Dec. 11, 1962 C. L. DAY 3,067,486

TARGET ELECTRODE FOR BARRIER GRID STORAGE TUBE
AND METHOD OF MAKING SAME
Filed June 20, 1957

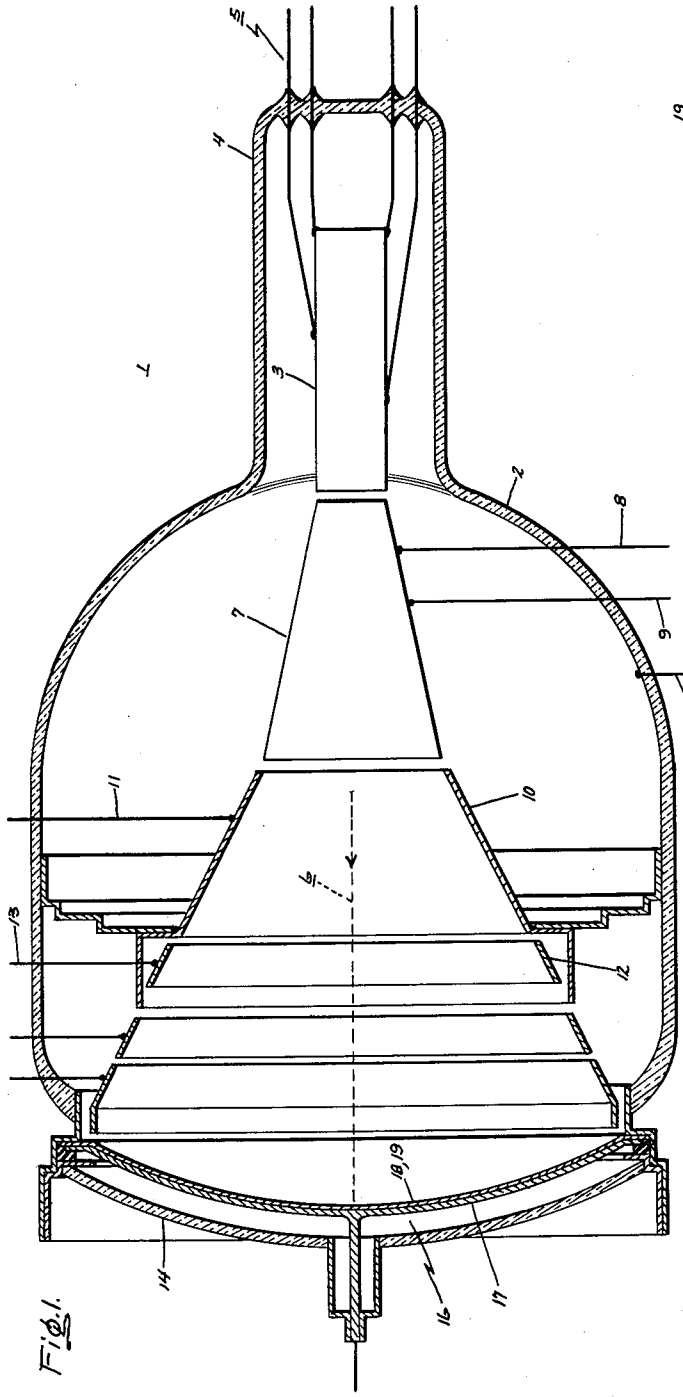

Fig. 1.

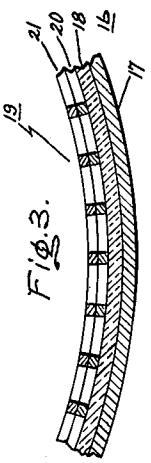

Fig. 3.

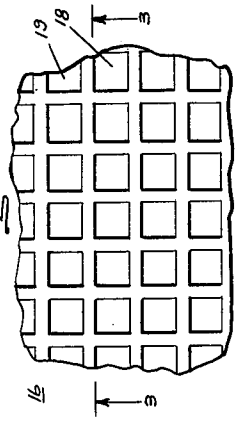

Fig. 2.

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# TARGET ELECTRODE FOR BARRIER GRID STORAGE TUBE AND METHOD OF MAKING SAME

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This invention relates to barrier grid storage tubes and more particularly to the target electrode assemblies incorporated in such tubes and to the method of making such target electrode assemblies.

Barrier grid storage tubes are now commonly used in computer technology, being employed in binary computers for storing and reading-out yes-no answers. These tubes, which are of the cathode ray type, are well-known in the art, as shown for example in Patent No. 2,538,836 of January 23, 1951, to A. S. Jensen. Such tubes conventionally include an electron gun assembly including a cathode heated by a suitable filament, a control grid and an accelerating anode, all positioned within an elongated envelope at one end thereof. Suitable deflecting and focusing elements are conventionally provided for causing the electron beam produced by the electron gun to scan a target electrode assembly positioned within the envelope at the other end thereof. The target electrode assembly comprises a grid or screen arranged on one side of a dielectric sheet and a metal plate arranged on the other.

The electron beam from the electron gun is caused to scan the target electrode assembly, providing secondary emission greater than unity. Each square of the target electrode formed by the screen or grid in essence forms a separator capacitor with the metal backing plate and thus may be charged positively or negatively by the electron beam, depending upon the polarity of the input signal applied to the metal plate and screen of the target assembly. These charges may subsequently be taken off of the target electrode assembly by a subsequent scanning by the electron beam.

In prior barrier grid storage tubes known to the applicant, the grid or screen of the target electrode has been mechanically attached to the dielectric. Such tubes were subject to microphonics due to vibration of the screen caused by external jarring of the tube and also caused by rapid reversal of the charge on the target electrode. Furthermore, the simple screen commonly employed for the grid structure has been found in some cases to be undesirably thin, thereby detrimentally affecting the accuracy of the tube.

I have found that the microphonics encountered in previous barrier-grid storage tubes can be eliminated by using glass or other fused dielectric material as the dielectric material of the target electrode and fusing the barrier screen thereto, and I have also found that better shading may be secured by increasing the thickness of the screen, as by plating. I have further discovered that in the bowl-shaped target electrode described in my copending application Serial No. 668,671, filed June 28, 1957, now Patent No. 3,020,622 issued Feb. 13, 1962, and assigned to the assignee of the present application, it is difficult to obtain a uniform thickness of the dielectric sheet when using mica, the material commonly employed for the dielectric layer in barrier grid storage tube target electrodes, but that a uniform thickness layer can readily be provided using a fuzed dielectric material as the dielectric layer; this invention therefore finds its principal utility as applied to bowl-shaped target electrodes.

It is therefore an object of this invention to provide an improved target electrode for barrier grid storage tubes.

It is another object of this invention to provide an improved target electrode for barrier grid storage tubes which is not subject to microphonics.



Yet another object of this invention is to provide an improved target electrode for barrier grid storage tubes in which the screen is fused to a glass dielectric.

A still further object of this invention is to provide an improved method of making a target electrode for a barrier grid storage tube.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a cross-sectional view of a barrier grid storage tube incorporating the improved target electrode assembly of this invention;

FIG. 2 is a fragmentary plan view (greatly magnified) of my improved target electrode assembly; and

FIG. 3 is a fragmentary cross-sectional view of the improved target electrode assembly of this invention taken along the line 3—3 of FIG. 2.

Referring now to FIG. 1, there is shown a barrier grid storage tube, generally identified as **1**. The tube **1** includes an elongated envelope **2** having an electron gun assembly **3** positioned therein adjacent end **4**. The electron gun assembly **3** may be any conventional type, as is well known in the art, including a cathode heated by a suitable filament, a control grid, and suitable accelerating anodes. The cathode, filament, control grid and accelerating elements are connected to suitable sources of voltage by leads **5**, as is well known in the art. The electron beam **6** produced by the electron gun assembly **3** is deflected vertically and horizontally by suitable deflecting electrodes **7** positioned within the envelope **2** and connected to suitable deflecting circuits by conductors **8** and **9**, it being understood that the vertical and horizontal deflection of the electron beam may be provided by deflecting coils arranged on the exterior of the envelope **2** rather than by the internal deflecting elements **7**. A shield electrode **10** is positioned within the envelope **2** and is connected to a suitable source of potential, for example —100 volts, by lead **11**. A collecting electrode **12** is likewise positioned within envelope **2** in front of the shield **10** and is connected to a suitable source of potential, for example +500 volts by lead **13**. Collecting electrode **10** is also connected to an output circuit, as is well known in the art. A conductive coating is applied to the inner surface of the envelope **2** intermediate end **4** and the other end **14**, which coating is adapted to be connected to a suitable source of voltage by conductor **15**. A suitable focusing coil may also be provided on the exterior of the envelope **2** connected to a suitable source of voltage, as is well known in the art. The target electrode assembly **16** of this invention is positioned within the envelope **2** at the end **14** thereof and is thus scanned by the electron beam **6**. It will be readily understood that the specific features of the barrier grid storage tube **1**, other than the target electrode assembly **16**, do not form a part of this invention and are here shown for illustrative purposes only: my improvd target electrode assembly may be utilized in barrier grid storage tubes constructed differently from that shown in FIG. 1.

Referring now to FIGS. 2 and 3, in addition to FIG. 1, the target electrode assembly **16** preferably includes a relatively thin bowl-shaped metal backing plate **17**, a relatively thin layer of glass **18** forming the dielectric of the target assembly **16**, the layer **18** being preferably fused to the metal backing plate **17**, and a metal grid structure **19** formed of a fine mesh screen **20** fused to the inner surface of the glass dielectric **18** and having its thickness increased as at **21**, as by plating.

I have tested in a barrier grid storage tube a target electrode of the type shown in FIGS. 1–3 in which the target electrode had a diameter of 4½ inches, the metal backing plate 17 was formed of Inconel having a thickness of .040 inch and a radius of curvature of 4½ inches, the glass dielectric layer 18 was .002 inch thick and fused to the inner surface of metal backing plate 17. A 250-mesh copper "lectroform" 20 screen having a thickness of .001 inch was employed fused to the inner surface of the glass dielectric layer 18, the screen 20 having a grid structure 21 integrally joined to its outer surface by plating to form an overall thickness of the grid of .0015 inch.

In the method of making the improved target electrode of this invention, the bowl-shaped metal backing plate 17 is preferably formed in the manner fully described in my aforesaid application Serial No. 668,671.

The completed bowl 17 is then placed in a rotating jig in a spray booth, the jig being arranged continuously to rotate the bowl while holding it in a vertical plane; the speed of rotation being very slow. I have used an external mix gun with a large head for spraying the inner surface of the bowl with glass. I adjusted the spray head to throw a spray at least one and one-half times as wide as the bowl diameter and have obtained very satisfactory results by utilizing a suspension of approximately twenty (20) grams of 325-mesh powdered glass to one hundred (100) milliliters of ethyl alcohol. Glass having a low melting point is employed, the specific glass used depending on the metal used for the metal backing plate; in the specific embodiment described above in which an Inconel metal backing plate was used, I use glass which softens at approximately 440° C. and melts at 500° C. The thermal expansion characteristics of the glass should further approximately match the thermal expansion characteristics of the metal backing plate, I have found that great care must be employed at all times to keep the glass powder in a suspension, the suspension being sprayed on by the spray head while the bowl is being slowly rotated. The bowl must be maintained damp at all times during the spraying operation, since if allowed to dry out the air from the spray gun blows the deposited glass away and in trying to retrieve a balanced and uniform coating I have found that watermarks or sagging may result. In the particular spray gun I employed, I have found that an air pressure of approximately twenty-five (25) pounds provided satisfactory results. If the spray suspension is too thick and greater air pressure is employed, it has been found difficult to keep from spraying too dry and encountering the watermarking and sagging described above. Care must further be exercised in adjusting the spray gun so that the stream is of uniform density throughout since I have found that otherwise heavy spots are deposited on the finished bowl. I have found that a uniform coating of glass is provided on the inner surface of the bowl by eight or ten passes of the spray gun, the layers varying from one thousandth (.001) of an inch to one hundredth (.010) of an inch.

Following spraying of the powdered glass on the inner surface of the bowl, the bowl is allowed to dry and inspected to detect any thick spots on the surface. If the bowl is satisfactory, it is then placed in a preheated furnace; I have found that in the case of the specific glass employed, the furnace should be heated to approximately eight hundred degrees C. (800° C.). The bowl is placed on a carrier of stainless steel with the glass up in the horizontal position and is left in the furnace until the glass starts to melt from the edge in. I have found that the bowl should be left in the furnace until the last bit of glass in the center melts and for a period of two (2) minutes beyond this time. I have found that if the bowl is left in the furnace for a substantial amount of time over two minutes following melting of the glass in the center, an oxide will begin to penetrate from the metal backing plate ruining the bowl for further use. If on the other hand the time the bowl is left in the furnace is a substantially shorter period of time, small particles of unmelted glass are visible on the surface giving it a rough appearance.



After the glass has been fused to the inner surface of the bowl, the bowl with the fused glass layer thereon is removed from the furnace while still on the carrier and allowed to come to room temperature as quickly as possible. I have found that care must be exercised during the molten stage to insure that dirt specks do not drop into the molten glass surface. After the bowl is cooled, it should again be inspected to determine thickness of glass over the entire surface and also for any imperfections. If the thickness of the glass layer is not uniform, the bowl may again be optically ground.

A fine mesh screen is then applied to the outer surface of the glass dielectric layer. These screens may be any non-magnetic material, such as copper, nickel, or stainless steel, however I have advantageously employed copper since the increasing of the thickness thereof by plating is accomplished relatively easily. I have employed a 250-mesh "lectroform" screen having a thickness from .002" to .0005". The screen may be formed into a bowl shaped snugly to fit within the glass layer on the inner surface of the bowl in any suitable manner, as by being sagged into the bowl at an elevated temperature; however, the screen is preferably formed by use of a punch and die set having a rubber punch portion as described and illustrated in my co-pending continuation-in-part application Serial No. 733,250 filed May 2, 1958, and assigned to the assignee of the present application. In order to provide for accurate readings from the barrier grid storage tube, it is very important that the wire mesh screen be drawn evenly and smoothly and be free of wrinkles and flaws. It should further be free of excessive distortion over its entire area.

After the grid is placed on top of the glass dielectric layer, the screen is preferably urged into intimate contact with the dielectric layer, as by a carbon weight formed to the same shape as the bowl. The sandwich of the bowl screen and weight is then placed in a preheated furnace; I have employed a furnace preheated at 600° C. The bowl, screen and weight are held in the furnace at this temperature just long enough to seal the screen to the glass dielectric layer, the time varying according to the thickness of the glass and the type of metal used in the screen. As soon as the screen is sealed to the glass dielectric layer, the assembly is withdrawn from the oven and allowed to cool in air to room temperature.

I have found that the sealing process should be carried out in an inert atmosphere, such as hydrogen, since if it is carried out in air the copper mesh screen becomes discolored. Any discoloration, however, can be removed from the copper mesh screen by cleaning it with diluted aluminum chloride.

The thickness of the screen is now increased, if desired, by plating over the the copper screen. This may be done by using an anode with approximately the same curvature and of the same material as the screen, preferably copper, covered with a glass cloth cover thick enough to retain a quantity of the plating bath. During the plating operation, I have found it desirable to replenish the plating bath by pumping it through holes in the anode at the required rate to replenish the spent bath. I have found that if the target electrode is completely flooded with a new plating bath, it will tend to plate the screen closed. This plating is continued until the screen has been built up to the desired thickness.

It will be readily understood that other fusible dielectric materials may be employed instead of glass, e.g., certain ceramic materials and eutectic mixtures of glass and ceramics will form a suitable dielectric layer and will permit fusing of the screen thereto. It will also be apparent that the glass dielectric layer may be separately formed, as by molding, rather than being sprayed on the metal backing plate.

With my improved target electrode, microphonics en-

countered in previous barrier grid storage tubes are completely eliminated since the entire area of the grid structure itself is solidly fused to the dielectric layer rather than being merely mechanically held against the dielectric as was previously the case. Furthermore, the plating of the fine mesh screen forms a convenient and simple way to increase the thickness of the grid structure.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention.

What is claimed is:

1. The method of making a target electrode for a barrier grid storage tube comprising the steps of: coating a metal backing plate with a fusible dielectric material; fusing said material to said plate at an elevated temperature; placing a metal screen on the outer surface of said dielectric material, fusing said screen to said material at an elevated temperature; and depositing additional metal on the outer surface of said screen thereby to increase the thickness thereof.

2. The method of making a target electrode for a barrier grid storage tube comprising the steps of: coating a metal backing plate with a fusible dielectric material; fusing said material to said plate at an elevated temperature; placing a metal screen on the outer surface of said dielectric material; fusing said screen to said material at an elevated temperature; and depositing additional metal on the outer surface of said screen by electroplating thereby to increase the thickness thereof.

3. The method of making a target electrode for a barrier grid storage tube comprising the steps of: forming a bowl from a metal plate; coating the inner surface of said bowl with a fusible dielectric material; fusing said material to said inner surface at an elevated temperature; forming a metal screen into a bowl shape; placing said screen within said metal bowl; and fusing said screen to said material at an elevated temperature.

4. The method of making a target electrode for a barrier grid storage tube comprising the steps of: forming a bowl from a metal plate; spraying the inner surface of said bowl with a suspension of approximately 20 grams of approximately 325 mesh glass which softens at approximately 440° C. and melts at approximately 560° C. in approximately 100 milliliters of ethyl alcohol thereby forming a layer of glass on the interior surface of said bowl; firing said glass layer in a furnace at approximately 800° C. for approximately two minutes thereby fusing said glass to said inner surface of said bowl; forming a metal screen into bowl shape; placing said screen within said metal bowl; and fusing said screen to said material at an elevated temperature.



5. The method of making a target electrode for a barrier grid storage tube comprising the steps of: forming a bowl from a metal plate; coating the inner surface of said bowl with a fusible dielectric material; fusing said material to said inner surface at an elevated temperature; forming a metal screen into a bowl shape; placing said screen within said bowl; pressing said screen into intimate contact with said dielectric material; placing said bowl with said screen therein in a furnace and heating in an inert atmosphere at approximately 600° C. for a sufficient time to fuse said screen to said dielectric material; and cooling said bowl and screen to room temperature.

6. The method of making a target electrode for a barrier grid storage tube comprising the steps of: forming a bowl from a metal plate; spraying the inner surface of said bowl with a suspension of approximately 20 grams of approximately 325 mesh glass which softens at approximately 440° C. and melts at approximately 560° C. in approximately 100 milliliters of ethyl alcohol thereby forming a layer of glass; firing said glass layer in a furnace at approximately 800° C. for approximately two minutes thereby fusing said glass to said inner surface of said bowl; forming a metal screen into bowl shape; placing said screen within said bowl; pressing said screen into intimate contact with said fused glass layer; placing said bowl with said screen therein in a furnace and heating in an inert atmosphere at approximately 600° C. for a sufficient time to fuse said screen to said fused glass layer; and cooling said bowl and screen to room temperature.

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