May 8, 1962 H. J. HANNAM 3,032,859

METHODS OF MANUFACTURING AND HANDLING TARGET ELECTRODES AND TARGET ELECTRODE ASSEMBLIES

Original Filed May 23, 1958 2 Sheets-Sheet 1

FIG.1.

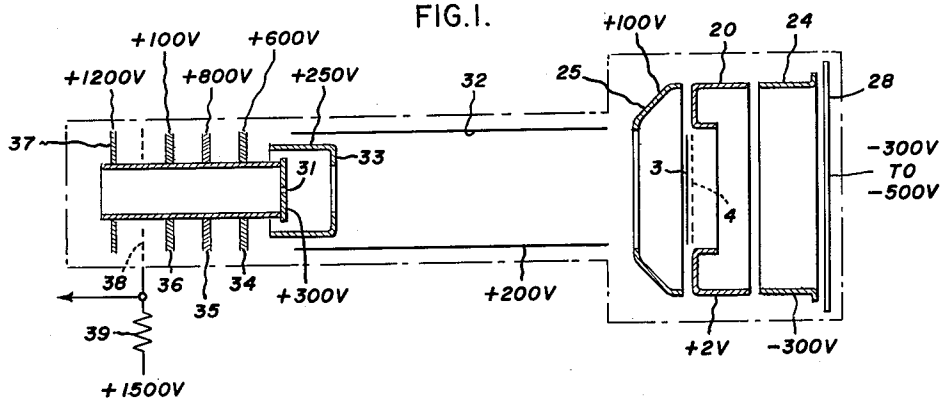
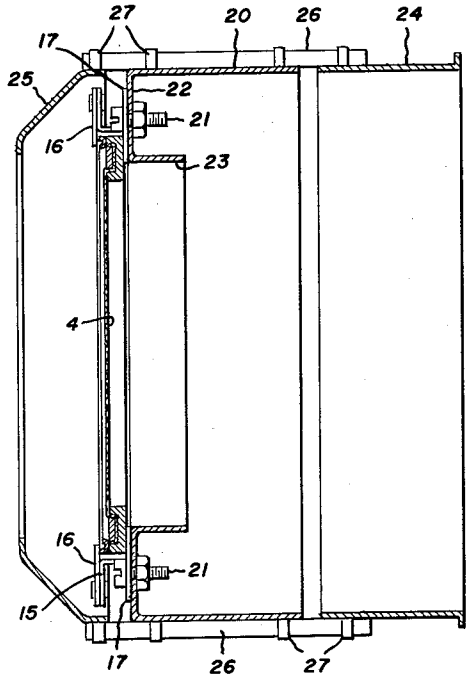


FIG.2.



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FIG.3.

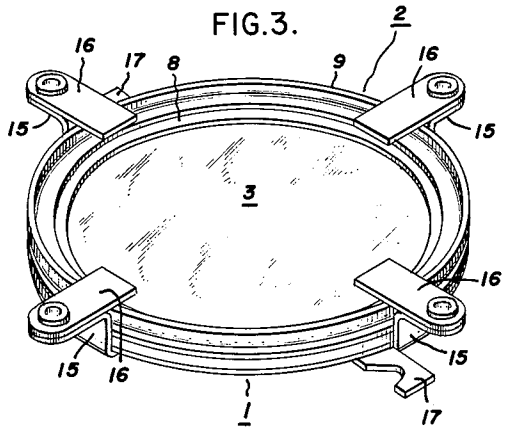


FIG.4.

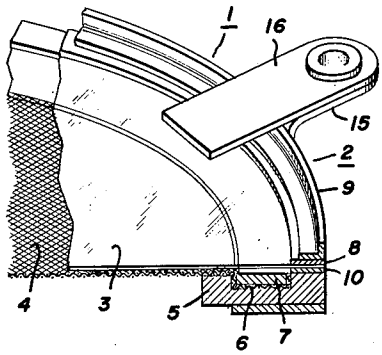


FIG.5.

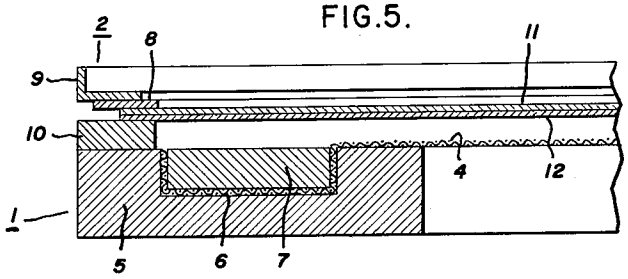
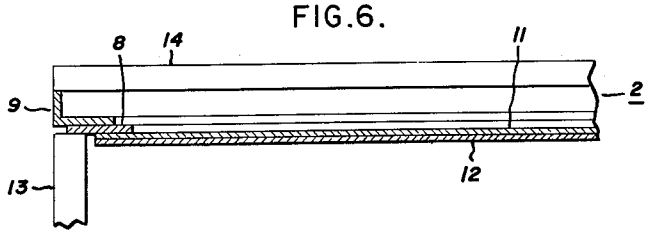


FIG.6.



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METHODS OF MANUFACTURING AND HANDLING TARGET ELECTRODES AND TARGET ELECTRODE ASSEMBLIES

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Original application May 23, 1958, Ser. No. 737,348, now Patent No. 2,922,907, dated Jan. 26, 1960. Divided and this application Aug. 11, 1959, Ser. No. 838,012

3 Claims. (Cl. 29—25.14)

My invention relates to an improved target electrode assembly and more particularly to an improved assembly of this type for producing a point-by-point electric charge pattern corresponding to a visual image or other information to be converted to electrical signals by scanning the target electrode with an electron beam. Additionally, my invention relates to storage electrodes employable in target electrode assemblies and improved methods of manufacturing and handling such electrodes and assemblies. This is a divisional application of my copending U.S. application Serial No. 737,348, filed May 23, 1958, and issued as U.S. Patent No. 2,922,907 on January 26, 1960.

In U.S. patent application Serial No. 630,683 of Harold R. Day, Jr., and Peter Wargo, filed December 26, 1956, entitled "Target Electrode Assembly" and assigned to the same assignee as the present application there is disclosed and claimed a target electrode assembly adapted for use, for example, in a known type of television camera tube, referred to as an "image orthicon." This assembly includes a thin transparent film of magnesium oxide and a conductive mesh supported from opposite sides of a relatively rigid glass mesh structure having a large number of closely spaced openings extending therethrough generally perpendicular to the film. This structure is mechanically rigid for minimizing undesirable mechanical vibrations which could result in microphonics or unwanted electrical signal modulations. Additionally, this structure is adapted for maintaining relatively constant electrical characteristics over long periods of use. It is considered that the conduction in a direction normal to the opposed faces of the magnesium oxide film is due to the transport through the film of electrons rather than ions, and there is no loss of available electrons in the film after long periods of use corresponding to the decrease in available mobile ions occurring in previously employable glass films. Thus this type of assembly is not subject to the undesirable phenomenom which has been called "burn-in" and which results in a tendency for an after image to be retained on the electrode for a period many times the frame repetition rate, causing the image to be superimposed upon later scenes. In operation of the structure disclosed in the above-referenced application Serial No. 630,683, a charge pattern is established on the magnesium oxide film in accordance with the secondary electrons emitted from one surface of the film in response to impingement upon the opposite surface thereof of electrons from a photocathode. Inasmuch as the magnesium oxide film provides a high yield of secondary electrons, it results in a sensitive target electrode.

The present invention contemplates an improved target electrode assembly which will afford all of the advantages obtainable with the above-described assembly of Day and Wargo without reliance on an intermediate electrode support and which affords substantial further advantages.

Accordingly, it is a primary object of my invention to provide a new and improved target electrode assembly which maintains its electrical characteristics over long periods of use.

Another object of my invention is to provide a new and improved target electrode assembly wherein a void is provided between the spaced electrodes thereof and thus is not subject to spurious signals due to charge accumulations on and leakages across elements interposed between the spaced electrodes.

Another object of my invention is to provide a new and improved target electrode assembly including new and improved means for avoiding undesirable mechanical vibrations and resulting unwanted electrical signal modulations without reliance on support means disposed within the area defined by the margin of the assembly.

Another object of my invention is to provide a new and improved storage electrode adapted for improved image resolution.

Another object of my invention is to provide a new and improved target electrode assembly adapted for increased electron transmission and thus adapted for higher sensitivity.

Another object of my invention is to provide a storage electrode which requires support only at its periphery and, thus, is capable of higher secondary emission than storage electrodes which require support structure across the surface thereof and which are subject to reduced secondary emission resulting from the adverse effects of foreign materials evolving from the support structure.

Another object of my invention is to provide an improvide target electrode assembly which comprises a reduced number of essential elements and thus is adapted for reducing the costs and efforts of manufacture.

Another object of my invention is to provide an improved storage electrode which overcomes the need for utilizing elements formed of materials such as glass which generally add to the difficulties of evacuating envelope structures adapted for containing such target electrodes.

Another object of my invention is to provide improved methods of manufacturing and handling target electrode assemblies and storage electrodes therefor adapted for facilitating and reducing the cost of manufacture.

Further objects and advantages of my invention will become apparent as the following description proceeds and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

In carrying out the objects of my invention I provide a target electrode assembly including a conductive mesh electrode and an annular electrode support corresponding generally to the margin of the mesh electrode. Extending tautly across the annular electrode support and supported solely thereby is a membrane of polycrystalline homogeneous magnesium oxide. The membrane is spaced a predetermined distance from the mesh electrode and has a thickness of substantially the same order of magnitude as the size of the crystals constituting the membrane. The membrane is of a mass per unit area which requires for excitation a vibrational frequency of such a high magnitude as to be practically vibrationless in ordinary target electrode environments. Furthermore, the resonant frequency is such as to be almost undetectable at normal frame and scanning rates. The target electrode is manufactured by first forming a vaporizable support film on an annular support member evaporating a magnesium coating on the film and then oxidizing the magnesium and vaporizing the support film, thereby to leave a taut magnesium oxide membrane supported only by the annular support. The magnesium oxide membrane is frail or subject to easy breakage and destruction of the membrane by relative air movement is avoided by maintaining an air breaking element in closely spaced relation with the membrane during manufacturing and assembly movements thereof.

For a better understanding of my invention reference may be had to the accompanying drawing wherein:

FIG. 1 is an elevational view in section, schematically representing a camera tube of the type to which the present invention may be applied;

FIG. 2 is an enlarged elevational view in section, illustrating the electrode assembly, including the target electrode, of the image section of tube shown in FIG. 1;

FIG. 3 is a perspective view showing the construction of the target electrode assembly of the present invention;

FIG. 4 is a perspective fragmentary view, partially in section and greatly enlarged, showing constructional details of the target electrode assembly of the present invention;

FIG. 5 is an enlarged fragmentary sectional view illustrating a step in one method of manufacturing the target electrode of the present invention; and

FIG. 6 is an enlarged fragmentary sectional view illustrating a step in another method of manufacturing the target electrode of the present invention.

As best seen in FIG. 4, the target electrode assembly of the illustrated embodiment of the present invention, includes planar electron-permeable electrode generally designated **1** and a storage electrode generally designated **2** including a transparent magnesium oxide membrane **3** supported in spaced relation to the electron-permeable portion of the planar electrode **1**.

The electrode **1** can comprise an electroformed mesh **4** which has been aluminized on both sides and is mounted on an annular support ring **5**. The support ring **5** includes an annular channel **6** in which is received a retaining ring **7** adapted for securely retaining the edge of the mesh **4** in the channel **6** and, thus, securing the mesh to the support ring **5**.

The magnesium oxide membrane **3** of the storage electrode **2** is supported solely by an annular support **8** which is formed to correspond generally to the outer edge or margin of the mesh supporting ring **5** of the electrode **1**. The support **8** has the membrane **3** directly mounted on the undersurface thereof in FIG. 4 and is suitably secured, as by brazing, to a ring **9** which is of angular cross-section and thus is adapted for rigidizing the ring **8**. An annular spacer **10** interposed between the elements **5** and **8** determines the spacing between the mesh **4** and the membrane **3**. Thus, the mesh **4** and the membrane **3** are adapted for being maintained in a spaced relation or are separated by a void which extends completely across the corresponding areas of these elements. Preferably the spacing can be from approximately .5 to 150 mils. For monochrome television purposes a spacing of 2.5 to 3 mils is highly satisfactory, while a spacing of approximately .5 mil works well for color television camera tubes. The spacing between the mesh and membrane determines the time constant of the assembly and it will be understood from the foregoing that this time constant can be varied by varying the spacing within the limits of the range noted.

The substance of the magnesium oxide membrane **3** is highly flimsy or frail in form and requires particular methods of manufacture and handling to obtain and sustain the formation of a membrane of such a substantial area as that defined by and extending otherwise unsupported across the annular membrane support **8**. In accordance with one preferred method of forming the membrane **3**, a suitable thin layer of nitrocellulose illustrated at **11** in FIG. 5 is applied to the membrane support **3** by first dropping onto the surface of a pan of water a small quantity of nitrocellulose dissolved in a suitable organic solvent such as amyl acetate. This solution spreads out into a thin film due to surface tension and the solvent evaporates, leaving a plastic film on the surface of the water. Thereafter, the membrane support ring **8**, which has been placed in the water either prior to the formation of the film or which is immersed in the water at the outer portion of the film, is raised gently to pick up the film on the surface of the ring.

After the film has dried completely, the ring is placed in an evaporator and a thin coating of magnesium shown at **12** in FIG. 5 is evaporated on the plastic film to a desired thickness. The thickness of the magnesium thus evaporated on the film is determined by the desired mechanical and electrical characteristics of the storage electrode. In the particular embodiment illustrated, the film of magnesium is approximately 500 angstroms thick.

Thereafter, the electron-permeable electrode **1** and the just-described target electrode structure are assembled in the manner shown in FIG. 5 and the whole assembly is placed in an oven and baked out in air, starting at a temperature of about 170° C. and terminating at about 400° centigrade for a period in the order of approximately five hours. This baking decomposes and vaporizes the nitrocellulose film which disappears completely and also is effective for reducing the magnesium to an oxide for thus forming a smooth, taut, transparent, colorless magnesium oxide film or membrane. During the baking operation and subsequently during handling of the assembly the magnesium oxide membrane, which is very flimsy or frail, is prevented from being destroyed by air movement relative thereto by the mesh **4** of the electrode **1** which serves as an air break or air baffling element. In view of the fact that the mesh **4** is included in the assembly which is subjected to the air bake it is essential that the mesh **4** be capable of withstanding the air baking operation without oxidizing.

With a magnesium oxide membrane thickness of 500 angstroms, the time constant of the storage electrode structure is suitable for a repetition rate of 30 frames per second used in television. The time constant increases as the thickness of the magnesium oxide membrane increases and information storage may be realized with magnesium oxide films of a thickness in the order of several thousands of angstroms.

In membrane **3** the conduction is electronic. That is, there is no reliance on ions which in prior art glass membranes has a tendency to become depleted and, therefore, the target conductivity in the present structure is stable and "burn-in" is eliminated. By the use of X-ray defraction patterns I have learned that the magnesium oxide membrane obtained by the above-described method is homogeneous and polycrystalline and that the crystal size is about 300 angstroms. Thus, in a membrane having a thickness of the order of 500 angstroms the membrane thicknesses is of substantially the same order of magnitude as the size of crystals constituting the membrane; and therefore, conductivity through the film by grain boundary conduction or bombardment induced conductivity is enhanced. This type of conduction enables the utilization of magnesium oxide as a membrane material even though it has a much higher resistivity than glass formerly used. This high resistivity results in extremely low lateral leakage which can be relied upon to improve image resolution.

In considering the substantially large area of the magnesium oxide membrane **3**, it might be felt that the assembly would be subject to microphonics due to drum head vibrations of the membrane. However, in the assembly of the present invention microphonics are substantially reduced due to the fact that the mass per unit area of the membrane **3** is about 100 times less than glass membranes formerly employed. Thus, the vibrational frequency of the membrane **3** is approximately 10 times as high as for a glass membrane when those types of membranes are under the same tension. Additionally, the membrane **3** can be placed under greater tension per unit cross section than can prior art glass membranes. The vibrational frequency of the membrane **3** is more difficult to excite and even if excited image variations resulting therefrom are not generally discernible at normal scanning rates and thus are not generally objectionable. For all practical purposes the membrane **3** might be considered vibrationless in ordinary target electrode environments.

Thus, it will be seen that the assembly of FIGS. 3 and 4 is adapted, since it operates by means of electron conduction rather than ion conduction for maintaining its electrical characteristics over long periods of use. Ad-

ditionally, the membrane 3 is effective for avoiding the undesirable mechanical vibrations and resultant microphonics without reliance on an intermediate support such as the glass mesh disclosed in application Serial No. 630,683. This has the desired effect of eliminating the need for the glass mesh which is currently a substantially expensive and difficult to manufacture element. Additionally, by providing a structure including a void between the mesh and membrane I have reduced the possibilities of spurious signals due to charge accumulations and leakages across portions of material extending between the electrodes. Due to the void between the elements electron transmission through the assembly is increased, thereby to afford improved image resolution. Also, increased electron transmission adapts the assembly for a higher sensitivity. Further, in structures utilizing a membrane support extending across the surface of the membrane secondary emission can be reduced substantially due to foreign matter evolving from the material of the support. Applicant's membrane 3 does not require this type of support and, thus, is adapted for desirably greater secondary emission. Still further, glass is noted as a material which desorbs vapor upon heating and the elimination of glass from the target assembly serves not only to eliminate the need for a relatively expensive element and to simplify the structure and effort of manufacture, but also serves to remove from a tube another element which might constitute a source of difficulty in evacuating an envelope containing the assembly.

Alternatively, the assembly of FIG. 3 can be obtained by forming a vaporizable film 11 on the annular ring 8, then coating the film with magnesium in the manner illustrated at 12 in FIG. 6, and then air baking this assembly while supported, for example, on a plurality of circumferentially spaced upstanding elements 13. Thus, the vaporizable film 11 is decomposed and the magnesium coating 12 is reduced to a magnesium oxide membrane 3 which extends completely across the member 8 and is solely supported thereby. When the storage electrode is formed in this manner it is necessary to transport it for assembly with the electron permeable electrode 1 and it is necessary to accomplish this without fracture or destruction of the membrane 3. To accomplish this I place a plate 14 over the target electrode 2 and in engagement with the rim of the element 9 and by concurrently grasping the contiguous edges of these elements it is possible to lift both and transport the target electrode to a position where it can be assembled to the electron permeable electrode 1 with the element 14 acting as an air break or air baffling means, thus to avoid fracture or destruction of the membrane by movement of air relative to the support 8 therefor. After the target electrode is assembled to provide the target electrode-electron permeable electrode assembly, the mesh 4 of the electrode 1 can serve to avoid destruction of the membrane 3 during movement of the target electrode assembly for mounting in a camera tube.

As best seen in FIGS. 2, 3, and 4 the mesh support ring 5 has secured thereto a plurality of angularly spaced brackets 15 which carry rotatable resilient tabs 16. The tabs 16 are adapted for being moved into the radially inwardly projecting positions thereof illustrated in FIGS. 3 and 4 wherein they are effective for retaining the target electrode 2 in assembled relation with respect to the electrode 1. Additionally, the support 5 carries a plurality of angularly spaced and laterally slotted mounting tab 17 which are adapted for mounting the assembly in a camera tube in the manner illustrated in FIG. 2. In the arrangement of FIG. 2 the target electrode assembly is supported transversely in a cylindrical target supporting electrode 20 by means of the electrode 20 by means of the slotted mounting tabs 17 being fitted about suitable holding bolts 21 carried by an inturned flange 22 formed on the cylinder 20. Thus, the target electrode assembly is supported opposite the opening in a cylindrical flange 23 comprising part of the target assembly supporting electrode 20. The latter electrode forms part of the assembly including an accelerating grid electrode 24 and a decelerating grid electrode 25. These three electrodes are supported in longitudinally spaced coaxial relation by suitable ceramic rods or stalks 26 spaced around the circumference of the electrodes and held thereto by suitable straps 27. This assembly is supported in the enlarged image section of the tube shown schematically in FIG. 1 with the accelerating grid electrode 24 spaced slightly from a photocathode 28 which provides a source of photoelectrons. The photoelectrons are accelerated toward the target electrode assembly to establish a charge pattern thereon in accordance with the image falling on the photocathode. At the opposite end of the tube is the electron gun and electron multiplier structure which are concentrically arranged. The gun, which provides the scanning beam, is shown merely as a hollow cylindrical grid electrode 30, having a small aperture 31 in the order of .002 inch in diameter in the end wall thereof, for producing a thin scanning beam. The outer surface of this end wall surrounding the aperture also provides the first dynode of the electron multiplier, as will be described in more detail hereinafter. A cylindrical electrode which may be formed as a metallic coating 32 on the neck of the tube provides for focusing the beam and the field controlling electrode 25, usually designated a decelerating electrode. As will be readily appreciated by those skilled in the art, the entire camera tube is subjected to an essentially homogeneous longitudinal collimating magnetic field. This field may have a strength of 75 gauss, for example. Electrons from the scanning beam are collected in accordance with the charge or potential pattern established on the target electrode so that returned electrons, which are the forward beam electrons minus those collected, vary with the charge pattern on the target electrode 3. These electrons do not reenter the aperture 31 but instead strike the plate surrounding the aperture, which is a high secondary emitter so that there results a multiplication of the electrons emitted compared with those returned from the storage electrode.

A generally cyindrical focusing electrode 33 for the electron multiplier section of the tube is supported at the end of the gun electrode 30 intermediate that electrode and the beam focusing grid electrode 32.

Several stages of electron multiplication are provided by electrodes 34–37 inclusive and the amplified electron current is collected by the anode 38 of the electron multiplier to produce a signal across the resistor 39 which varies in accordance with the charge pattern on the membrane 3. In FIG. 1 of the drawing, suitable direct current operating voltages for the various electrodes have been indicated. These voltages are relative to the cathode and may vary appreciably from the values given.

When the target electrode is scanned by an electron beam, the variations in beam current collected by the anode 38 reproduces point-by-point an electrical signal varying in accordance with a charge pattern on the target electrode. The time constant of the membrane 3 determines the frame speed on which the device operates, hence it is essential that the residual charges from one frame to another be so small as not to interfere with the production of an electrical signal indicative of the image falling on the photocathode in any particular frame.

With the magnesium oxide membrane 3, the electrical characteristics remain relatively constant over extended life of the membrane. The undesirable "burn-in" phenomenon resulting from what is generally understood to be a depletion of the mobile ions in glass membranes is non-existent. The magnesium oxide membrane 3 provides a target which is available on both faces for the impingement of the electron. Also, the structure of the present invention provides for relatively vibrationless target electrode which is substantially free of undesirable microphonics due to target electrode movement. Addi-

tionally, in the present structure no intermediate electrode support means is required which affords improved resolution, higher sensitivity, higher secondary emission, freedom from certain spurious signals, and reductions in costs and efforts in manufacturing the electrode assembly as well as an evacuated device incorporating same.

While I have shown and described a particular embodiment of my invention, I do not desire my invention to be limited to the particular form shown and described, and I intend by the appended claims to cover all modifications within the scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of manufacturing and handling a storage electrode comprising the steps of forming a vaporizable film across an annular support having a transverse dimension comparable to that of a finished electrode, evaporating a magnesium coating on said film, heating the assembly in an oxidizing atmosphere to both decompose said film and convert said magnesium coating to a taut, frail magnesium oxide membrane extending completely across and being solely supported by said annular support, and maintaining an air baffling element in spaced relation with said membrane, thereby to avoid destruction of said membrane by relative movement of air.

2. The method of processing a target electrode assembly comprising the steps of forming a vaporizable film across an annular support approximately the size of a finished assembly, evaporating a magnesium coating on said film, securing said support with said film thereon to a mesh electrode with said mesh electrode disposed in spaced confronting air baffling relation to said magnesium coating, air baking the assembly to both decompose said film and convert said magnesium coating to a taut, frail discrete magnesium oxide storage membrane which extends completely across said annular support in spaced relation to said mesh and is solely supported by said annular support, with said mesh electrode acting as air baffling means for said membrane.

3. The method of manufacturing a storage target electrode comprising the steps of forming a vaporizable film across an annular support member having a dimension comparable to that of a finished electrode, evaporating a magnesium coating on said film, heating the assembly in an oxidizing atmosphere for a period in the order of approximately 5 hours starting at a temperature of about 170° C. and terminating at about 400° C. to decompose said film and oxidizing said magnesium coating to a taut, homogeneous polycrystalline magnesium oxide membrane extending completely across and being solely supported by said annular support.

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