

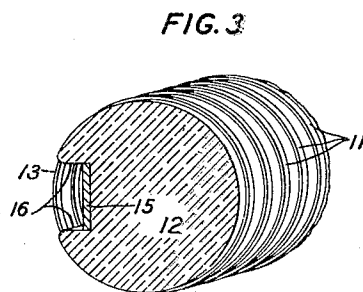
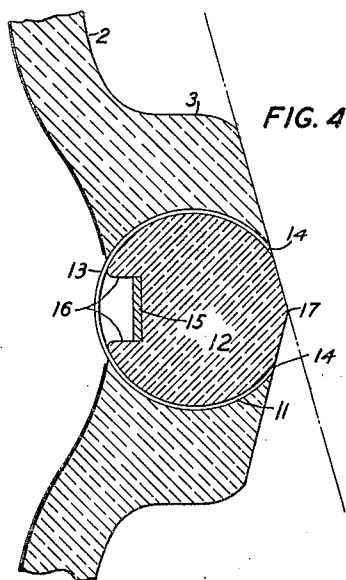
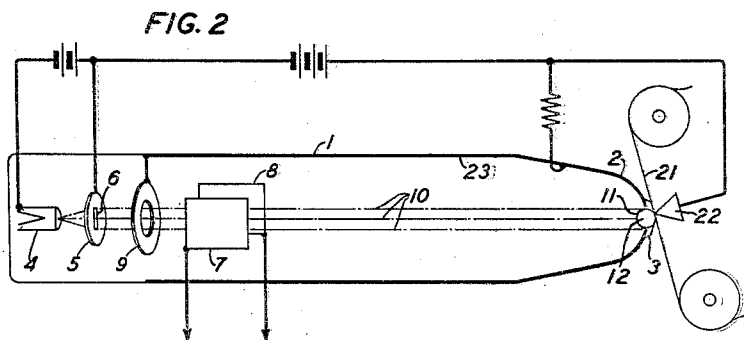
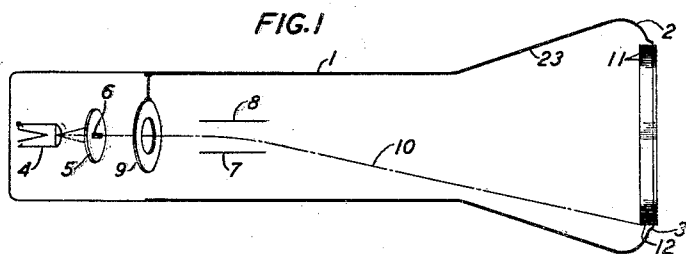
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CATHODE RAY TUBE

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CATHODE RAY TUBE

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Application April 10, 1940, Serial No. 328,819

19 Claims. (Cl. 250-164)

This invention relates to cathode ray devices and particularly to a cathode ray tube having a current window in the beam-receiving end thereof.

Application Serial No. 328,816, filed April 10, 1940 of E. Bruce draws attention to the need, particularly to serve as a facsimile printing device, of a tube provided with a current window in the form of a fine sharp line, constituting in effect an electron current slit. In that application the impossibility of adapting known structures to fill this need is pointed out, and a novel structure which serves the purpose is described and claimed.

Accordingly, it is among the objects of this invention to provide a tube having such an electron current slit of modified form, which shall be rugged, durable, inexpensive and easy to construct. A further object is to facilitate sharp focusing of a high energy cathode beam on the member constituting the current slit without hindrance from space charge effects due to secondary electrons which may appear within the tube from bombardment of parts thereof by primary electrons of the cathode beam.

To the end of accomplishing these and other objects there has been devised an improved construction of which a preferred modification consists of a tube having embedded in the beam-receiving end wall thereof a rod or cane of glass or other insulating material, about which are snugly fitted a plurality of small discrete loops of conducting material arranged parallel with but separated from each other, one part of each loop being inside the tube and exposed to the cathode beam and another part of each loop being exposed to the air outside of the tube. Thus each half of each loop constitutes a low resistance path of minute cross-section for the cathode beam to the exterior of the tube, and the parallel array or comb constitutes a current window in the form of a sharp, narrow line or slit. The loops may be open at the exterior of the tube, or they may be closed.

The tube and one form of window may be made by winding a helical coil of suitable wire about an insulating rod, the turns being evenly spaced from each other, securely anchoring the ends of the coil to the ends of the rod, sealing or embedding the rod, bearing the coil, in the wall of the beam-receiving end of a cathode ray tube, the turns being exposed on the inside and covered by glass outside the tube, and lastly, grinding away the sealing glass on the outside to sever every turn of the coil and convert it into an open loop with the ends exposed. The grinding is

preferably such as to leave a ridge of glass between the open loop ends. An alternative procedure is to wind the rod with a masking coil, apply conductive material to the unmasked portions of its surface by sputtering, plating, or otherwise, and then remove the masking coil, leaving exposed a plated winding. Thereafter the steps may be as above described in the case of the conducting coil.

To form a current window of which the individual conductors are continuous loops, masking material may first be applied to the rod in continuous loops, as for example, by spraying it from a fine orifice while the rod is rotated in a lathe. The unmasked portions of the rod, which are likewise continuous loops, may then be covered, for example by sputtering, with conductive material, and the masking material removed. The rod, bearing its continuous loop conductors, may now be sealed into the end wall of the tube which has preferably first been provided with an aperture to receive it. The loops are thus exposed outside of the tube as well as inside, and the grinding is avoided.

In no case need the rod be of circular or of any particular cross-section. In the case of continuous loops, it is preferable that the rod have at least one sharp edge which is placed outward of the tube wall. This assists in obtaining definiteness and sharpness of impression in the principal contemplated use of the tube.

In accordance with another aspect of the invention, the glass rod may be provided with a longitudinal channel and a metal strip fixed therein, the metal surface being exposed, and the helical coil then wound around the channeled rod, each turn of the winding thus passing over the metal strip without touching it. In the ensuing sealing operation, the rod is so positioned in the tube end wall that the metal strip faces the oncoming electron beam. This metal strip, if connected to a suitable source of potential, may serve to collect secondary electrons which may be knocked from the individual loops by electrons of the cathode beam, and to shield the glass surfaces from the beam.

The tube embodying the improved current window of this invention will be more fully understood from the following description of a preferred embodiment thereof taken in connection with the appended drawing in which:

Fig. 1 is a schematic plan view of a cathode ray tube provided with a conducting comb in accordance with the invention;

Fig. 2 is a schematic side elevation of the tube

of Fig. 1 showing one of the loops of a conducting comb as seen in the direction of its axis;

Fig. 3 is an enlarged perspective view of a part of a conducting comb according to this invention before sealing into a tube and showing also an absorber for secondary electrons; and

Fig. 4 is an enlarged side view of the beam-receiving end of the tube, showing the comb construction and the mounting of the comb in the tube wall.

Referring now to the figure, Figs. 1 and 2 show a closed glass vessel having a neck portion 1 and a beam-receiving portion 2 which is enlarged in one dimension and flattened out in the other dimension into the form of a blunt wedge having a greatly thickened end wall 3 with a central recess therein. An electron gun including a cathode 4, an anode 5 having a beam-defining aperture 6 therein, a pair of beam-deflecting plates 7, 8 and an accelerating anode 9, are mounted in the neck portion 1 of the tube. The path of an electron beam originating in the electron gun and deflected by an electric field between the deflecting plates is indicated by a dotted line 10. The beam may be of rectangular cross-section, as defined by the rectangular aperture 6.

The details of one form of the current window element of the invention and the manner in which it is mounted in the tube wall are more clearly shown in Figs. 3 and 4. The individual conductors are in the form of loops of wire 11 which may be closed as in Fig. 3 or nearly closed as in Fig. 4, in which event the bend or U-shaped part 13 of each loop is inside the tube wall 2 and the open ends or tips 14 of the loops outside. These individual loops are arranged side by side on an insulating base 12 which, in the embodiment shown, is a glass rod of circular section.

An electrosensitive tape 21, a current-collecting knife edge 22, a conductive tube lining 23 and suitable electric connections for causing the cathode beam 10 to make impressions on the tape 21 are shown in Fig. 2. The operation of the system may be substantially as described in the aforementioned application Serial No. 328,816, filed April 10, 1940. In particular, it is to be noted that the part 13 of each conductor 11 which is exposed inside the tube lies at an angle to the direction of the oncoming electron beam 10, and presents a substantial area to the beam so as to reduce the stringency of beam-focusing requirements and permit concentration of a large amount of electron current energy on a single conductor 11 by the use of a beam of rectangular cross-section, as broadly described and claimed in the aforementioned application Serial No. 328,816, filed April 10, 1940. It is, moreover, of advantage to spread some high resistance fluorescent material, such as zinc silicate, on the glass surfaces between and adjacent to the parts 13 of the conducting loops 11 which are exposed inside the tube to enable focusing to be adjusted visually.

As above stated, an additional feature of the invention lies in the incorporation into the improved current window of a conductive strip for removing and absorbing secondary electrons which may be knocked out of the metal of the comb wires by bombardment thereof by the primary electrons of the cathode beam. As shown in Fig. 3, a conductive metal strip 15 is placed in and snugly fitted into a channel 16 formed in the

insulating rod 12 at the side toward the electron gun and running the full length of the rod 12. This channel should preferably have rounded edges and may be preformed either by molding, grinding, or in any other convenient manner. The strip 15 may be held in place in the channel in any convenient manner such as by sealing it in place with a sharp flame torch.

After the channel has been formed and the metal strip 15 is in place (or, if the metal strip is not required, before), the rod 12 may be tightly and evenly wound with a suitable small gauge conducting wire in a helix and both ends of the helix securely anchored by a few turns of considerably heavier wire welded thereto. The rod and helix are then sealed by fusion into the thickened end wall 3 of the tube which has preferably been provided with a central depressed portion of suitable size and shape to receive the rod, the molten tube material being drawn over the outer side of the rod, bearing its winding. After the sealing operation is completed and the rod 12 is securely fixed in its correct position, the glass covering the outer face of the rod may be removed by grinding or otherwise to sever each turn of the coil into an open loop whose ends lie flush with the ground face of the glass. In the grinding operation a central ridge 17 of glass is preferably left between the ends of the loops to prevent their touching any flat or convex surface together.

The dimensions of an improved current window element in accordance with the invention which has been employed with success as a facsimile printer tube in accordance with the system described and claimed in application Serial No. 331,716, filed April 26, 1940, are as follows:

Diameter of glass rod base— $\frac{1}{16}$ th inch
Width of channel—.060 inch
Depth of channel—.040 inch
Electron absorbing strip—.05 x .005 inch platinum ribbon
Helix—.002 inch x .0015 inch platinum ribbon, tightly wound, 96 turns to the inch.

With this construction the bend or U-shaped portion 13 of each loop which is exposed inside of the tube presents to the projected cathode beam an area substantially in excess of the square of the center-to-center spacing distance of the loops. That this is so appears from the following. The area presented by each loop to the cathode beam is equal to the product of the width of the strip material out of which the loop is formed by the length of the exposed portion. Referring to Fig. 4 the length of the exposed portion is at least greater than the width of the channel 16. From the dimensions given above, this exposed area is therefore at least greater than $.060 \times .002 \text{ in.}^2$, that is, it is at least greater than $12 \times 10^{-5} \text{ in.}^2$. The center to center spacing distance is $\frac{1}{16}$ inch and the square of this distance is closely $11 \times 10^{-5} \text{ in.}^2$. Thus the exposed area is at the very least greater than the square of the spacing distance; and since the exposed length of the inner portion of the loop is actually in excess of the width of the channel 16, the difference is in fact still greater.

As above stated, the conducting loops may be closed, if preferred, the end of a finished tube, in such case, presenting the appearance of Fig. 4 as modified by the substitution of the arrangement of Fig. 3 for the central portion. A current window of this sort may be constructed, for example, by the masking process above outlined,

and the end wall 2 of the tube should preferably be provided with a suitably shaped aperture to receive the insulating base 12 bearing its closed conducting loops. The edges of the aperture may then be sealed to the insulating member 12, a portion of each of the closed loops 11 being left exposed inside the tube and another portion outside.

For many purposes an insulating member 12 of circular section will be found less suitable than one of some other, for example, a triangular section. It is to be understood that the cross-section of this member and therefore the shape of the conducting loops which partially or completely encircle it may be of any desired form without in any way departing from the spirit of the invention.

What is claimed is:

1. A cathode ray device which comprises a vessel having a non-conductive boundary wall, means within said vessel for projecting a cathode beam, and a current window element sealed into said wall in position to be impinged by said beam, said window element comprising a plurality of discrete open loops of conductive material arranged parallel to and insulated from each other, a part of the body of each loop intermediate its tips being exposed to the interior of the vessel and at least one tip of each loop being exposed to the exterior of the vessel in position to make contact with a record element in the air outside of said vessel.

2. A cathode ray device which comprises a vessel having a non-conductive boundary wall, means within said vessel for projecting a cathode beam, and a current window element sealed into said wall in position to be impinged by said beam, said window element comprising a plurality of discrete open loops of conductive material arranged parallel to and insulated from each other, the bend of each loop being exposed to the interior of the vessel and at least one tip of each loop being exposed to the exterior of the vessel and lying in the same plane as the exterior face of said boundary wall in position to make contact with a record element in the air outside of said vessel.

3. A cathode ray device which comprises a vessel having a non-conductive wall, means within said vessel for projecting a cathode beam, and a current window element sealed into said wall in position to be impinged by said beam, said window element comprising a plurality of discrete open loops of conductive material in parallel coaxial arrangement and insulated from each other, a part of the body of each loop intermediate its tips being exposed on one face of said wall and each tip of each loop being exposed on the other face of said wall and flush with said other face of said wall and a ridge of non-conducting material between opposite tips of all of said loops.

4. A cathode ray device which comprises a vessel having a non-conductive wall, means within said vessel for projecting a cathode beam, and a current window element mounted in said wall in position to be impinged by said beam, said window element comprising a supporting member solid at least in part, and a plurality of discrete conducting loops embracing said member and arranged in a single row, parallel with and insulated from each other, a part of each loop being exposed on one side of said wall and another part of each loop, embracing a solid part of said supporting member, being exposed to the other side of said wall.

5. A cathode ray device which comprises a vessel having a non-conductive wall, means within said vessel for projecting a cathode beam, and a current window element sealed into said wall in position to be impinged by said beam, said window element comprising a supporting member of insulating material, solid at least in part, and a plurality of discrete open loops of conducting material partly encircling said member and arranged in a single row, parallel with and spaced from each other, a part of the body of each loop intermediate its tips being exposed on one side of said wall and at least one tip of each loop, adjacent to a solid part of said supporting member, being exposed to the other side of said wall.

6. A cathode ray device which comprises a vessel having a non-conductive wall, means within said vessel for projecting a cathode beam, and a current window element sealed into said wall in position to be impinged by said beam, said window element comprising an elongated cylindrical insulating member of cross-section at least in part solid, and a plurality of discrete open loops of conducting material coaxially spaced from each other on said member, partly encircling and snugly embracing said member, a part of the body of each loop intermediate its tips being exposed on one side of said wall and at least one tip of each loop adjacent to a solid part of said supporting member being exposed on the other side of said wall.

7. A cathode ray device comprising a vessel having a non-conductive boundary wall, means within said vessel for projecting a cathode beam, and a current window element sealed into said wall in position to be impinged by said beam, said window element comprising an elongated cylindrical insulating member having a longitudinal channel in one side thereof, a strip of conductive material disposed in said channel, and a plurality of discrete open loops of conductive material coaxially arranged on said member, parallel with and spaced from each other and partly encircling said member, a part of the body of each loop intermediate its tips passing over said channel and said strip, said part and said strip being exposed to the projected cathode beam inside of the vessel and the tips of said loop being exposed to the exterior of the vessel in position to be contacted by a record element in air outside the vessel.

8. A cathode ray device which comprises a vessel having a non-conductive wall, means within said vessel for projecting a cathode beam, and beam-receptive means mounted in said wall in position to be impinged by said beam, said beam-receptive means comprising a supporting member and a plurality of discrete conducting loops embracing said member and arranged in a single row, parallel with and insulated from each other, a part of each loop being exposed to the interior of the vessel and another part of each loop being exposed to the exterior of the vessel, and fluorescent material spread on said supporting member between said loops.

9. A current window element adapted to be sealed into the wall of a vessel, comprising an elongated insulating member, the cross-section of one side of said member being solid, said member having a longitudinal channel in the opposite side thereof, a longitudinal strip conductor fixed in and substantially covering the bottom of said channel, and a plurality of discrete open loops of conductive material coaxially arranged on said member, parallel with and spaced from each other and partly encircling said mem-

ber, a part of the body of each loop intermediate its tips passing over said channel and said strip, and the tips of said loops being adjacent to said solid side.

10. A cathode ray device having a non-conductive wall, means within said vessel for projecting a cathode beam, a current window element sealed into said wall, said window element comprising an insulating member having a channel in one side thereof, a plurality of discrete open loops of conductive material partly encircling said member, a part of the body of each loop intermediate its tips overlying said channel and being exposed to the interior of the vessel in position to be impinged by said projected cathode beam, a branch of each of said loops extending through the wall of said vessel to expose a tip of each of said branches in a row on the exterior surface thereof and provide a plurality of air-tight paths for the current of said beam to the exterior of said vessel, and a conductor for drawing off stray electrons fixed in said channel.

11. In combination, a cathode ray device having a non-conductive wall, means within said vessel for projecting a cathode beam, a current window element sealed into said wall, said window element comprising an elongated insulating member having a longitudinal ridge and a plurality of discrete open loops of conductive material partly encircling said member, a part of the body of each loop intermediate its tips being exposed inside of said vessel to said projected beam, the branches of all of said loops extending through the wall of said vessel, their tips lying in two rows on the exterior surface of said vessel and separated by said ridge, to provide parallel rows of air-tight paths for the current of said beam to the exterior of said vessel in position to have either the one or the other of said rows of tips simultaneously contacted by a sheet of electricity-sensitive material disposed in a plane defined by said row and the apex of said ridge.

12. In combination, a cathode ray device having a non-conductive wall, means within said vessel for projecting a cathode beam, a current window element sealed into said wall, said window element comprising an elongated insulating member provided with a longitudinal ridge and a plurality of discrete open loops of conductive material partly encircling said member, a part of the body of each loop intermediate its tips being exposed inside of said vessel to said projected beam, a branch of each of said loops extending through the wall of said vessel, said tips lying in a row on the exterior surface of said vessel and parallel with said ridge, to provide a multiplicity of air-tight paths for the current of said beam to the exterior of said vessel in position to be contacted by a sheet of electricity-sensitive material disposed in the plane defined by said row of tips and the apex of said ridge.

13. A device comprising a closed evacuated envelope of insulating material defining a chamber and separating said chamber from the air outside of said device, and a current window element sealed into said envelope, said element comprising a supporting member of insulating material and a plurality of discrete loops of conductive material embracing said member, said loops being arranged in a single row and insulated from each other and extending through said envelope to provide conductive paths from said chamber to a record element outside of said envelope.

14. A cathode ray device which comprises a closed evacuated envelope of insulating material

defining a chamber and separating said chamber from the air outside of said device, means within said envelope for projecting a cathode beam, and a current window element sealed into said envelope in position to be impinged by said beam, said current window element comprising a plurality of discrete loops of conductive material arranged in a single row and insulated from each other, a part of each loop being exposed to the interior of the envelope and another part of each loop being exposed to the exterior of the envelope in position to make contact with a record element in the air outside of said envelope.

15. A cathode ray device which comprises a closed evacuated envelope of insulating material defining a chamber and separating said chamber from the air outside of said device, means within said envelope for projecting a cathode beam, a current window element sealed into said envelope, said window element comprising a supporting rod of insulating material and a plurality of discrete conducting loops of wire of the order of 0.0015 inch wide embracing said rod and evenly spaced apart thereon, a part of each loop being exposed to said projected cathode beam inside of said envelope and another part of each loop being exposed to the exterior of the envelope.

16. A cathode ray device which comprises a closed evacuated envelope of insulating material defining a chamber and separating said chamber from the air outside of said device, means within said envelope for projecting a cathode beam, a current window element sealed into said envelope, said window element comprising a supporting rod of insulating material and a plurality of discrete conducting wire loops embracing said rod and evenly spaced apart thereon by distances of the order of 0.01 inch, a part of each loop being exposed to said projected cathode beam inside of said envelope and another part of each loop being exposed to the exterior of said envelope.

17. A cathode ray device which comprises a closed evacuated envelope of insulating material defining a chamber and separating said chamber from the air outside of said device, means within said envelope for projecting a cathode beam, a current window element sealed into said envelope, said window element comprising a supporting rod of insulating material and a plurality of discrete conducting loops of wire of the order of 0.0015 inch wide embracing said rod and evenly spaced apart thereon by distances of the order of 0.01 inch, a part of each loop being exposed to said projected cathode beam inside of said envelope and another part of each loop being exposed to the exterior of said envelope.

18. A cathode ray device which comprises a vessel having a non-conductive boundary wall, means within said vessel for projecting a cathode beam, a current window element sealed into said wall, said window element comprising a plurality of discrete non-overlapping conducting open loops of wire extending through said wall, the center-to-center spacing of said loops being uniform and close, a part of the body of each loop intermediate its tips being exposed to said projected cathode beam and presenting to said beam an area substantially in excess of the square of said center-to-center spacing distance, tips of all of said loops being exposed to the exterior of said vessel and lying in a single row in position to make contact with a record element in the air outside of said vessel, the exposed area of each

of said tips being less than the square of said spacing distance.

19. A cathode ray device which comprises a vessel having a non-conductive wall, means within said vessel for projecting a cathode beam, and a current window element sealed into said wall in position to be impinged by said beam, said window element comprising an elongated insulating member having a longitudinal channel in one side thereof, and a plurality of discrete loops of conductive material arranged in a row

on said member and extending through said wall, a part of the body of each loop overlying said channel and being exposed to the interior of the vessel in position to be impinged by said projected cathode beam, another part of each loop being exposed to the exterior of the vessel, said loops providing a plurality of air-tight paths for the current of said beam to the exterior of the vessel, and a conductor element disposed longitudinally in said channel.

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