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P. E. STOGOFF
POWER SUPPLY SYSTEM

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Fig. 1.

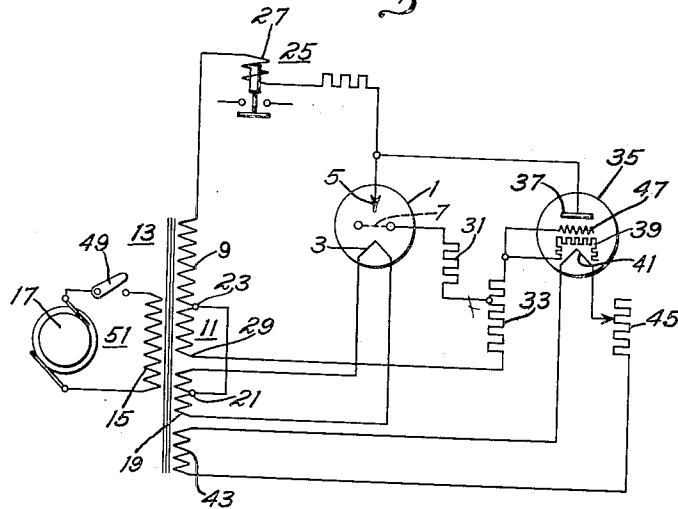
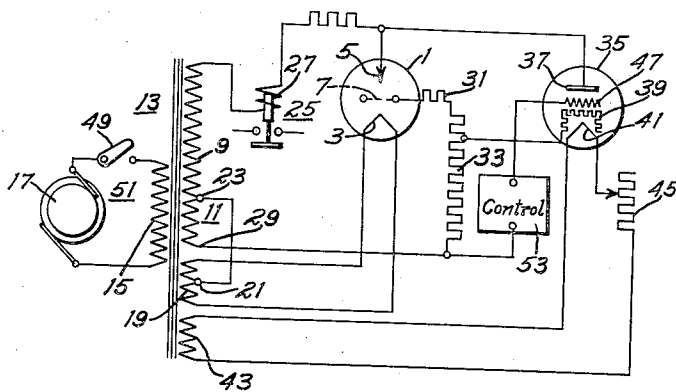


Fig. 2.



WITNESSES:
P. D. Williams
Hyman Diamond

INVENTOR
Peter E. Stogoff.
BY *F. W. Lyle.*
ATTORNEY

UNITED STATES PATENT OFFICE

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POWER SUPPLY SYSTEM

Peter E. Stogoff, Wilkinsburg, Pa., assignor to
Westinghouse Electric & Manufacturing Com-
pany, a corporation of Pennsylvania

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My invention relates to power supply systems and it has particular relation to apparatus of the type incorporating electric discharge devices.

In power supply apparatus of the type where-
in substantial current is required, the practice
has been in accordance with the teaching of the
prior art, to utilize electric discharge devices of
the gas-filled type. Normally, the devices that
are utilized are of the excited cathode type and
the preferred practice in a number of the more
common applications is to utilize hot-cathode
devices.

If the apparatus is of a type requiring consid-
erable current, the cathodes utilized in the elec-
tric discharge devices incorporated in the appa-
ratus are comparatively heavy, and as a result
must be heated for a considerable interval of time
before they attain a condition appropriate for
emission. On the other hand, if a difference of
potential is applied between the cathode and the
anode of a device of this type before the cathode
attains a proper temperature for emission, the
cathode is deteriorated by ion-bombardment and
the life of the tube is considerably shortened.

It is accordingly, an object of my invention to
provide for power supply apparatus of the type
incorporating hot-cathode gas-filled electric dis-
charge devices, a system whereby the cathode of
each electric discharge device shall be pro-
tected from deterioration by reason of premature
emission.

Another object of my invention is to provide
power supply apparatus incorporating gas-filled
electric discharge devices of the hot-cathode type
in which each electric discharge device shall be-
come excited a predetermined interval of time
after it is energized, the interval depending on
the period of time required for the cathode of
the gas-filled device to attain a proper condition
for emission.

Still another object of my invention is to pro-
vide apparatus incorporating gas-filled electric
discharge devices of the hot-cathode type in
which the electro-motive force between cathode
and anode is supplied simultaneously with the
power for heating the cathodes and deterioration
of the cathode by reason of premature emission
does not occur.

A specific object of my invention is to provide
a circuit to be utilized in connection with elec-
tric discharge devices of the gas-filled hot-cath-
ode type whereby the cathodes of the devices shall
be protected from deterioration.

More concisely stated, it is an object of my in-
vention to provide for a power supply system in-
corporating a hot-cathode gas-filled electric dis-
charge device, a time switch whereby the excita-
tion of the gas-filled electric discharge device
shall be delayed for a predetermined interval after
the device is energized; the said interval being

consistent with the time required for the cathode
of the device to attain an appropriate temperature
for emission.

In accordance with my invention, I provide a
power supply system incorporating a gas-filled
hot-cathode electric discharge device of the grid-
control type. An electro-motive force is supplied
between the cathode and the anode of the device
from a power supply source while the control
electrode is normally connected to a point in the
power supply source which is at a potential nega-
tive with respect to the cathode. The cathode
of the device is thus normally prevented from
emitting regardless of the fact that it is ener-
gized.

A high vacuum electric discharge device, prefer-
ably of the type incorporating an indirectly
heated cathode, is connected between the anode
of the gas-filled electric discharge device and the
control electrode thereof.

The anode of the high vacuum device may be
connected directly to the anode of the gas filled
device or it may be connected to a point in the
principal circuit of the gas filled device which is
at a potential different from the potential of the
anode. The particular potential point to which
the anode of the high vacuum device is connected
is dependent on the properties of the high vacuum
device of the gas-filled device associated there-
with and of the circuit in which they are asso-
ciated.

On operation the gas-filled device and the
vacuum device are simultaneously energized.
Initially the cathode of the gas-filled device is
effectively at a positive potential relative to the
control electrode that is of such magnitude that
a discharge through the device is prevented.
However, after the cathode of the vacuum device
attains the proper temperature for emission, an
electromotive force is supplied to the control elec-
trode of the gas-filled electric discharge device
through the vacuum device and the control elec-
trode is raised substantially to the potential of
the anode of the gas-filled electric discharge de-
vice or to the potential of the point to which the
anode of the vacuum device is connected.

The period of time required for the cathode
of the vacuum device to attain the proper tem-
perature for emission is regulated by a variable
resistor in the heating circuit of the cathode.
This period of time may be so regulated that it
corresponds to the time required by the cathode
of the gas-filled electric-discharge device for at-
taining the appropriate temperature for emission.
The result of the arrangement is thus that the
control electrode of the gas-filled electric dis-
charge device is properly polarized for blocking
the emission of the cathode of the gas-filled device
until the latter attains a proper temperature for
emission. In such a case the potential of the con-

control electrode is charged by reason of the conductive path provided by the high vacuum electric discharge device and the cathode of the gas-filled device is permitted to provide the electrons necessary for ionizing the gas in which the electrodes are immersed.

In a modification of my invention, the high vacuum electric discharge device provided for the purpose of delaying the excitation of the gas-filled device until the cathode of the latter attains the proper temperature for emission is utilized as a combined amplifier and time-delay switch. In such a system the high vacuum device may amplify such impulses as are produced, for example, by a photo-sensitive device or the like. The activity of the gas filled device is dependant in this system not only on the condition of the cathode of the high vacuum device but also on the condition of the photo-sensitive device or the other control element the impulses of which are amplified by the vacuum device.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments when read in connection with the accompanying drawing in which:

Figure 1 is a diagrammatic view showing the circuits of an embodiment of my invention; and,

Fig. 2 is a diagrammatic view showing the circuits of a modification of my invention.

The apparatus shown in Fig. 1 comprises an electric discharge device 1 of the gas-filled type, incorporating a hot cathode 3, an anode 5 and a control electrode 7. An electromotive force is supplied between the cathode 3 and the anode 5 of the device 1 from a section 9 of the secondary 11 of a transformer 13, the primary 15 of which is supplied with power from a suitable source 17. The cathode 3 of the device 1 is moreover heated from an independent section 19 of the secondary 11 of the transformer 13, the midpoint 21 of which is connected to an intermediate point 23 of the secondary section 9 whereby the electromotive force is supplied between the cathode 3 and the anode 5. A load is symbolized by a relay 25, the exciting coil 27 of which is connected in the circuit of the anode 5 and the cathode 3 of the electric discharge device 1.

The control electrode 7 of the electric discharge device 1 is connected to the lower tap 29 of the secondary section 9, whereby power is supplied to the principal circuit of the device 1 through a suitable grid impedance 31 and a portion of a second impedance 33. It will be noted that when the cathode 3 of the gas-filled device 1 is at a potential negative with respect to the anode 5 thereof the control electrode 7 of the device is at a potential negative with respect to the cathode. The potential tap 23 of the cathode 3 on the secondary section 9 of the transformer 13 may be so adjusted relative to the potential tap 29 of the control electrode 7, that the latter, by its electrostatic effect, normally blocks the passage of substantial current between the cathode 3 and anode 5 of the electric discharge device 1.

The potential applied to the control electrode 7 is varied by a second electric discharge device 35, the anode 37 of which is connected to the anode 5 of the gas-filled electric discharge device 1 and the cathode 39 of which is connected through a section of the impedance 33 and the grid imped-

ance 31 to the control electrode 7 of the gas-filled device. The electric discharge device 35 is preferably of the high vacuum type and preferably incorporates a cathode 39 of the indirectly heated type.

The heater element 41 for the cathode 39 is energized from an independent section 43 of the secondary 11 of the power supply transformer 13 through a variable resistor 45 of suitable character. In apparatus of the type shown in Fig. 1, I have found it convenient to connect the control electrode 47 of the high vacuum device 35 directly to the cathode 39 thereof.

It will be noted that when the high vacuum electric discharge device 35 passes substantial current the control electrode 7 of the gas-filled device 1 is raised to substantially the same potential as the anode 5 thereof by reason of the conductive path provided by the high vacuum device.

Normally the elements of both electric discharge devices 1 and 35 are simultaneously energized by a switch 49 in the primary circuit 51 of the power supply system. Heating current flows to both the cathode 3 of the gas-filled electric discharge device 1 and the heating element 41 of the cathode 39 of the high vacuum discharge device 35. Both cathodes begin to heat up and emission in the gas-filled electric discharge device is prevented by the control electrode 7 which is for the present maintained at a proper negative potential relative to the cathode 3.

The current transmitted by the high vacuum electric discharge device 35 rises to a substantial value in an interval of time predetermined by the character of the cathode 39, that is utilized by the heating element 41 and by the magnitude of the variable resistor 45 in the heating circuit. These characteristics are so adjusted that the period of time required for substantial current to be transmitted by the high vacuum device 35 is substantially equivalent to the period of time required for the cathode 3 of the gas-filled device 1 to attain a proper temperature for emission.

It is seen that when substantial current is transmitted by the high vacuum device 35 the control electrode 7 of the gas-filled device 1 is raised to a potential in the neighborhood of the potential of the anode 5 of the device and ceases to obstruct the transmission of a current. The gas-filled device 1 then transmits sufficient current to energize the exciting coil 27 of the relay 25 which in turn accomplishes the purpose for which it has been incorporated in the system.

It is well to point out here that it often happens that the electromotive force required in the plate circuit of the gas-filled device 1 is considerably different from the electromotive force required in the plate circuit for the operation of the high vacuum device 35. In such a case the plate 37 of the vacuum device 35 may be connected to a suitable point on the secondary section 9 of the transformer 13 rather than to the anode 5 of the gas-filled device 1.

In apparatus of the type shown in Fig. 2 the high vacuum device 35 is utilized as a combined amplifier and time-delay element.

In this system the current transmitted by the high vacuum device 35 is regulated by its control electrode 47 which is connected to the cathode 39 thereof through a control element 53 of suitable characteristics, depending on the particular purpose to which the system is applied. The control element 53 may be, for example, a photo-sensitive device, an antenna or the like.

In systems of this type, when the switch 49 in

the primary circuit 51 is closed, the gas-filled electric discharge device 1 is prepared for excitation after a predetermined interval of time depending on the character of its cathode 3. However, unless the control element 53 in the grid circuit of the time-delay device 35 is properly energized, the control electrode 7 of the gas-filled electric discharge device 1 is not raised to the proper potential for emission and the gas-filled electric discharge device 1 remains in an unexcited condition.

In experimenting with the system described herein I have found that for any particular combination of elements the time-delay periods produced by the high vacuum device 35 are highly reproducible and may be predicted within a fraction of a second. In a system which I have found to be of particular utility, I have incorporated a hot-cathode electric discharge device of the type capable of delivering a current of approximately .6 amperes, in combination with a time-delay element having substantially the characteristics of the radiotron UY227.

In the embodiments of my invention which I have shown and described herein, circuits of specific types were utilized. It will be understood that my invention is not to be restricted to the specific circuits shown and may, with advantage, be incorporated in systems wherein circuits of other types, well-known in the art, are utilized.

Let me also add that while the time delay relay of the high vacuum type has numerous advantages over relays of other types that might be utilized in the practice of my invention and while the high vacuum tube cooperates with the gas-filled tube to provide a rather simple and tractable structure, relays of other types are contemplated by my invention. Such relays may be electric discharge devices of proper character and possibly also relays of the electromagnetic type. In particular a time delay relay of the electro-magnetic type may be so incorporated in the system that through its contacts when normally closed a bias is maintained in the control electrode of the gas filled electric discharge device such that the device is prevented from becoming energized. When the contacts of the relay are opened a predetermined interval after its coil together with the cathode of the electric discharge devices have been excited, the grid of the electric discharge device is disconnected from the biasing means and is permitted to float. When the blocking potential is no longer applied to the control electrode the electric discharge device becomes energized.

Although I have shown and described certain specific embodiments of my invention, I am fully aware that many modifications thereof are possible. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In a power supply system a gas-filled electric discharge device of the hot cathode type, said device having a plurality of principal electrodes and a control electrode, power supply means for energizing said electric discharge device, means associated with said power supply means to apply a potential to said control electrode to render said electric discharge device inactive and means including a high vacuum electric discharge device to apply a potential to said control electrode

after a predetermined period of time to render said device active.

2. In a power supply system an electric discharge device of the type incorporating at least a cathode, an anode and a control electrode, said cathode being of the type that must attain a predetermined state of excitation before it emits electrical charges to a substantial extent and that is deleteriously affected if it emits substantially before attaining said state of excitation, power supply means for energizing said electric discharge device, means associated with said power supply means to apply an electromotive force to said control electrode to prevent substantial emission from said cathode before it attains its emitting state of excitation and means, including an electric discharge device incorporating at least a cathode and an anode, said cathode being of the type that must attain a predetermined state of excitation before it emits electrical charges to a substantial extent and that is not deleteriously affected by substantial premature emission, to apply an electromotive force to said control electrode of said first-named electric discharge device to permit substantial emission from the cathode of said first-named electric discharge device when said cathode attains a proper state of excitation for emission.

3. In a power supply system of gas-filled electric discharge device of the hot cathode type, said device having a plurality of principal electrodes and a control electrode, power supply means for energizing said electric discharge device, means associated with said power supply means, to apply a potential to said control electrode to render said electric discharge device inactive and means including a high vacuum electric discharge device of the type incorporating an indirectly heated cathode to apply a potential to said control electrode after a predetermined period of time to render said device active.

4. In a power supply system a gas-filled electric discharge device of the hot cathode type, said device having a plurality of principal electrodes and a control electrode, power supply means for energizing said electric discharge device, means associated with said power supply means, to apply a potential to said control electrode to render said electric discharge device inactive, means including an electric discharge device of the type incorporating a cathode and means for heating said cathode, to apply a potential to said control electrode after a predetermined period of time to render said device active, and means for varying the rate of heating of said cathode to vary said period of time.

5. In combination with an electric discharge device of the gas-filled type and means for energizing said device, a contrivance to respond to a disturbance for regulating the activity of said device and unitary means for amplifying the response of said contrivance to the disturbance and for delaying the excitation of said electric discharge device for a predetermined time after said electric discharge device is energized.

6. In combination with a hot-cathode gas-filled electric discharge device and means for energizing said device, a high vacuum electric discharge device to be energized simultaneously with said gas-filled device for delaying the excitation of said device for a predetermined interval after it has been energized.

PETER E. STOGOFF.