high frequency generator 10 are connected to leads 3 and 4 respectively and lead 9′ is connected to said lead 4 between said choke-coil 8 and electrode 6. Said high frequency generator 10 consists of a spark gap, an inductance, an oscillatory circuit and a high frequency transformer in the case of an alternating current source and consists of a magnetically operated circuit breaker and an inductance in the case of a direct current source, as is well known in the art. Leads 11 and 12 of the high frequency generator 10 are looped around the container of said electric discharge device 7 in the vicinity of the electrodes 5 and 6 thereof as shown at 11′ and 12′, or said leads 11 and 12 may be connected directly to said electrodes 5 and 6 as desired. The high frequency generator 10 is adapted to operate on the potential of the current source, such as 220 volts, but does not operate on the potential flowing to it after the start of the electric discharge device 7, which is in the order of 100 to 120 volts. Accordingly the high frequency generator 10 ceases operating immediately on the establishing of the electric discharge in electric discharge device 7.

The starting and operating circuit arrangement shown in Fig. 2 is similar to that shown in Fig. 1 with the exception that said electric discharge device 7 is connected to a transformer having its primary coil 13 and its secondary coil 14 wound over each other, the primary coil 13 of said transformer 13, 14 being connected to the terminal posts 1 and 2 of a suitable current source. In this embodiment of the invention the choke-coil 8 is connected into the circuit of the primary current to function as a ballasting device, as is well known in the art. In this embodiment, as in the embodiment illustrated in Fig. 1, the high frequency generator 10 is so designed that it ceases to function when the potential applied at starting drops to the operating potential caused by the establishing of the electric discharge in electric discharge device 7.

In the starting and operating circuit arrangement shown in Fig. 3 a leaky transformer 15, 16 is used in place of the transformer shown in Fig. 2. The inductive potential drop of the transformer 15, 16 makes the use of a choke-coil or other resistance superfluous. In this embodiment of the invention the high frequency generator 10 is adapted to operate on a lower potential than the potential of the current source and may, for example, operate on a 6 volt potential. The high frequency generator 10 is connected by leads 17, shown in broken lines, to the proportionate part 16′ of the secondary coil 16. The high frequency generator 10 is so designed that it does not operate when its operating potential is reduced to half its value on the establishment of the electric discharge in electric discharge device 7. The electrodes 5 and 6, which in this embodiment of the invention are electron emitting incandescent electrodes, are connected to proportionate parts 16″ of the secondary coil 16, by leads 18 and 19, shown by broken lines in the drawings. A heating circuit for the electrodes 5 and 6 is thus formed consisting of leads 3 and 18, 4 and 19. After electric discharge device 7 has started into operation the electrodes 5 and 6 are maintained at incandescence by half the heating potential and it is not necessary to cut out the heating circuit.

In the circuit arrangement shown in Fig. 4 a small gaseous discharge lamp 20 is connected to lead 9 of the high frequency generator 10, said lamp 20 may have either cold electrodes or heated electrodes as desired. Said lamp 20 operates during the starting period of the electric discharge device 7 as its operating potential is somewhat lower than the potential of the current source, but during the operation of said device 7 said lamp 20 is inoperative as its operating potential is higher than that of said electric discharge device 7. If, for example, said device 7 has a 200 volt starting potential, and an operating potential of 100 to 120 volts said lamp 20 should have a starting potential of 160 to 200 volts and operating potential of not less than 140 volts. Cathode glow lamps are especially suitable for this purpose as such electric discharge devices usually have a difference of only 10 to 30 volts between their starting potential and the potential at which they will not operate.

In this embodiment of the invention a small transformer having a primary coil 21 and secondary coils 22, 23 is connected into the circuit for the purpose of heating the electrodes 5 and 6. Leads 3 and 4 are bridged by leads 24 and 24′ connected to the primary winding 21 of said transformer 21, 22, 23. Said lead 24′ is connected into lead 4 between

the choke-coil 8 and the electrode 6, so that said transformer 21, 22, 23 is connected in parallel to the discharge path of said electric discharge device 7 and behind the resistance, such as choke-coil 8, which supplies the necessary potential drop for said electric discharge device 7. As heretofore pointed out the high frequency generator 10 is connected into the circuit in the same manner as the transformer 21, 22, 23. The secondary coil 22 of said transformer 21, 22, 23 is connected to electrode 5 indirectly by lead 25 connected to lead 3 and directly thereto by lead 25'. The secondary coil 23 is in a like manner connected to electrode 6 indirectly by lead 26 connected to lead 4 and directly thereto by lead 26'. A small gaseous discharge device 27 requiring the same starting and operating potentials as said device 20 is connected into lead 24 of the primary winding 21 of said transformer 21, 22, 23. The entire circuit, when desired, may be connected with and disconnected from the current source by means of switch 28 connected into lead 3.

In the starting of the gaseous electric discharge device the electrodes 5 and 6, the high frequency generator 10, and the small transformer 21, 22, 23 are connected directly to a current source, or to a transformer furnishing the proper potential, by closing switch 28. The gaseous discharge devices 20 and 27 conduct current at a relatively few volts less than their starting potential. The choke-coil 8 has only a slight potential drop at the instant of connecting the circuit to the current source due to the small current consumption of the high frequency generator 10 and the transformer 21, 22, 23. Therefore, and instantly on the start of said electric discharge device 7, which takes place after said electrodes 5 and 6 have been sufficiently heated, the gaseous electric discharge devices 20 and 27 stop operating, as the potential between the choke-coil and the electrodes of said device 7 is then lower than the operating potential of said gaseous electric discharge devices 20 and 27. If the high frequency generator 10 has not ceased operating entirely said electric discharge device 20 then operates to cut off the current thereto. Said device 27 operates in the same manner to cut out of circuit said transformer 21, 22, 23.

The electrodes 5 and 6 are maintained at a glow or incandescence during the operation of the device 7 by the flow of current through the container of said device. As the transformer is connected into the circuit only during the short starting period it may be considerably under dimensioned with respect to the starting potential.

In the starting and operating circuit shown in Fig. 5 a small gaseous electric discharge device 20 forms a part of the high frequency generator which in this case consists of said discharge device 20 connected into lead 9, 9' together with a resistance 29, a condenser 30 connected in parallel to said electric discharge device 20, and transformer 31. As is well known in the art oscillations are generated in the circuit of said electric discharge device 20 and are conducted through the transformer 31 and the leads 11, 12 to the electric discharge device 7. As said discharge device 20 has an operating potential greater than the operating potential of said device 7 said device 20, together with the other parts of the high frequency generator, ceases to function immediately on the start of said device 7.

The small gaseous electric discharge device 27, which is connected into the circuit between the heating transformer 21, 22, 23 and the current source, protects the heating transformer and the heated electrodes from sudden changes in potential such as the strongly diminishing of potential which occurs immediately after a glow or an arc discharge has been established in said electric discharge device 7. The heating transformer 21, 22, 23 may be considerably under dimensioned with respect to the starting potential. A resistance having a strong negative temperature coefficient may be used in place of the small gaseous discharge device 27, such a resistance is, for example, a thyrite or a silicium rod. During the starting period the silicium rod is strongly heated by the starting potential and in this heated condition is a good current conductor. When electric discharge device 7 has been started into operation the potential drops to approximately half of the starting potential as heretofore described and as a result the heating effect on the silicium rod is greatly reduced. Said rod then offers considerable resistance to the current to protect the transformer in the same manner as the small gaseous electric discharge device 27.

In the starting and operating circuits shown in Figs. 4 and 5 the cathode glow lamps 20 and 27 are connected in series with the high frequency generator and the heating transformer 21, 22, 23 respectively. It is, therefore, necessary to provide a high ohmic resistance placed in the socket of said devices 20 and 27 to serve as a resistance for the cathode glow lamps during the operation of the high frequency generator and the heating transformer.

While we have shown and described and have pointed out in the annexed claims certain new and novel features of our invention it will be understood of course that various omissions, substitutions and changes in the form and details of the device and in its use and operation may be made by those skilled in the art without departure from the broad spirit and scope of the invention.

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

1. In combination, an electric discharge de-

vice comprising a container, electrodes sealed therein, said electrodes being connected across the terminals of a current source for said device, a starting means for said device comprising a high frequency generator connected to said source and to starting terminals on said device, said high frequency generator being operative on the starting potential of said electric discharge device, but inoperative on the operating potential of said electric discharge device.

2. In combination, an electric discharge device comprising a container, electrodes sealed therein, said electrodes being connected across the terminals of a current source for said device, a starting means for said device comprising a high frequency generator connected to said source and to starting terminals on said device, said high frequency generator being operative on the starting potential of said electric discharge device, but inoperative on the operating potential of said electric discharge device, and means responsive to changes in current flow in the said electric discharge device for interrupting the operation of said high frequency generator.

3. In combination, an electric discharge device comprising a container, electrodes sealed therein, said electrodes being connected across the terminals of a current source for said device, a starting means for said device comprising a high frequency generator and a heating circuit for said electrodes connected across the other terminals of said electrodes, said high frequency generator being operative on the starting potential of said electric discharge device, but inoperative on the operating potential of said electric discharge device.

4. In combination, an electric discharge device comprising a container, electrodes sealed therein, said electrodes being connected across the terminals of a current source for said device, a starting means for said device comprising a high frequency generator and a heating circuit for said electrodes connected across the other terminals of said electrodes, said high frequency generator and said heating circuit being operative on the starting potential of said electric discharge device, but inoperative on the operating potential of said electric discharge device.

5. In combination, an electric discharge device comprising a container, electrodes sealed therein, said electrodes being connected across the terminals of a current source for said device, a starting means for said device comprising a high frequency generator and a heating circuit for said electrodes connected across the other terminals of said electrodes, said high frequency generator and said heating circuit being operative on the starting potential of said electric discharge device, but inoperative on the operating potential of said electric discharge device and means responsive to changes in current flow in the said electric discharge device for interrupting the operation of said high frequency generator and said heating circuit.

In witness whereof we have hereunto set our hands this 9th day of February, 1931.

KURT WIEGAND.
HANS EWEST.
MARTIN REGER.