Jan. 4, 1927. 1,612,835

W. SCHOTTKY

INTERMEDIATE ELECTRODE IN INCANDESCENT CATHODE TUBE

Filed August 30, 1921

Fig. 1

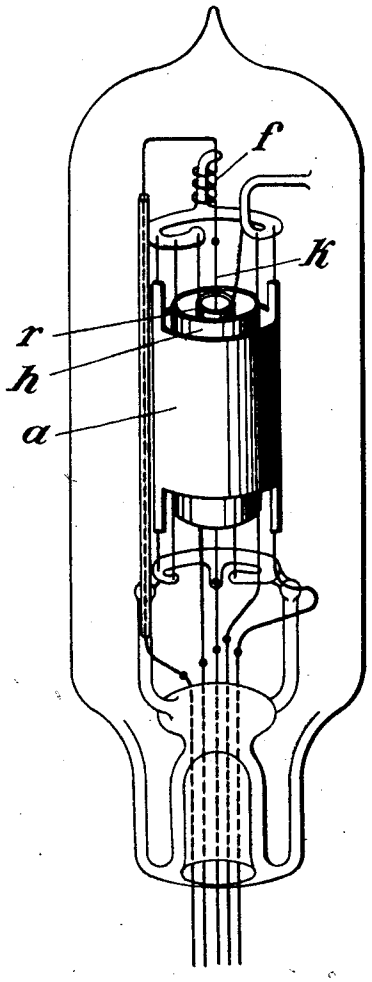


Fig. 3

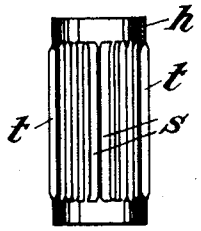


Fig. 4

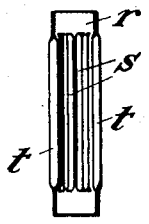
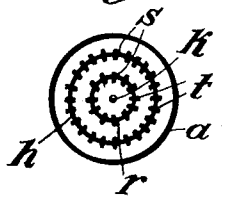


Fig. 2



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UNITED STATES PATENT OFFICE.

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INTERMEDIATE ELECTRODE IN INCANDESCENT CATHODE TUBE.

Application filed August 30, 1921, Serial No. 497,005, and in Germany January 23, 1917.

My invention relates to intermediate electrodes in incandescent cathode tubes.

It is a frequent practice to introduce intermediate electrodes with apertures into incandescent cathode tubes; these perforated electrodes either serve for controlling the anode current (so-called auxiliary screen) or else, for influencing the field between the electrodes electrostatically in some way (e. g. tension screen, anode protection screen). Provided that a sufficiently high vacuum exists inside the tubes, these intermediate electrodes will only emit a noticeable current in case they have been charged with positive electricity as against the cathode.

This present invention refers to a special design of such intermediate electrodes which during the operation, either continuously or during a certain phase of the electric process, possess a positive potential as against the incandescent cathode; as compared with hitherto known forms of construction, the present form offers very material advantages.

The efficiency of an electric discharge tube being mainly determined by the amount of current emanating from the anode, it is obvious that the current intercepted by the intermediate electrode is lost in so far as the amplifying, rectifying or wave-producing action of an incandescent cathode tube is concerned. For this reason it is necessary to construct the intermediate electrodes in such a way that they intercept only a very small portion of the electron current passing through. In cases where it was impracticable to keep the intermediate electrode concerned permanently at negative potential as against the cathode a solution of this problem has hitherto been attempted by constructing the body of such an intermediate electrode of thin wires which are for instance wound upon a small glass frame.

However, this construction of electrodes has a drawback which has hitherto escaped notice. For establishing a basis for the following consideration it is intended first of all to contemplate a case in which the intermediate electrode has the effect of a space charging screen, i. e. in which the perforated electrode interposed between the glow-cathode and auxiliary screen, by means of the positive potential impressed upon it, is to neutralize the space charging effect of the electrons, thus rendering the positive control of large quantities of electrons possible.

In this case a field exists between the cathode and space charging screen as also between the latter and the auxiliary screen, this field tending to draw the electrons towards the space charging screen. Consequently, it is not sufficient to prevent the electrons which are to reach the anode, from impinging upon the screen body of the space charging screen during their first passage. It will be necessary, moreover, to guard against any violent deflection (straying) of the electrons during their passage through the screen because, according to the law of energy, any gain in lateral velocity due to the deflection will be attended by a corresponding loss of velocity in the normal direction. This loss may easily increase to such an extent that the electron so affected is seized by the field directed to the rearward and, during the second or third passage, may be discharged on the screen body of the space charging screen. It must now be remembered that with thin wires the stray field is exceedingly strong because in the immediate proximity of such wires the lines of force come together from all sides. In this manner, the advantages which thin wires offer with respect to intercepting effect, are partly neutralized again by their straying action. Even if care be taken by the overlapping anode field, that the majority of the electrons deflected pass through the auxiliary screen and over to the anode, the sharpness of the current rise with changing screen potentials is, nevertheless considerably impaired by this deflection, and it may happen that, more especially in amplifier tubes and in amplifier rectifier tubes, the action of the space charging screen is rendered almost void.

Additional disadvantages of screen bodies of thin wires for the space charging screen

are the following: Owing to the stray fields around each individual wire, the potential half-way between the wires is very much lower than near the wires. For this reason the potential of the screen body itself must in some cases be taken very much higher than the potential required at the respective plane for neutralizing the space charging effect. This, however, entails a stronger stray effect and therefore, a stronger discharge of the electrons into the space charging screen. Finally it may happen with arrangements consisting of very thin wires that owing to the deflected electrons which frequently hover around the wires of a space charging screen, local space charges are produced there which partly neutralize the effect of the positive charges accumulating there, thus resulting in the necessity of further increasing the potential at the screen body.

In cases where a field for accelerating the electrons exists behind the intermediate electrode, the discharge of deflected electrons to the positively charged intermediate electrode does not matter. But even in this case the stray effect on the screen wires is objectionable inasmuch as in the auxiliary screen the sharpness of the directive force is impaired, whereas in the anode protecting screen the electrostatic screening effect is reduced so that also in this case, the employment of bodies consisting of thin wires is a disadvantage. In wave generating tubes, moreover, it may happen that the auxiliary electrode possesses a stronger positive potential as against the cathode than the electrode (anode) located behind it. In such cases a strong stray action of the auxiliary electrode is equivalent to an actual loss of current for the anode, which is obvious from the explanation given above.

In such cases as described, according to the present invention the electrostatic advantages of solid electrodes are combined with the geometrical advantages of thin wire bodies by making the essential portions of the intermediate electrodes of very small sectional area in the direction of the plane of the electrode, whereas in a direction at right angles thereto they are made of rather large size. Accordingly the essential parts of the electrodes may consist of strips of sheet metal placed on edge relatively to the electrode surface, these strips being arranged in grid fashion. If for instance the thickness of the sheet metal strips used is reduced to .1 to .2 millimetres, which offers no great difficulties, the intercepting effect of the electrodes is thereby reduced to a minimum whereas on the other hand a sufficient electrostatic effect may be obtained by making the strips considerably wider (one half to several millimetres). A particularly simple form of electrode of the type described is the following: A thin sheet is provided with parallel slits over the entire field in which it is to act as intermediate electrode. The webs left standing between the slits are comparatively wide, e. g. 1 mm. By subsequently turning them through an angle of 90 degr. these webs are thus placed at right angles to the surface of the screen. If a cylindrical shape is selected for the electrode, which is particularly favourable for the space charging screen, it is natural that the direction of the slits must be parallel to the axis of the cylinder. In that case the turning of the webs at right angles to the surface of the screen would mean that they are all turned into radial alinement.

A perspective view of an incandescent cathode tube showing a space charging screen of the type described and an auxiliary screen of the same construction is illustrated in Fig. 1 of the accompanying drawing. Fig. 2 represents a sectional view through the entire arrangement of electrodes, whereas Figs. 3 and 4 are longitudinal sectional views of a cylindrical auxiliary screen and space charging screen alone.

The incandescent cathode *k* consists of a wire kept under tension by a spring *f*. It is surrounded by three concentric cylinders, the innermost of which represents the tension or space charging screen *r;* then follows the auxiliary screen *h*, and the outer cylinder is the anode *a*. Space charging screen *r* and auxiliary screen *h* consist each of one single piece of sheet metal into which parallel slits *s* have been punched. The comparatively wide webs *t* left standing between the slits *s* are placed at right angles to the surface of the sheet by subsequent setting, as may be seen from Figs. 2 to 4. Thereupon the perforated sheets are bent into a cylindrical shape in such a manner that the slits and webs run longitudinally in parallel to the axis of the cylinder, but the webs extend transversely in radial direction.

What I claim is:

1. In incandescent cathode tubes an anode, a cathode and at least one intermediate screen-like electrode, the essential parts of said screen-like electrode possessing a depth of material normal to the surface of said intermediate electrode greater than the thickness thereof, taken at right angles to said normal.

2. In an incandescent cathode tube, an anode, a cathode and at least one intermediate screen-like electrode, said intermediate electrode having webs between the screen openings, which consist of sheet metal strips placed on edge against the surface of said intermediate electrode, so as to form a grid.

3. A grid electrode, comprising a plurality of thin strips of metal having a plurality of

spaced thin metallic strips therebetween, said spaced strips being twisted.

4. A grid electrode comprising a sheet of metal having a plurality of apertures cut therein, the strips of metal between said apertures being twisted without changing the general configuration of said sheet.

5. A grid electrode comprising a pair of lateral members, and a plurality of cross members integral therewith, the plane of each cross member being twisted relative to the plane of said lateral members.

In testimony whereof I affix my signature.

WALTER SCHOTTKY.