

May 12, 1925.

1,537,708

W. SCHOTTKY

THERMIONIC VACUUM TUBE

Filed Aug. 27, 1919

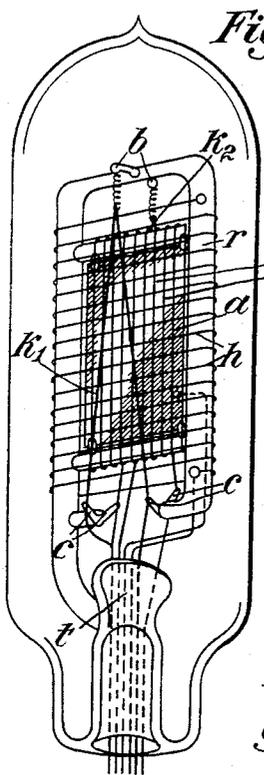


Fig. 1

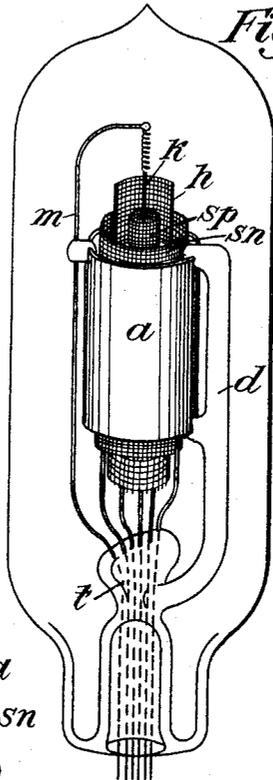


Fig. 3



Fig. 4

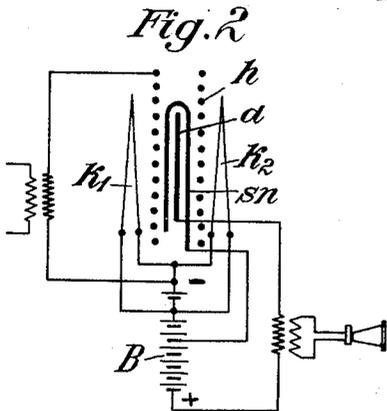


Fig. 2

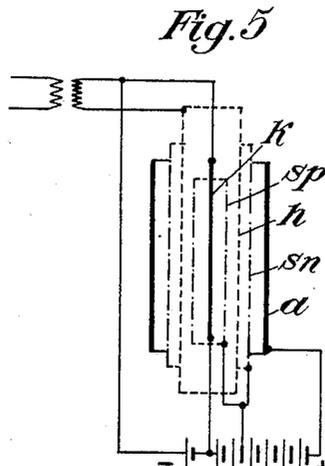


Fig. 5

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Patented May 12, 1925.

1,537,708

UNITED STATES PATENT OFFICE.

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THERMIONIC VACUUM TUBE

Application filed August 27, 1919. Serial No. 320,246.

(GRANTED UNDER THE PROVISIONS OF THE ACT OF MARCH 3, 1921, 41 STAT. L., 1313.)

To all whom it may concern:

Be it known that I, WALTER SCHOTTKY, a German citizen, residing at Berlin-Charlottenburg, Germany, have invented certain new and useful Improvements in Thermionic Vacuum Tubes (for which I have filed applications as follows: Germany, May 31, 1916, Pat. No. 300,617; France, June 24, 1919, Pat. No. 518,623; Holland, May 28, 1919, Ser. No. 12,100, and Holland, October 25, 1920, Ser. No. 16,916; Italy, June 27, 1919, Pat. No. 176,732/52-510; Sweden, June 27, 1919, Ser. No. 2,962/19, and Sweden, December 23, 1919, Ser. No. 5,808/19; Switzerland, June 16, 1919, Pat. No. 86,781; Norway, December 24, 1919, Ser. No. 18,769; Denmark, April 14, 1920, Ser. No. 994/20; Austria, May 15, 1917, Ser. No. A. 2,263-17; Hungary, May 19, 1917, Ser. No. S. 8,618; Czechoslovakia, March 18, 1921, Ser. No. P, 1806-21; Japan, July 2, 1920, Ser. No. 58,350; Great Britain, June 17, 1920, Pat. No. 145,421), of which the following is a specification.

My invention refers to electrical apparatus and more especially to cathode ray relays or vacuum amplifying tubes provided with a glow cathode and an auxiliary electrode and its particular object is to improve the efficiency of such tubes or relays.

As is well known, the amplification of electrical energy in cathode relays or amplifying tubes provided with a glow cathode and an auxiliary electrode depends to a considerable degree upon the fact, that the controlled current is influenced to a far greater extent by changes in the potential of the auxiliary or grid electrode or by magnetic influence upon the path of the rays than by changes in the potential of the anode. According to this theory the increase of energy will grow, provided that suitable translators and other parts be employed, at the same ratio as the sensibility of the control current decreases in relation to the variation of the anode potential. This phenomenon may be interpreted as a kind of reaction of the secondary circuit on what takes place within the amplifying tube. The more this reaction is diminished, the greater will be the amplifying effect.

According to my invention this reaction

may be diminished by arranging in front of the anode an open-work or grid shaped conductor insulated from the anode as well as from the controlling grid electrode, and possessing a constant voltage relatively to the cathode. In the following I shall call this conductor a "protective net".

The peculiar action of this protective net is explained by the fact, that it protects electrostatically the field in the vicinity of the auxiliary or grid electrode against the field of the anode, while at the same time the field directed from the grid towards the protective net and partly transgressing into the space between cathode and grid causes a considerable part of the electrons to pass through the grid even in the case where, as is recommendable also for other reasons, the grid is given a potential lower than that of the cathode.

In order to provide against a substantial part of the current being diverted to the protective net, it is preferable to keep the potential of the protective net in such tubes, which are mainly operated with electron currents, lower than the potential of the anode. Where space charging effects need not be feared, I even prefer keeping the potential lower than that which would be obtained with the anode voltage used, but without employing a protective net, at the point where this net is disposed.

In the drawings affixed to this specification and forming part thereof two different modifications of a tube according to my invention are illustrated, Fig. 1 being an elevation and Fig. 2 a diagram showing the connections of the first modification, while Fig. 3 is an elevation, Fig. 4 a plan of the electrode arrangement and Fig. 5 a diagram showing the connections of the second modification.

Referring to the drawings, the electrodes shown in Fig. 1 to be disposed within a glass tube evacuated as far as possible are fixed on a frame *r* formed of glass tubes, this frame being fixed in turn to the base *t*. The vertical arms of the frame consist of tubes of a larger diameter. Within the frame there is fixed the anode *a*, consisting of a thin hard metal plate. A thin tungsten wire *sn* is wound around the

transverse arms of the glass frames r in a vertical direction, thus surrounding the anode a on both sides at a certain distance and fully insulated from it. A second layer of wire h , this layer also being insulated, is arranged over the first one in the form of another tungsten wire wound around the longitudinal arms of the frame r in a horizontal direction.

The frame further carries detents b and c serving as supports for two V-shaped tungsten wires k_1 , k_2 , these wires representing the glow cathode of the tube. As shown in Fig. 2 both cathode wires are connected parallel and thus form a reserve in case one of the wires should burn out. Moreover under ordinary conditions they serve to increase the efficiency of the amplifying tube.

The wire grid h serving as auxiliary or grid electrode is kept in the usual manner on a slightly negative potential relatively to the cathode wires k_1 , k_2 , and serves for controlling the currents passing from the cathode k to the anode a . On the other hand the protective net sn is connected only at one end to such a point of the battery B, which renders its potential lower than the potential due to the voltage drop between the cathode and the point where the grid is located as a result of the current flow between the anode and the cathode.

An especially favourable effect of the amplifying tubes is obtained, if besides the protective net another so called voltage net is used, this net being arranged in tubes operated with pure electron currents between cathode and grid electrode in order to suppress the space charging effect of the electrons, and being provided with a higher positive potential than is due to its surroundings.

A tube of this latter kind is shown in Figs. 3 to 5. The glow cathode k has the form of a single thread, concentrically surrounded by the voltage net sp , which is enclosed in its turn within the grid electrode h having the form of a cylindrical net, this electrode serving as a controlling device.

The grid electrode is surrounded by the protective net sn and this latter is enclosed in the anode a , consisting of a thin piece of sheet metal easily freed of gases. The nets are preferably made of a metal of high melting point, such as iron or nickel, and the parts are fixed so that the anode is carried by a glass rod d fixed to the base t , the individual nets being fixed thereon by glass beads g , connected therewith by fusing. A similar glass bead carries the metal rod m having fixed to its upper end the cathode thread k .

The voltage net sp and the protective net sn are preferably conductively connected with each other and have such a potential relatively to the adjacent electrodes, and are arranged at such a distance therefrom, that the conditions mentioned above regarding the relation of the potentials of the two additional nets to their surroundings are observed.

I claim:

1. In a vacuum tube of the character described in combination, a glow cathode and a grid electrode both connected to the input circuit, an anode connected to the output circuit, and a grid-shaped conductor disposed between said first-named grid electrode and said anode, the potential of said conductor relatively to said cathode being constant and positive but lower than the potential of said anode.

2. In a vacuum tube of the character described in combination, a glow cathode, an anode, a grid electrode and two grid-shaped conductors disposed between said cathode and said anode and insulated therefrom, one of said conductors having a potential relatively to the cathode lower than that of said anode, while the other conductor has a positive potential relatively to said cathode exceeding the potential corresponding to its position in the space between the cathode and anode.

In testimony whereof I affix my signature.

WALTER SCHOTTKY.