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ELECTRON RAY TUBE

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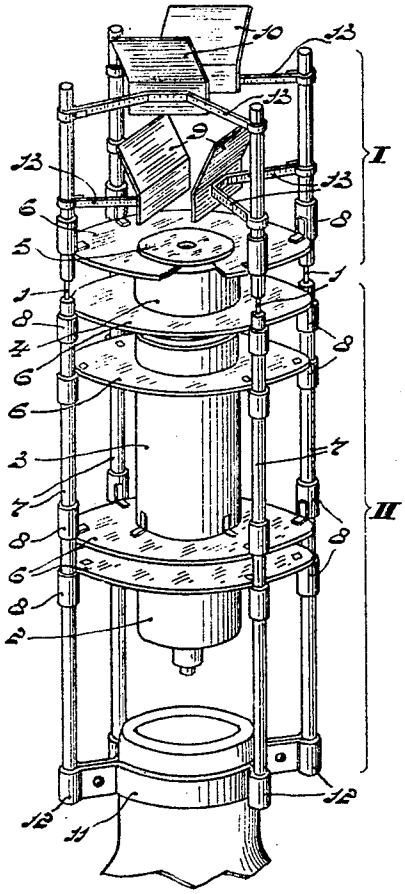

Fig. 1

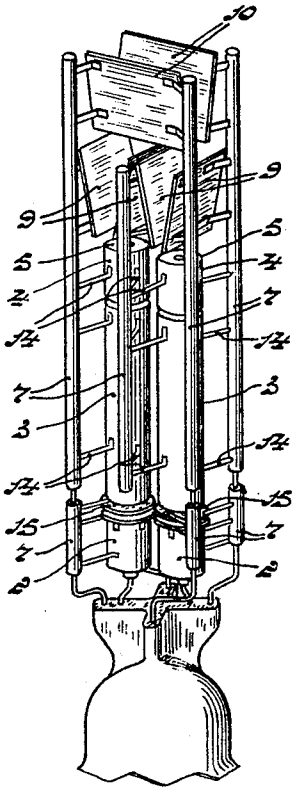

Fig. 2

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ELECTRON-RAY TUBE

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The electrode-system for producing and focussing a directed electron beam in electron-ray tubes comprises a certain number of electrodes which, by means of a mounting jig, can be easily and exactly adjusted at the required distance from each other and symmetrically with respect to the axis of the beam.

In the common systems, in which use is made of electrostatic deflection of the electron-beam, this does not hold for the pairs of deflecting plates, whose mounting always requires the use of separate mounting jigs.

It has been found in practice that the position of the pairs of plates with respect to the axis of the beam is of great importance. In mounting the pairs of plates various other errors may be made, which consist of such small deviations that they are not even found upon inspection. Not before the electrode sytem has been incorporated in the tube and the latter has been put into service can it be ascertained, by means of the figure described by the beam on the projection screen, whether the tube is serviceable despite the inaccuracies caused in mounting.

The method adopted is mostly such that first of all the electrode-system parts having rotational symmetry are provided on a mounting pin having a suitable shape and maintained in the desired position by means of a clamping device. After attachment of the said parts to the supporting members the mounting pin is removed and then the pairs of deflecting plates are provided.

Most trouble is experienced from the mounting errors when the direction of the axis of the beam is determined accurately. This holds in regard to electrode-systems comprising a control electrode, a first anode and in addition a stop which exhibits a small aperture bounding the section of the beam. To suit the purpose this stop should be located at some distance from the first anode, it being of importance that this distance is large in comparison with the distance between the first anode and the control electrode. It is customary that both of these electrodes also consist of stops having a small aperture; however, the directional effect of this electrode-combination is very small, since the electrodes must be placed close together.

The deflecting plates must be placed exactly symmetrically with respect to the axis of the beam. In this case the maximum deflection sensitiveness is obtained, since the distance between the plates may be reduced to a minimum. The limit to which one may go in reducing this

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distance is determined by the maximum deviation required by the beam for making the spot of light appear at the edges of the projection screen, when the plates are not yet allowed to intercept electrons from the beam. Due to unsymmetrical positioning of the plates with respect to the axis of the beam it may occur that the beam is capable of deviating over a larger angle in one direction than in the opposite direction. In this case, however, the beam is intercepted by one of the edges of the plate, before the spot of light has reached the edge of the projection screen. This drawback can be avoided by making the distance between the plates larger, it is true, but this expedient is detrimental to the deflection sensitiveness. The detrimental effect thereof is particularly manifest in regard to the pair of plates, to which plates the voltage to be measured is applied when using the tube for measuring purposes.

Inaccuracies in positioning the deflecting members, in tubes having more than one electrode-system by which directed electron-beams are produced simultaneously, involve graver errors due to which the results obtained in measuring and comparing variable characteristics, which are represented on the projection screen by means of the different beams, may be offset.

In such tubes the plates must be positioned symmetrically with respect to the axes of the beams and in addition care must be taken that one pair of plates in each system extends exactly normal to the line connecting the centres of the apertures of the stops bounding the beams. The plates of the other pair of plates which may be common to the various systems, must extend parallel with this line. If the last-mentioned plates are placed a little obliquely this causes a slight deviation in the distance between the lines described on the screen as a result of the application of a variable voltage to these plates. However the lines remain parallel. If, however, the plates by which the beams are caused to deviate in the direction of the connecting line of the stops are not exactly normal to this line, the lines appearing on the screen on applying deflecting voltages to these pairs of plates no longer coincide. There occurs a lateral displacement without any of the beams being acted upon in that direction. It will be appreciated that such a deviation is not permissible. Another error, due to which the figures recorded by the distinct beams are turned relative to one another makes its appearance if the central planes of these pairs of plates are not exactly parallel but are at a

small angle. In the present case the expression "central plane" is to be understood to mean the plane extending between the plates of a pair of plates, with respect to which the plates are placed symmetrically.

The invention has for its object a structural improvement of electrode-systems for electron-ray tubes, as a result of which mounting errors can be easily kept within the permissible tolerances. According to the invention the stop bounding the beam and, as the case may be, one or more electrodes forming part of the same electrode-system, together with the pair of plates most remote from the projection screen are assembled to form a unit distinct from the remaining electrodes. Of the remaining electrodes at least the control electrode and the first anode form an assembly.

No particular difficulties are experienced in positioning the stop bounding the beam and the next pair of plates in such a manner that the plates extend symmetrically with respect to the perpendicular that may be imagined to be drawn in the centre of the aperture of the stop normal to the plane of this electrode. The way of proceeding will be more fully set out hereinafter. The remaining electrodes may be assembled into a unit in a known manner. After the two parts have been finished they are interconnected, care having to be taken only that the axis of the one part is coincident with the perpendicular with respect to which the adjustment of the plates has been made. According to another feature of the invention connecting members, enabling a slight deformation, may be used between the two parts. As a result thereof the adjustment of the parts with respect to one another in securing them together need not take place with absolute accuracy. In this case, moreover, the deformations occurring due to heating and cooling of the joints in fastening the parts can still be corrected. The exact adjustment may take place during the final inspection. This yields the advantage that in twisting the system parts with respect to each other the position occupied by the plates with respect to the stop bounding the beam need not be altered.

In electrode systems for tubes having more than one electron-beam care has to be taken to position accurately these pairs of plates with respect to the connecting line of the stops and, moreover, the axes of the beams should extend in exactly the same plane, since crossing axes involve errors of the same order, as has already been stated in regard to a wrong positioning of the plates. By mounting the elements in accordance with the invention the errors in positioning the plates relative to the connecting line of the stops can be easily avoided. Inaccuracies in the form of the axes of the beams can be corrected in a simple manner in the electrode system. To attain a high accuracy use is preferably made of optical means for the adjustment of the axes of the beams. To this end a source of light is substituted for the cathode. The beams of light separated by the apertures in the stops placed in tandem are caused to fall on a screen, the form of the axes of the beams being ascertained by means of the luminous points visible on the screen. As a result of the flexible joint between the two parts they can be slightly displaced or turned with respect to one another so as to obtain the correct position, the adjustment of the plates remaining unchanged.

In order that the invention may be clearly understood and readily carried into effect it will now be described with reference to the accompanying drawing representing, by way of example, two forms of construction of electrode systems for use in electron-ray tubes according to the invention.

Figure 1 represents an electrode system for a tube having one electron-ray, Figure 2 representing an electrode system such as may be used in tubes wherein two electron-beams are produced.

In both figures corresponding parts bear the same reference numerals.

The electrode system shown in Figure 1 comprises two parts I and II which are interconnected by thin metal rods 1. The electrodes, of which the control electrode is denoted by 2, the first anode by 3, the accelerating electrode by 4 and the stop bounding the beam by 5, are fastened in plates 6. If the supporting rods 7 consist of insulating material these plates 6 can be made from metal. The plates are fixed by means of bushings 8 clamped about the supporting rods and the displacement of the bushings can be prevented by means of a suitable cement. The rods secured to the stop 5 carry also the pairs of deflecting plates 9 and 10. The whole of the system is secured to the stem of the tube by means of a clamping ring 11; holders 12, which are secured to the clamping ring and project in a lateral direction, act as supports for members 7.

The mounting may take place as follows. The electrodes 2, 3 and 4 are slipped on a mounting pin preferably consisting of a cylindrical metal rod whose diameter is chosen in such a manner that the electrodes 3 and 4 are a tight fit. One end of the rod comprises a thinner cylindrical part whose diameter corresponds to the aperture in the first anode stop. This portion must be accurately centered with respect to the centre line of the rod. The cylindrical first anode 3 is slipped on the pin and after that a bushing is placed on the thin portion, the height of this bushing determining the distance between the first anode and the control electrode. After that the control electrode is slipped on the thin portion of the pin and the electrodes are maintained in this position, e. g., by means of an elastic clamping ring. Subsequently the electrode 4 is slipped on the pin from the other end with the interposition of a bushing and is pushed against the first anode by means of a suitable clamping device, the electrodes being previously furnished with supporting plates 6. After that the supporting members 7, on which the required clamping rings may be slipped beforehand, are placed along the supporting plates and the tags of the bushings on the rods are connected to the plates by welding. By means of a suitable cement capable of being hardened or glazed, for instance by heating, displacement of the bushings is prevented.

For mounting the portion 2, use is made of a mounting jig, by means of which the plates of the first pair of plates 9 can be exactly adjusted, and which comprises a cylindrical part whose centre line represents the axis of the beam; the diameter thereof corresponds to that of the aperture in the stop 5 bounding the beam. After the plates 9 have been clamped against the jig and the electrode 5 has been slipped on the pin, the attachment to the supporting rods may take place.

The thin cylindrical part of the jig may have such a length as to extend into the aperture of

the first anode after the two system parts have been brought into alignment at the desired distance between the electrodes 4 and 5. Of course, the mounting pin used for the portion II must be removed beforehand. In this construction the adjustment of the two parts relative to each other may take place with sufficient accuracy by means of the eye. The pin connected to the mounting jig assures an excellent conduction, so that a correct adjustment of the pair of plates with respect to the axis of the beam is always insured. The stop 5 and the cylindrical accelerating electrode 4 have the same potential, so that the positioning of the stop does not affect the electric field of the projection lens between the first anode 3 and this cylindrical part.

Finally the plates 10 of the second pair of plates are provided, which can be adjusted with sufficient accuracy by means of a separate jig. The best results are obtained if this jig likewise comprises a positioning member in the form of a thin cylindrical pin extending through the aperture of the stop 5 into the aperture of the first anode. The plates are connected by metal strips 13 to the supporting members of the part I. During the final inspection of the system the parts I and II may be slightly displaced relative to one another if some correction should prove to be necessary. In the system thus established, for a single beam tube this will usually not be necessary.

In the form of construction shown in Figure 2 the electrodes may be mounted in the same manner. In this case the separation between the portions I and II of the electrode system takes place at a point different from that in the form of construction represented in Figure 1. The portion II comprises the control electrodes 2 and stops 15 to which the first anode voltage is applied during operation of the tube. The stops 15 are separated from the cylindrical members 3 so that on displacing the portions I and II with respect to one another these members are displaced relative to the stops. These members receive the same voltage as the stops so that there is no electric field therebetween in which otherwise the shifting of the lines of force with the displacement might adversely affect focusing.

The projection lens is formed between the cylindrical electrodes 3 and 4 which can be acccurately adjusted with respect to one another by means of a cylindrical rod-shaped mounting pin and are secured to the supporting members 7 in this position. Together with the electrodes 4, the stops 5 bounding the beams are assembled to form a unit. After that the pairs of plates 9 and 10 are provided, particular care being taken to position accurately the plates 9 which must extend exactly perpendicularly to the connecting line of the stops.

One may also proceed in the reverse order and first adjust the pairs of the deflecting plates nearest the stops relative to the stops and the connecting line of the centres thereof. After the plates and the cylindrical electrodes 4 equipped with stops have been secured to the supporting members the electrodes 3 are adjusted by means of mounting pins exactly engaging the cylindrical parts 4, and secured to the supporting rods.

The position of the deflecting plates must remain the same and in addition the electrodes, between which are set up the electric fields

bringing about the lens effect, should not change their place when the portions I—II of the system are to be slightly twisted with respect to one another for obtaining the correct adjustment. This is achieved by placing in different sections from each other the first anode stop and the cylindrical part having the same potential during operation of the tube. The plane of separation of the system parts extends between these two electrodes.

After these have been correctly spaced apart the adjustment takes place, and care has to be taken that the line connecting the centres of the apertures in the stops bounding the beams extends parallel with the connecting line of the centres of the apertures in the first anode stops. The correct adjustment can be approximated by means of the available mechanical means. The accuracy attained is sufficient with respect to the parallelism of the axes of the beams. As an artifice use may be made of a jig for the adjustment of the plates comprising a long thin pin which extends into the aperture of the first anode stop. Applicant has found, however, that the crossing of the axes of the beams can never be avoided completely. This defect may be found in the optical final inspection but in the common systems it can no longer be corrected at this moment without affecting the correct adjustment of the pairs of plates. The invention permits this correction to be made without altering the position of the deflecting electrodes with respect to the stops.

The invention is of particular importance for cathode ray tubes for measuring purposes. The voltage to be measured, or a voltage corresponding with the characteristic to be measured, is applied between the plates of one pair of plates, whereas the other pair of plates, which brings about a deviation of the beam in a direction normal to the deviation brought about by the first pair of plates, receives a voltage varying as a function of time. The mounting of the first-mentioned pair of plates requires most care, so that it will be located nearest the stop bounding the beam.

The supply conductors are not represented in these forms of construction. They are preferably provided before the final inspection of the system since otherwise their attachment may affect the positioning of the electrodes.

The invention is not limited to the supporting members for the electrodes used in these forms of construction. It may also be utilized for other supporting purposes, for instance when using gauge rings of insulating material, such as the material sold under the registered trade-mark calite, having such a shape as to engage each other perfectly while clamping the electrodes.

Furthermore the two parts of the electrode system according to the invention may be mounted each individually on the stem of the tube. The manner of attachment of the electrodes is not essential when providing joints between the system parts, which permit a slight displacement of one part with respect to the other.

What I claim is:

1. An electrode assembly for a cathode ray tube to direct a beam of electrons, comprising a first portion having electrical elements comprising a control electrode and a first anode, a second portion having electrical elements more distant from said control electrode than said first anode, said second portion elements comprising a stop

through which said beam passes and a pair of deflection plates, and means mechanically interconnecting said elements and having a part thereof relatively more easily deformable than the other parts thereof and arranged upon deformation of said part to relatively move said first portion with respect to said second portion, one said element of one portion being positioned next to one said element of the other said portion and being electrically directly connected thereto to provide a field-free space for the passage of the electron beam between said two portions.

2. An electrode assembly for a cathode ray tube to direct a beam of electrons, comprising a first portion having electrical elements comprising a control electrode and a first anode, a second portion having electrical elements more distant from said control electrode than said first anode comprising a stop through which said beam passes and a pair of deflection plates, and means mechanically interconnecting said elements and comprising rod-like members positioned substantially parallel to the beam, said members having a part thereof more easily deformable than the other parts thereof and arranged upon deformation of said part to relatively move said first portion with respect to said second portion, one said element of one portion being positioned next to one said element of said other portion and being electrically directly connected to provide a field-free space for the passage of the electron beam between said two portions.

JOHANNES DE GIER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,058,293	Broadway et al.	Oct. 20, 1936
2,185,807	Gabor	Jan. 2, 1940
2,391,273	Rutherford	Dec. 18, 1945

FOREIGN PATENTS

Number	Country	Date
483,435	Great Britain	Apr. 20, 1938

OTHER REFERENCES

Ser. No. 334,552, Riedel et al. (A. P. C.) Pub. May 25, 1943.