June 13, 1933. G. SEIBT ET AL 1,914,044

GLOW TUBE FOR AMPLIFYING, DETECTING, AND OTHER PURPOSES

Filed Sept. 7, 1929 2 Sheets-Sheet 1

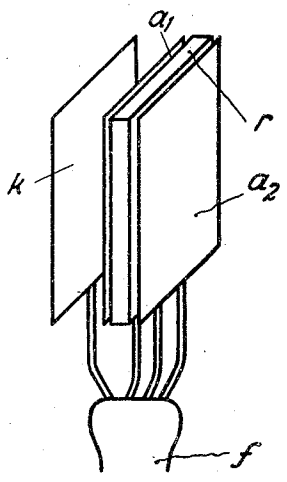


Fig. 1

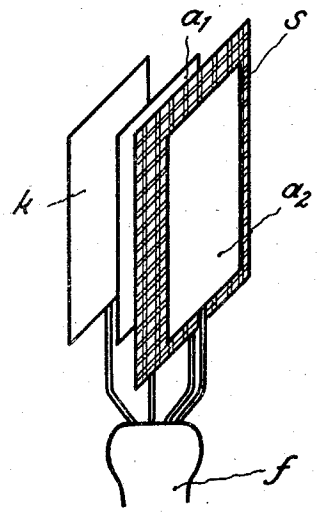


Fig. 2

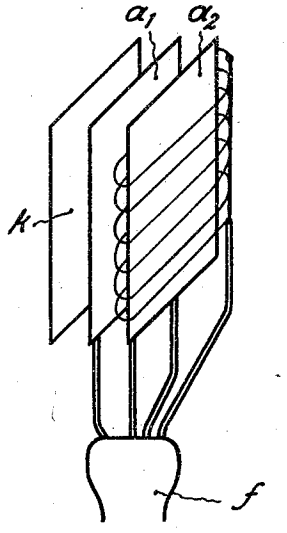


Fig. 3

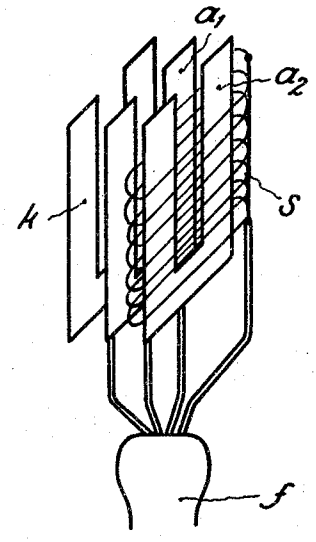


Fig. 4

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GLOW TUBE FOR AMPLIFYING, DETECTING, AND OTHER PURPOSES

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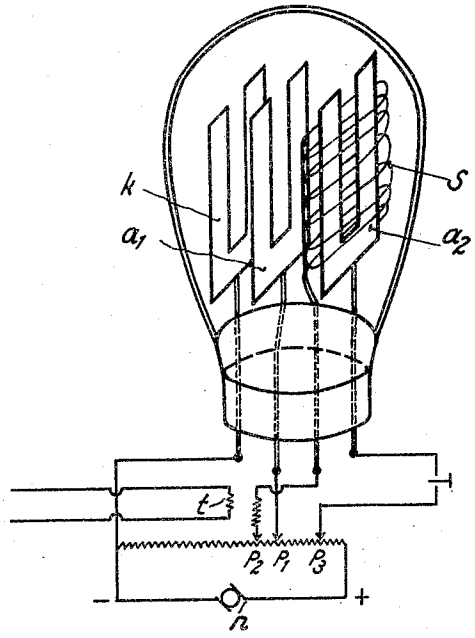


Fig.5

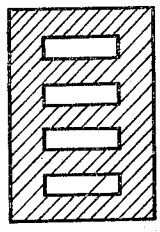


Fig.6

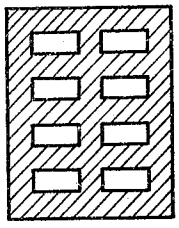


Fig.7

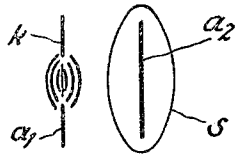


Fig.8

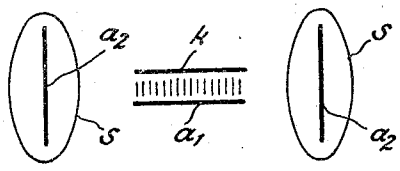


Fig.9

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UNITED STATES PATENT OFFICE

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GLOW TUBE FOR AMPLIFYING, DETECTING, AND OTHER PURPOSES

Application filed September 7, 1929, Serial No. 391,049, and in Germany October 17, 1928.

It has been proposed to use a glow tube for the amplification of small alternating currents instead of the known high-vacuum thermionic tube in which an electron discharge is effected by means of an incandescent cathode. However, it has not hitherto been possible to construct a glow tube capable of being used in practice as an amplifying tube.

In contradistinction thereto, the present invention relates to a glow discharge tube which can be used in practice with good amplifying results in the same way as the well-known amplifying thermionic tubes working with an incandescent cathode. Further, the amplifying glow tube according to the present invention is in many respects far superior to the usual amplifying tubes. The main advantage consists in this that there is no heating of the cathode and consequently the heating battery is dispensed with. A further advantage consists in this that with the same consumption and voltage, the improved tube is substantially superior to the amplifying tubes in which the cathode is heated as regards the slope of the characteristic and the output. A further important practical advantage lies in the use of the improved tube in connection with continuous and alternating current supply circuits. The apparatus which have hitherto been placed on the market to be connected on to the mains, for instance in the case of wireless broadcasting, have still the drawback that the disturbing noises cannot be completely avoided, this being mainly due to the direct heating of the incandescent cathode.

The amplifying glow tube according to the invention is especially suitable and advantageous when radio receiving apparatus or other devices operated by means of tubes have to be fed from the mains.

The construction and operation of the improved glow tube are as follows:—

A glow discharge is produced between an electrode acting as a cathode and an electrode acting as anode. Electrons as well as ions move in the space between the cathode and the anode. By means of a second anode, the electrons are, so to say, drawn off from the discharge space by means of a second anode, which has preferably a higher potential than the anode first referred to, so that the electrons pass over to it and are controlled in a known manner by means of a meshed intermediate electrode.

According to the present invention, the first anode is not constructed in the form of a grid, as has hitherto been the case, but in the form of a plate.

Various modes for carrying the invention into effect are illustrated, by way of example, in the accompanying drawings.

Figs. 1, 2 and 3 show three different arrangements of systems of electrodes in which the anodes and the cathode consist of rectangular plates, whilst the controlling electrode has different shapes, being in the form of a frame in Fig. 1, in the form of a net-like member in Fig. 2 and a wire helix in Fig. 3.

Fig. 4 illustrates a system of electrodes in which the anodes and the cathode are U-shaped.

Fig. 5 illustrates diagrammatically the arrangement of a system of electrodes as indicated in Fig. 4 in a tube, together with the essential parts of the diagram of connections.

Figs. 6 and 7 illustrate different forms of discharge electrodes, whilst Figs. 8 and 9 illustrate diagrammatically different modifications of the arrangement of the glow discharge electrodes with respect to the second anode and the controlling electrode.

Referring to the construction illustrated in Fig. 1, k is a cathode, a_1 the first anode, towards which the discharge takes place, and a_2 the second anode.

Between the first and the second anode, there is provided in the proximity of their edges a frame r which acts as a controlling member. All the electrodes are secured to a leg f. Amplifying effects have been obtained with the construction just referred to although they were comparatively small. The slope of the current voltage characteristic of this arrangement was 0.3 mA/V and the amplification factor 2.5. No grid current due to positive ions could be detected.

An improvement of the conditions was secured by the arrangement illustrated in Fig. 2, in which the controlling electrode s is con-

structed as a net-like member, which is slightly larger than the plate anode a_1 and anode a_2. The surface of the plates k, a_1 and a_2 is 20×30 mm. The net-like member projects on each side about 4 mms. The slope of the current voltage characteristic of this arrangement was 0.2 mA/V and the amplification factor about 4.

In the two forms of construction just referred to, it is assumed that the electrons are drawn by the anode a_2 from the discharge space between k and a_1 along the edge, which thus can be considered to be a kind of an edge effect. In connection with this hypothesis, it may be mentioned that the electrons in the gas-filled discharge tube do not all follow a straight path and that they impinge on gas molecules and are reflected by the latter.

A further improvement has been obtained with the arrangement illustrated in Fig. 3, which differs from that illustrated in Fig. 2 by this that the anode a_2 is surrounded on both sides by the controlling electrode s, which is made of helical form. The slope of the current voltage characteristic was in this case 1.3 mA/V and the amplification factor about 7.

It has already been pointed out that the anode a_2 draws the electrons from the discharge space between k and a_1 over the edges of the electrodes. This led to increasing the edges of the electrodes, which may for instance be secured by the construction of U-shaped electrodes. Fig. 4 illustrates an arrangement of this character. The amplification factor of this tube was found to be 6 and the slope of the current voltage characteristic 2.5 mA/V.

The voltage between k and a_1 used during the experiments was about 200 V. The voltage of a_2 was about 10 V higher than that of a_1.

A diagram of connections is illustrated, by way of example, in Fig. 5. A source of current n of 220 Vs. is shunted by a potentiometer resistance. The negative pole of the source of current is connected to the cathode k, whilst the lead to the anode a_1 is tapped at p_1 at about 200 Vs. and the lead to the anode a_2 is tapped at p_3 at a voltage of about 210 Vs. A telephone is inserted in the lead to the anode a_2. The lead to the controlling electrode s, which is tapped at a point p_2, which is negative with respect to p_1, contains a transformer t, which receives the currents to be amplified.

Figs. 6 and 7 illustrate, by way of example, further forms of construction of the electrodes proposed with the object of increasing the edge effect and consisting of plates provided with a number of openings.

All the forms of construction of the electrodes hereinbefore described are mainly intended for the two discharge electrodes k and a_1. However, it is an advantage, more especially with respect to the manufacture, to construct the second anode a_2 in the same way.

It is to be understood that the discharge electrodes k and a_1 may be so arranged that the main discharge field does not take place at right angles to the surface of the anode a_2 but parallel thereto. Such arrangements are illustrated, by way of example, in Figs. 8 and 9. Whilst in Fig. 8 the discharge electrodes k and a_1 are still parallel to a_2, they lie in a common plane; in contradistinction thereto, in Fig. 9, the electrodes k and a_1 are both at right angles to a_2 but face one another. The system of electrodes s and a_2 may be used in duplicate and be arranged symmetrically with respect to the two sides of the system of discharge electrodes k and a_1. Such an arrangement has been shown in Fig. 9, it being understood that it may also be used in connection with the arrangement illustrated in Fig. 8.

It has been found of special advantage that the construction according to the invention works well when the anode a_2 has a positive potential of only 1 volt with respect to a_1. In all the experiments, the controlling electrode had a negative voltage bias of 1–2 volts with respect to the anode a_1. Use was made of neon gas and the pressure during the experiments was about 6 mms.

It has been ascertained by further experiments that a mesh of several millimetres, for instance 4 mms., and more for the controlling electrode led to satisfactory results. Naturally the proper mesh must be determined by experiments.

When constructing the improved amplifying tube, it has been found important to surround the leads to the electrodes with an insulating material, preferably with glass tubes, so that no discharge should take place between them. It has also been found of great importance to use the rare gas in a condition of great purity, it being also necessary never to remove the mercury vapours during the evacuation, which may be ensured by a gas trap.

It is to be understood that the tube according to the invention is not limited to its use as an amplifying tube but that it may also be used as a detector, generator of oscillations, or the like.

What we claim is:—

1. A glow discharge tube containing a cathode and a first anode for producing a glow discharge, a second anode arranged behind said first anode outside the glow discharge space between said cathode and said first anode and adapted to receive a higher positive potential than said first anode, and a controlling electrode between said first and said second anode for modulating the electron current consisting of electrons of said glow discharge and passing from said glow

discharge space to said second anode, said cathode and said first anode lying parallel to each other and consisting of plates of the same form, having apertures of equal size facing exactly one another.

2. A glow discharge tube containing a cathode and a first anode for producing a glow discharge, a second anode arranged behind said first anode outside the glow discharge space between said cathode and said first anode and adapted to receive a higher positive potential than said first anode, and a controlling electrode between said first and said second anode for modulating the electron current consisting of electrons of said glow discharge and passing from said glow discharge space to said second anode, said cathode and said first anode lying parallel to each other and consisting of U-shaped plates of equal size.

3. A glow discharge tube containing a cathode and a first anode for producing a glow discharge, a second anode arranged behind said first anode outside the glow discharge space between said cathode and said first anode and adapted to receive a higher positive potential than said first anode, and a controlling electrode between said first and said second anode for modulating the electron current consisting of electrons of said glow discharge and passing from said glow discharge space to said second anode, said cathode and said first anode lying parallel to each other and said cathode, said first anode and said second anode consisting of plates of the same form and of equal size and having apertures of equal size facing exactly one another.

In testimony whereof we have signed our names to this specification.

GEORG SEIBT.
HELLMUTH BLEY.