

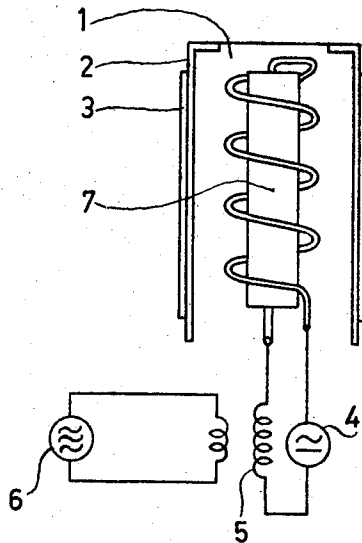
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METHOD AND ARRANGEMENT FOR MORE RAPIDLY HEATING
INDIRECTLY HEATED CATHODES IN ELECTRON TUBES

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METHOD AND ARRANGEMENT FOR MORE RAPIDLY HEATING INDIRECTLY HEATED CATHODES IN ELECTRON TUBES

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6 Claims. (Cl. 315-94)

ABSTRACT OF THE DISCLOSURE

A method and device for temporarily increasing the heat supplied to an indirectly heated cathode in order to shorten heating time. High-frequency energy is supplied to the cathode heater which is converted into heat in the cathode support which surrounds the heater by induction.

The invention relates to a method and an arrangement for rapidly heating indirectly heated cathodes in electron tubes, preferably in high-power tubes.

In apparatus comprising electron tubes, the time from the instant at which the apparatus is switched on to the instant at which the apparatus is ready for operation, normally depends on the heating time of the electron tubes provided therein. Heating time is to be understood herein to mean the time from the instant at which a voltage is applied to the heating wire of the tube to the instant at which the normal cathode temperature is attained. Especially in high-power tubes this heating time is very long, which is experienced as disturbing, for example, in transmitting devices which apart from the output tube, only comprise semi-conductor structural elements, since the time from the instant of switching-on to the instant at which the operating condition is attained then only depends upon the comparatively long heating time of the indirectly heated output tube.

In order to shorten this heating time, use may be made of tubes having directly heated cathodes the heating time of which is considerably shorter; it is desirable in many cases, however, that the heating circuit should be separated from the cathode circuit.

It is known to shorten the heating time of tubes having indirectly heated cathodes in that the power supplied to the heating wire is raised in excess of the normal value during heating. Such an increase, be it only transient, of the power supplied is very detrimental to the heating wire so that the life is considerably shortened.

The invention provides a method of rapidly heating indirectly heated cathodes in electron tubes of high power in which the said disadvantages are avoided. According to the invention, the heater of the cathode is supplied with additional high-frequency energy during heating, which energy is converted into heat by induction in the cathode support which surrounds the heater and is constructed in the form of a closed ring.

The cathode support is very rapidly heated by the high-frequency energy induced in it via the heater and in this manner the heating time is reduced to 10% of the normal heating time.

The invention will now be described with reference to the drawing which shows an embodiment.

The figure shows a heater 1 which is provided in a support 2 which takes the form of a closed ring and is coated with an emissive layer 3. The normal heating energy is supplied to the heater 1 from a suitable current source 4. In order to reduce the heating time of the cathode, additional high-frequency energy is supplied through a trans-

former 5 to the heating circuit for a short time after the normal current source 4 has been switched on. This high-frequency energy is produced in a generator 6 switched on for a short time.

For the high-frequency energy supplied to the heating circuit, the heater 1 and the cathode support 2 are to be considered as a primary winding and as a shortcircuited secondary winding of a transformer. In order to obtain a more satisfactory energy transmission, the heater 1 preferably has a helical shape, as shown in the drawing. The temperature of the heater and hence also the temperature of the emissive layer 3 is rapidly increased by the high-frequency energy induced in the support 2.

The coupling may be further increased, for example, in the manner shown by the provision of a ferrite core 7 in the helical filament 1.

In order that the generator 6 may become operative immediately after being switched on, it consists of semiconductor elements.

The considerable reduction of the heating time of an indirectly heated cathode operated and built up in accordance with the invention may be explained on coarse approximation with reference to the following numerical example:

With a transmitter tube of 1 kw., the energy content of the indirectly heated cathode heated to the operating temperature amounts to 1 kcal. (1 cm.³ of material, ca. 10 gms., 1000° C., specific heat .1 kcal./kg./T.), 1 kcal. ≈ 4000 w. sec. In order to compensate for the heat losses in continuous operation, a power of 100 w. must constantly be supplied.

This leads to a normal heating time of

$$T_h \approx \frac{4000 \text{ w. sec.}}{100 \text{ w.}} = 40 \text{ seconds}$$

When during heating an additional power $Q_H = 900 \text{ w.}$ is supplied to the cathode by the high-frequency generator 6, this results in a reduction of the heating time of

$$T_h' = \frac{4000 \text{ w. sec.}}{900 + 100 \text{ w.}} = 4 \text{ seconds}$$

Consequently, the heating time is reduced to 1 of the normal value.

The numbers stated in the above calculation are only approximate values; deviations due to variations of the heat resistance with temperature and due to heat losses during the heating time have been neglected.

Instead of using a separate generator 6, the high-frequency energy may alternatively be produced by a stage, for example a control stage or a pre-amplifier stage connected with the tube to be heated rapidly, for example a transmitter tube, and adapted to be correspondingly commutated.

What is claimed is:

1. A circuit arrangement for rapidly heating an indirectly heated cathode in an electron discharge tube, said cathode having a heating element surrounded by a cathode support, said circuit arrangement comprising means to connect said heating element to a source of electrical energy for heating the same, and means to couple said heating element to a source of high-frequency energy, and means to inductively couple said heating element to said cathode support to heat the same.

2. A circuit arrangement as claimed in claim 1, in which the heating element has a helical shape.

3. A circuit arrangement as claimed in claim 2, in which the coupling means between the heating element and the cathode support includes a ferromagnetic ferrite body.

4. A circuit arrangement as claimed in claim 3, in

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which the ferrite body has the shape of a rod which is provided in the helical heater.

5. A circuit arrangement as claimed in claim 3 in which the source of high-frequency energy comprises semi-conductor elements.

6. A method of rapidly heating an indirectly heated cathode in an electron discharge tube, said cathode having a heating element surrounded by a cathode support, said method comprising the steps of connecting said heating element to a source of electrical current to heat the same, and initially applying to said heating element for a pre-

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determined period of time high-frequency energy, and inductively coupling said heating element to said cathode support to heat the same with the high-frequency energy.

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DAVID J. GALVIN, *Primary Examiner.*

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,349,282

October 24, 1967

Helmut Krieger

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the heading to the printed specification, line 10, for "D 34,937/64" read -- P 34,937/64 --; column 1, lines 20 to 22, the paragraph should not appear as a part of the ABSTRACT OF THE DISCLOSURE.

Signed and sealed this 26th day of November 1968.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

EDWARD J. BRENNER

Commissioner of Patents