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COLD EMISSION ELECTRON DISCHARGE DEVICE

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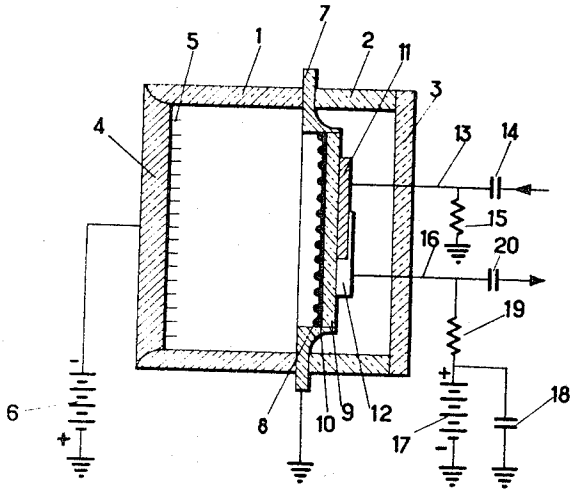


FIG. 1

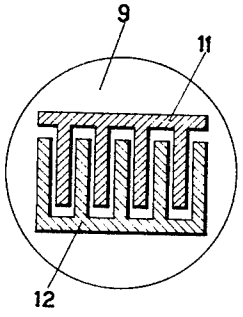


FIG. 2

INVENTOR:
Daniel CHARLES

BY Paul M. Craig, Jr.
ATTORNEY

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COLD EMISSION ELECTRON DISCHARGE DEVICE

Daniel Charles, 79 Blvd. Haussmann, Paris, France

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12 Claims. (Cl. 313—310)

The present invention relates to triodes with cold cathodes by field emission.

It is known that the cold cathodes by field emission operate with high voltages of the order of several kilovolts or several tens of kilovolts, and that, within this range of voltages, the current modulation is very difficult if the triode comprises a grid and an anode of conventional construction.

The object of the present invention is a triode with cold cathode by field emission in which the modulation is, in contrast thereto, simple and easy.

According to the present invention, the fast electrons issued from a cold cathode by field emission bombard a target with induced conductivity which supports the grid and the anode in the form of metallizations on the insulating face thereof.

It is known that targets with induced conductivity, usually utilized in storage tubes, comprise a metallic layer in contact with an insulating layer made of a dielectric such as zinc sulphide, having the property of becoming momentarily conductive when rapid electrons penetrate into the insulating layer. This target is bombarded on the metallic side thereof by rapid electrons which traverse the metallic layer and penetrate into the insulating layer which they traverse to a greater or lesser extent. Along the paths thereof within the insulating material, these electrons liberate a quantity of secondary electrons in such a manner that the insulation becomes momentarily conductive which constitutes the phenomenon of induced conductivity. The number of secondary electrons liberated within the insulating layer by each primary electron is called coefficient of multiplication of the target. These secondary electrons may be removed, for example, by a metallization carried at a positive potential applied on the insulating face of the target.

It has already been proposed in my copending application filed on March 3, 1963, under Serial No. 263,277, now Patent No. 3,240,988 and entitled "Storage Tube" to utilize, particularly in analyser storage tubes, a target with induced conductivity supporting on the insulating face thereof a grid operating as control of the coefficient of multiplication of the target. In the present invention, however, a target with induced conductivity is utilized supporting on the insulating face thereof two metallizations, of which one, carried at a positive potential, serves to remove the secondary electrons by causing the same to flow off and functions as anode of the triode, and the other, carried at an adjustable or controllable potential, serves to cause the coefficient of multiplication of the target to vary and functions as control grid of the triode.

Accordingly, it is an object of the present invention to provide a cold cathode electron discharge device which eliminates, by simple and effective means, the aforementioned shortcomings noted hereinabove that are normally encountered in analogous prior art devices.

It is another object of the present invention to provide an electron discharge device provided with a cold cathode operating by field emission which permits, by simple means, of controlling the amplitude of the output current thereof.

Still another object of the present invention resides in the provision of an electron discharge device of the cold

cathode type operating by means of field emission with relatively high voltages which permits modulation of the output current with relatively low voltages notwithstanding the high voltages utilized in producing the electron emission from the cold cathode, and which solves the problems of insulation within the tube in a completely satisfactory manner without unduly complicated and expensive structures.

Still a further object of the present invention resides in the provision of an electron discharge device provided with a cold cathode operating by field emission in which the anode and control grid are constituted by auxiliary elements adjoined to a target having induced conductivity so as to eliminate any problems resulting from the use of the high voltages necessary to produce electron emission from the cold cathode.

These and other objects, features and advantages of the present invention will become more obvious from the following description when taken in connection with the accompanying drawing which shows, for purposes of illustration only, one embodiment in accordance with the present invention and wherein:

FIGURE 1 is a longitudinal cross sectional view through a triode-type electron discharge device in accordance with the present invention, and

FIGURE 2 is a transverse cross sectional view, taken along line 2—2 of FIGURE 1, of the target with induced conductivity utilized in the electron discharge device of FIGURE 1.

Referring now to the drawing wherein like reference numerals are used throughout the two views to designate therein like parts, the triode illustrated in FIGURE 1 comprises an evacuated enclosure, delimited by rings **1** and **2** made, for example, of ceramic material, a cover **3** also made of ceramic and a metallic bottom or base **4**. On the bottom **4** is placed an array of small points **5**, for example, of tungsten or zirconium carbide, constituting the cold cathode by field emission, which is carried by means of source **6** at a high negative potential, for example, −10 kv. to −30 kv., with respect to ground. A mounting **7**, extending to the outside between the rings **1** and **2**, supports thereon a target with induced conductivity, realized as usual by vaporizing on a very fine grid **8**, serving as support, a very thin layer, for example, of 0.5 to 2 microns, of dielectric **9** such as zinc sulphide, imparting to the target a high coefficient of multiplication, and by subsequently metallizing the insulating surface on the side of the grid **8** with a layer **10**, for example, of aluminum of a thickness of about 0.03 to 0.1 micron.

According to the present invention, there are disposed on the insulating face of the target opposite the metallization **10**, for example, by vaporization in vacuum, two metallizations **11** and **12**, for example, in the form of an interdigital comb-type structure (FIGURE 2) of which one serves as grid and the other as anode of the triode. The grid **11** has a connection **13** passing through the cover **3** and its connection **13** receives the input signal across the capacitor **14** at the terminals of a biasing resistance **15**. The anode **12** also has a connection **16** passing through the cover **3**, and its connection **16**, which is carried at a positive potential by means of source **17** uncoupled by the capacitor **18** across a charging resistance **19**, supplies the output signal across the capacitor **20**.

Operation

The tube described hereinabove operates as follows:

The rapid electrons, extracted by field emission from the points **5** upon application of the high voltage from source **6**, traverse the metallization **10**, and thereupon penetrate into the insulating layer **9** where they liberate along their paths secondary electrons which flow off

through the anode 12 and form a direct current in the charging resistance 19. Nevertheless, the quantity of secondary electrons liberated is controlled by the potential applied to the grid 11, and the variations of this potential under the effect of the input signal introduces in the output current of these electrons a modulation which appears as an amplified output signal transmitted through the capacitor 20. Thus, one can readily find again in the structure described hereinabove the operation of a conventional triode with its ease of modulation, while preserving at the same time the advantages inherent in the cold cathodes.

While I have shown and described one embodiment in accordance with the present invention, it is obvious that the same is not limited thereto but is susceptible of numerous changes and modifications within the spirit and scope thereof, and I therefore do not wish to be limited to the details shown and described herein but intend to cover all such changes and modifications as are encompassed by the scope of the appended claims.

I claim:

1. A triode, comprising:
a cold emission cathode providing an unmodulated stream of electrons;
a target having induced conductivity properties and facing said cathode with one face thereof receiving said unmodulated stream of electrons;
a first metallization located on the other face of said target;
and a second metallization located on said other face and galvanically separated from said first metallization,
means applying input signals to one of said metalizations and means extracting an output signal from said other metalization.

2. A triode, comprising:
a cold emission cathode providing an unmodulated stream of electrons;
a target having induced conductivity properties and facing said cathode with one face thereof receiving said unmodulated stream of electrons;
a first metallization located on the other face of said target;
and a second metallization located on said other face and galvanically separated from said first metallization;
said one face being the face of a metal layer and said other face being the face of an insulating layer having induced conductivity properties and adhering to said metal layer,
means applying input signals to one of said metalizations and means extracting an output signal from said other metalization.

3. A triode, comprising:
a cold emission cathode providing an unmodulated stream of electrons;
a target having induced conductivity properties and facing said cathode with one face thereof receiving said unmodulated stream of electrons;
a first metallization located on the other face of said target;
and a second metallization located on said other face and galvanically separated from said first metallization,
said first and second metallizations being in the form of mutually interleaving comb-like structures,
means applying input signals to one of said metallizations and means extracting an output signal from said other metallization.

4. A triode, comprising:
a cold emission cathode providing an unmodulated stream of electrons;
a target having induced conductivity properties and facing said cathode with one face thereof receiving said unmodulated stream of electrons;

means for applying a relatively high voltage between said target and said cathode;
a first metallization located on the other face of said target;
and a second metallization located on said other face and galvanically separated from said first metallization,
means applying input signals to one of said metallizations and means extracting an output signal from said other metallization.

5. A triode, comprising:
a cold emission cathode providing an unmodulated stream of electrons;
a target having induced conductivity properties and facing said cathode with one face thereof receiving said unmodulated stream of electrons;
a first metallization located on the other face of said target;
a second metallization located on said other face and galvanically separated from said first metallization;
output means operatively connected with one of said first and second metallizations for deriving a signal therefrom;
and input control means coupled to the other of said first and second metallizations for applying a modulating signal thereto.

6. An electron discharge device having amplification characteristics, comprising within an evacuated enclosure:
cold emission cathode means;
target means having induced conductivity properties and provided with two sides with one side thereof facing said cathode means;
anode means effectively constituted by a first metallization located on the other side of said target means;
and control grid means effectively constituted by a second metallization located also on said other side and galvanically separated from said first metallization,
means applying input signals to one of said metallizations and means extracting an output signal from said other metallization.

7. A triode, comprising:
a cold emission cathode providing an unmodulated stream of electrons;
a target having induced conductivity properties and facing said cathode with one face thereof receiving said unmodulated stream of electrons;
means for applying a relatively high voltage between said target and said cathode;
a first metallization located on the other face of said target;
and a second metallization located on said other face and galvanically separated from said first metallization;
said one face being the face of a metal layer and said other face being the face of an insulating layer having induced conductivity properties and adhering to said metal layer,
means applying input signals to one of said metallizations and means extracting an output signal from said other metallization.

8. A triode, comprising:
a cold emission cathode providing an unmodulated stream of electrons;
a target having induced conductivity properties and facing said cathode with one face thereof receiving said unmodulated stream of electrons;
means for applying a relatively high voltage between said target and said cathode;
a first metallization located on the other face of said target and a second metallization located on said other face and galvanically separated from said first metallization;
said one face being the face of a metal layer and said other face being the face of an insulating layer hav-

ing induced conductivity properties and adhering to said metal layer;

said first and second metallizations being in the form of mutually interleaving comb-like structures,

means applying input signals to one of said metallizations and means extracting an output signal from said other metallization.

9. In an electron discharge device providing a gain and having, within an evacuated enclosure, cold emission cathode means;

the improvement essentially consisting of target means with induced conductivity properties;

said target means including electrically conductive first means effectively forming a first electrode;

and electrically conductive second means effectively forming a second electrode galvanically separated from said first means,

means applying input signals to said first means and means extracting an output signal from said second means.

10. In combination, a triode including a cold emission cathode, a target having induced conductivity properties and facing said cathode with one side thereof, a first metallization located on the other face of said target, and a second metallization located on said other face and galvanically separated from said first metallization and being interdigitated therewith;

and a circuit for said triode including means for applying to one of said first and second metallizations a positive potential with respect to said target to thereby operate said one metallization as anode of the triode, means including signal means for biasing the other of said first and second metallizations thereby operating said other metallizations as control electrode of said triode.

11. In combination, a triode including a cold emission cathode, a target having induced conductivity properties and facing said cathode with one side thereof, a first metallization located on the other face of said target, and a second metallization located on said other face and galvanically separated from said first metallization;

and a circuit for said triode including means for applying to one of said first and second metallizations a positive potential with respect to said target to thereby operate said one metallization as anode of the triode, means for biasing the other of said first and second metallizations thereby operating said other metallization as control electrode of said triode, and modulating signal input means operatively connected to said control electrode for application of a modulating signal thereto and signal output means operatively connected to said anode.

12. In combination, a triode including a cold emission cathode, a target having induced conductivity properties and facing said cathode with one side thereof, a first metallization located on the other face of said target, and a second metallization located on said other face and galvanically separated from said first metallization;

and a circuit for modulating said triode including means for applying to one of said first and second metallizations a positive potential with respect to said target to thereby operate said one metallization as anode of the triode, means for biasing the other of said first and second metallizations thereby operating said other metallization as control electrode of said triode, and control means for said control electrode.

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JOHN W. HUCKERT, *Primary Examiner.*

A. J. JAMES, *Assistant Examiner.*