Aug. 2, 1938. M. BENJAMIN ET AL 2,125,418

CONSTRUCTION OF ELECTRODES FOR CATHODE RAY TUBES AND THE LIKE

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Fig. 1.

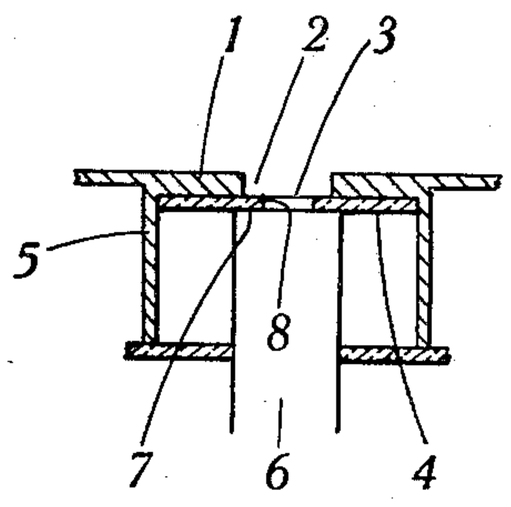

Fig. 2.

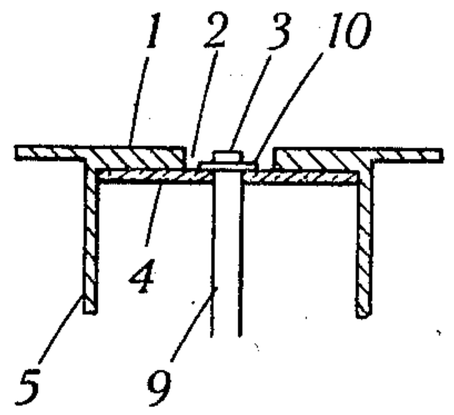

Fig. 3.

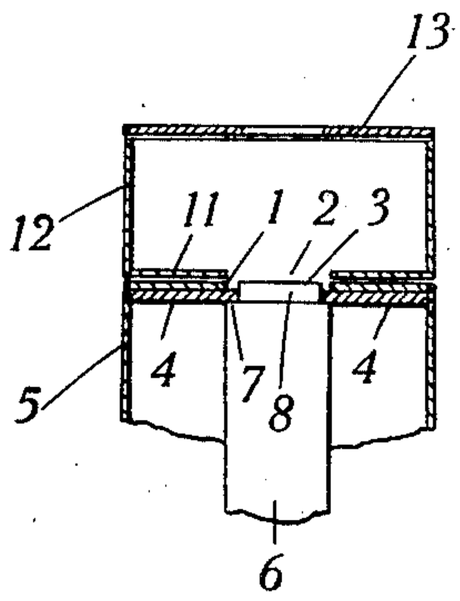

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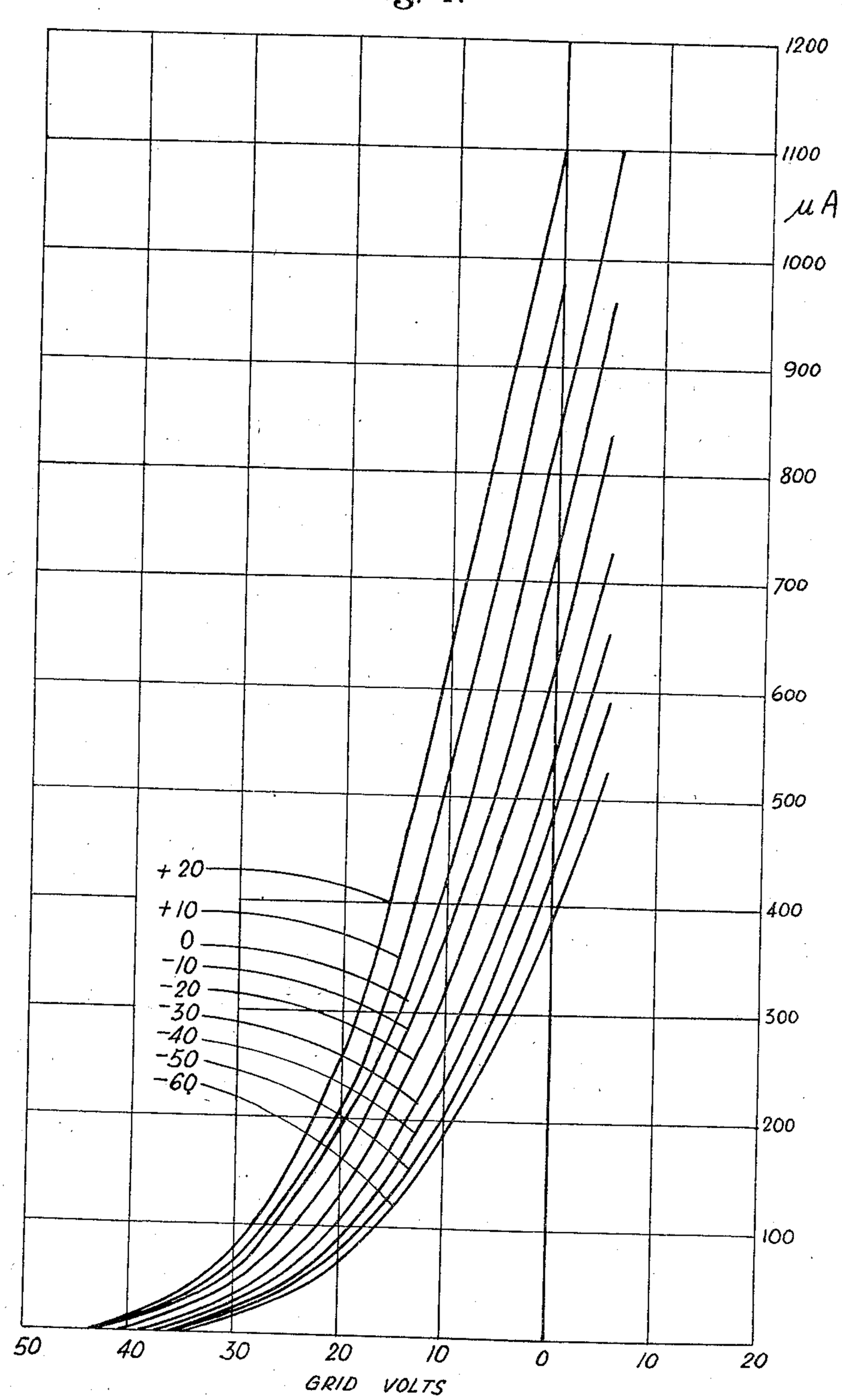
Fig. 4.



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CONSTRUCTION OF ELECTRODES FOR CATHODE RAY TUBES AND THE LIKE

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7 Claims. (Cl. 250—27.5)

This invention relates to cathode ray tubes and the like of the type comprising (*a*) an indirectly heated cathode, the envelope of which is of approximately cylindrical form, bearing on one end a thermionically active surface (usually constituted by a patch of alkaline earths) serving as the source of electrons, and (*b*) a modulating electrode (sometimes called a Wehnelt cylinder) relative to some face of which the said active surface has to be located accurately. Since the invention is concerned wholly with the relation of parts (*a*) and (*b*) any electron discharge device having these parts is to be regarded as a cathode ray tube or the like.

The primary object of the invention is to provide a construction which enables the said accurate location to be effected with ease and certainty. A secondary object is to provide a construction which enables the operating characteristic of the tube to be varied in a convenient manner, by means of the bias of the modulating electrode.

According to the main feature of the invention the indirectly heated cathode (*a*) is provided with a shoulder which abuts against a washer of suitable insulating material (for example mica or steatite) so that a relatively small part of the length of the cathode, bearing the active surface, projects into or through a hole in the washer, and the modulating electrode (*b*) is provided with a recess into which the said washer fits, so that one face of the washer abuts against the said face of the modulating electrode.

Two embodiments of the invention will now be described with reference to Figures 1 and 2 of the accompanying drawings each of which shows a longitudinal section of the assembled parts (*a*) and (*b*). Figure 3 shows a further embodiment and Figure 4 depicts characteristic curves.

In both figures the modulating electrode (*b*) is constituted primarily by a metal plate **1**, pierced with a circular hole **2**, 1.5 mm. in diameter. The active surface of the indirectly heated cathode is the circular end **3**, 1.3 mm. in diameter, coated with alkaline earth. This active surface is required to lie accurately concentric within the hole **2**. **4** is a washer of mica with a central hole fitting into a cylinder **5** projecting from the lower surface of the plate **1**.

In the arrangement shown in Figure 1 the cathode is introduced from below; the active surface has to be flush with the lower surface of the plate **1**, which is 0.4 mm. thick. The main part then consists of a cylinder **6**, 1.7 mm. in diameter, so that it is considerably wider than the active surface **3**. Near the end **3** it is reduced to the diameter of the circular end **3**, namely 1.3 mm. thus forming a shoulder **7**. The washer **4** has a central hole through which the reduced portion **8** projects; the thickness of the washer and the length of this reduced portion have to be equal, and both (say) 0.4 mm.

In the arrangement shown in Figure 2 the cathode may be introduced either from above or from below. Its main part **9** is then of reduced diameter, but there is left a ring **10**, near the active end, of greater diameter but still of less diameter than the hole **2**. The sides of this ring form shoulders either of which may abut against the washer.

Of course, with the same modulating electrode, the longitudinal position of the active surface will necessarily be different according as the cathode is introduced from above or from below. In the example shown the cathode is introduced from above, and the active surface has to be 0.2 mm. below the upper surface of the plate 1. Then the thickness of the ring **10** may be 0.2 mm., the length of the portion **8** may be 0.4 mm; the plate **1** has then to be 0.8 mm. thick; the thickness of the washer will not matter so long as it is sufficient for mechanical strength.

In either construction the accuracy of the location will depend wholly upon dimensions that can be adjusted accurately when the combination of (*a*) and (*b*) is disassembled.

The lateral location is determined by the diameter of the cylinder **5**, the outer diameter of the annular washer **4**, the position and diameter of the hole in the washer **4** and the diameter of the reduced portion **3** of the cathode which fits into the hole. The longitudinal location, relative to the lower face of the modulating electrode, is determined by the distance between the end of the cathode and its shoulder, together (in some cases) with the thickness of the washer. If these dimensions be accurate, the parts can be simply pushed into place; there is no need for observing the location of the cathode in situ, as there is in many known constructions.

But even if complete accuracy be attained in the location of the cathode relative to the modulating electrode, the characteristic of the tube in respect of modulation may not always be the same, for example, owing to variations in the position of the first accelerating electrode. Or again, it may be desirable that the characteristic should vary from tube to tube to allow for variations in the cathode emission or in the modulating circuit. For those and possibly other reasons,

it is desirable that the slope of the modulation characteristic should be variable after the tube is assembled, preferably without concurrent variation of the value of the modulating voltage at which the beam current becomes zero for a given accelerating voltage. By the slope of the characteristic is meant di/de_m, where i is the beam current and e_m the potential on the modulating electrode.

A secondary object of the invention is to make possible such adjustment of the slope of the characteristic.

According to a second feature of the invention this object is attained by associating with the plane part of the modulating electrode relative to face of which the said active surface is located accurately, as aforesaid, another parallel plane part, insulated from the first part but closely adjacent to it, by piercing both parts similarly, i. e. by a common hole, and by locating the said active surface within this hole. In operation the modulating voltage is applied to said second part and a constant bias to said first part.

We are aware that it has often been proposed to associate with a part of a modulating electrode, the potential of which is varied, another part the constant potential of which serves as the bias of the modulation.

One example of the invention embodying this second feature will now be described by way of example with reference to Figure 3 of the accompanying drawings.

The parts denoted by reference numerals 1—3 are similar to those similarly denoted in the aforesaid Figure 2; but the end 3 is no longer flush with the upper surface of the washer 4; it projects above it into the hole 2. The plate 1 is the first part and the second part is a parallel plate 11 forming the bottom of a cylindrical dish 12 and closely adjacent to the plate 1. This plate 11 is pierced with a central hole which is a continuation of the hole 2. Above the dish 12 is the first accelerating electrode 13 also pierced with a central hole. The members 1, 12 and 13 are retained in their relative position by means (not shown) outside the electrodes.

The various dimensions are as follows:

	mm.
Diameter of main part of cathode 6	1.5
Diameter of reduced portion 8	1.3
Length from surface 3 to shoulder 7	0.4
Thickness of washer 4	0.25
Diameter of cylinders 5 and 12	9.0
Diameter of holes 2	1.5
Thickness of plates 1 and 11	0.2
Distance between plates 1 and 11	0.1
Height of dish 12	4.0
Distance of 13 from top of dish	0.25

The variable component of the modulating voltage is applied to the part 11; the constant bias is applied to the part 1; in each case the other terminal is the cathode 6. When the voltage on the first accelerator was 1,000 volts, the characteristics shown in Fig. 4 of the accompanying drawings were obtained. Here the ordinates are the beam current; the abscissae are the potentials applied to the part 1; the bias applied to the part 1 is different for each curve and is marked against it.

It will be seen that as the bias increases from —60 to +20 volts; the slope of the approximately straight part of the characteristic increases from about 25 to 45 μA/volts. At the same time the grid voltage at which the beam current falls to practically zero (say less than 5 μA) varies by only about 10 volts.

We claim:

1. In a cathode ray tube or the like, an electron discharge device comprising a modulator electrode having a disc portion with a central opening and a cylindrical hollow portion concentric with said opening, a flat washer of insulating material within the modulator electrode and having one face thereof in contact with said disc portion and its peripheral edge closely fitting the interior of said cylindrical hollow portion, said washer having a circular opening in axial alignment with but of smaller diameter than the opening in said disc portion for holding the cathode centrally of the latter opening, an indirectly heated cathode having a cylindrical body portion closely fitting the hole in said washer and having a circular end surface coated with an active material and a shoulder on the cathode cooperating with one face of said washer for positioning the activated end surface of the cathode within and in precise relation to the hole in said disc portion of the modulator electrode.

2. In a cathode ray tube or the like, an electron discharge device as in claim 1 wherein said shoulder on the cathode engages the face of the insulating washer which is opposite the face in contact with the disc portion of the modulator electrode.

3. In a cathode ray tube or the like, an electron discharge device as in claim 1 wherein said shoulder on the cathode engages the face of the insulating washer which is in contact with the disc portion of the modulator electrode and the body of said cathode is of a diameter to pass through the hole in said washer.

4. In a cathode ray tube or the like, an electron discharge device as in claim 1 wherein a second electrode of approximately the same diameter as the disc portion of said modulator electrode and having a hole of the same diameter as the hole in said disc portion is insulatedly mounted with said holes in register in close parallel relation to said disc portion for joint cooperative action therebetween in modulating the electron discharge.

5. In a cathode ray tube or the like, an electron discharge device as in claim 1 wherein said shoulder on the cathode engages the face of the insulating washer which is opposite the face in contact with the disc portion of the modulator electrode and said disc portion comprises two parallel discs spaced apart and insulated from each other, said discs being provided with central holes of the same diameter which are in register.

6. In a cathode ray tube or the like, an electron discharge device as in claim 1, wherein said shoulder on the cathode engages the face of the insulating washer which is in contact with the disc portion of the modulator electrode and the body of said cathode is of a diameter to pass through the hole in said washer, said disc portion comprising two parallel discs spaced apart and insulated from each other and provided with central holes of the same diameter which are in register.

7. In a cathode ray tube or the like, an electron discharge device as in claim 1 wherein a second electrode of approximately the same diameter as the disc portion of said modulator electrode and having a hole of the same diam-

eter as the hole in said disc portion, is insulatedly mounted with said holes in register in close parallel relation to said disc portion, said electrodes being adapted to have prearranged voltages applied thereto, a constant voltage being adapted to be applied to said disc portion and a variable voltage being adapted to be applied to said second electrode for joint cooperative action therebetween in modulating the electron discharge.

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