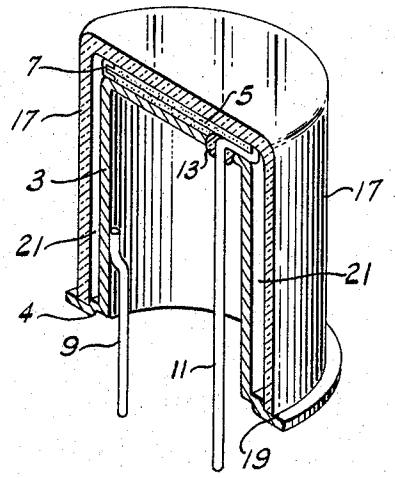
June 20, 1967 C. C. CASAMO ETAL 3,326,618

PROCESS OF MANUFACTURING A PHOTO-CONDUCTOR DEVICE

Filed March 4, 1963

Fig. 1



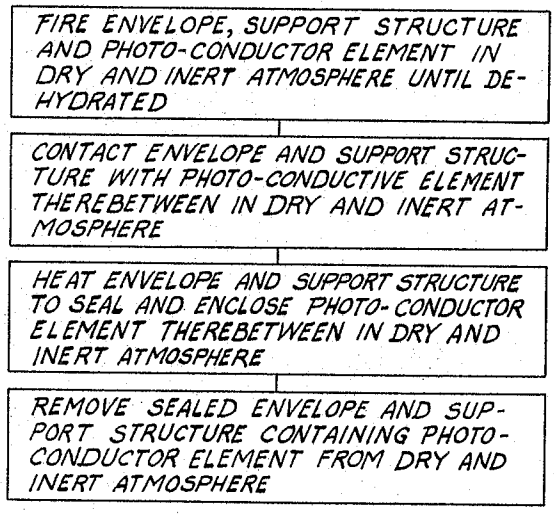


Fig. 2

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PROCESS OF MANUFACTURING A PHOTO-CONDUCTOR DEVICE

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This invention relates to photoconductor tubes and a process for the manufacture thereof and more particularly to a photoconductor tube structure and a process for dehydrating and hermetically sealing the structure to provide a photoconductor tube.

Known photoconductor tubes generally consist essentially of a light-frequency responsive element hermetically enclosed intermediate and within a glass bulb and a supporting structure. The glass supporting structure usually supports the light-frequency responsive element and a pair of conductors are connected thereto. Additionally, the conductors are formed to extend through the glass supporting structure to permit electrical contact with an external supply.

Further, the glass supporting structure usually has an exhaust tube extending therefrom which, after the glass bulb has been sealed to the structure, permits evacuation of the atmosphere surrounding the light-frequency responsive element and replacement thereof with a dry and inert atmosphere. Moreover, the bulb which is sealed to the glass supporting structure is transparent or at least partially so and aligned with the light-freqency responsive element to permit light energization of the element.

In one process for manufacturing photoconductor tubes, the above-mentioned glass envelope and glass supporting structure are brought into contact and heat applied thereto in sufficient amount to cause the formation of a seal. Following, the atmosphere intermediate the glass bulb and glass supporting structure is evacuated and replaced with a dry and inert atmosphere.

Although the type of structure and processing is commonly used in photoconductor tube manufacture, it has been found that the heat required to formulate the seal is difficult to confine within the seal area. Further, the amount of heat permitted for the sealing process is critical because of the deleterious effects of excess heat on the light-frequency response element. Additionally, the sealing of glass is a slow and costly operation and a glass supporting structure does not satisfactorily conduct heat away from the light-frequency responsive element. Moreover, the replacement of the atmosphere surrounding the light-frequency responsive element is unwieldly and requires expensive equipment. Furthermore, the operation is not well adapted to automation.

Therefore, it is an object of this invention to enhance the operating temperature of a photoconductor tube.

A further object of this invention is to improve the heat dissipating characteristics of a photoconductor tube structure.

A still further object of this invention is to improve the hermetic sealing of a photoconductor tube whereby the light-frequency response element thereof is not deteriorated during the manufacturing process.

Another object of this invention is to provide a process for photoconductor tube manufacture which does not require expensive evacuation equipment.

Still another object of this invention is to simplify the photoconductor tube manufacturing process.

And yet another object of this invention is to enhance the rigidity and ruggedness of a photoconductor tube structure.

Briefly, these objects are fulfilled in one aspect of the invention by the provision of a photoconductor tube construction having a metal supporting structure and a light-frequency responsive element attached thereto. Further, a light-frequency transparent envelope is sealed to the metal supporting structure forming an enclosure therebetween wherein the light-frequency responsive element is contained. In the photoconductor tube manufacturing process, the envelope and a supporting structure having an affixed response element are dehydrated in a dry and inert atmosphere. Subsequently, the envelope and support structure are contacted and a seal is made therebetween. Thus, the light-frequency responsive element is enclosed and hermetically sealed in a dry and inert atmosphere.

For a better understanding of the present invention, together with other and further objects, advantages, and capabilities thereof, reference is made to the following disclosure and appended claims in conjunction with the attached drawings in which:

FIG. 1 is an elevated view of a photoconductor tube; and

FIG. 2 is a block diagram illustrating the process for making the photoconductor tube.

Referring to FIG. 1 of the drawings, there is illustrated a photoconductor tube having a cup-shaped support structure 3 with a flared skirt portion 4 at the open end thereof. The structure 3 is formed from metal or a metal alloy such as a nickel-chrome-iron alloy, which has a desired heat dissipating characteristic and an affinity to the formation of a hermetic seal. Further, the cup-shaped configuration acts as a "heat sink" wherein excess processing and operating heat is absorbed. Additionally, the flared skirt portion 4 provides a radiating surface whereby absorbed heat is removed from the structure 3.

Affixed to and supported by the support structure 3 is a light-frequency response element 5. The response element 5 may be any of the numerous light-frequency response materials and is affixed to support structure 3 by a hold down connector 7 and a conductor 11. The hold down connector 7 electrically and mechanically interconnects the response element 5 and the support structure 3. Further, the conductor 11 is formed to provide electrical and mechanical attachment to response element 5 and is insulatingly but mechanically attached to support structure 3 by means of a glass bead 13 imbedded therein. Additionally, the conductor 11 extends from support structure 3 for electrical connection to an external supply. Moreover, a conductor 9 is formed to extend from and is attached to the support structure 3 to provide electrical connection from the response element 5 through the holddown connector 7 and support structure 3 to an external supply.

A light-frequency transparent envelope 17 which may be of ceramic, plastic, and numerous other materials but preferably of glass, is hermetically sealed to the support structure 3 at the jointure position 19. Thus, the envelope 17 and support structure 5 form a sealed enclosure 21 wherein is contained the light-frequency response element 5.

In the process of making photoconductor devices, as illustrated in FIG. 2, the envelopes and supporting structures with the light-frequency response elements affixed thereto, are fired in a dry and inert atmosphere. The firing time as well as the atmosphere temperature is adjusted to cause the complete deyhdration of the envelopes and the combined supporting structures and response elements.

As is well known, the dehydrating temperature of the envelopes usually differs from the dehydrating temperature of the supporting structures and affixed response elements. Thus, separate atmosphere temperatures or alternately separate furnaces are preferable for the firing or dehydration process.

Following, an envelope is placed in contact with a supporting structure without exposing either element to other than a dry and inert atmosphere. Further, the area of contact between the envelope and support structure provides a jointure adapted to the formation of a seal therebetween. Additionally, the envelope may be, if desired, but not necessarily need be placed in contact with the response element to provide a heat conductive path for the removal of heat therefrom. Moreover, when the envelope and response element are touching, the volume of atmosphere entrapped intermediate the envelope and supporting structure is reduced.

Subsequently, sufficient heat is directed on the jointure or contacting envelope and support structure area to cause a seal therebetween, whereupon the response element is hermetically enclosed in a dry and inert atmosphere. The heat, sufficient to provide a seal, may be supplied in any of a number of ways, and one preferred method is to use RF heat radiated from an appropriately positioned RF coil. Further, during the actual process of seal formation, a blast of dry and inert atmoshpere may be directed into and striking the closed end of the cup-shaped support structure to provide additional cooling for the response element affixed thereto. After sealing the device is removed from the furnace in completed condition.

As a specific illustration of the process, a cadmium-sulfide wafer was affixed to a nickel-chrome-iron alloy supporting structure. This particular alloy consists essentially of 42 percent nickel, 4–8 percent chrome, and the balance substantially iron. The supporting structure and response element were placed in a furnace having a dry nitrogen atmoshpere flowing therethrough which was maintained at a temperature in the range of 125° C. to 225° C. and preferably at about 175° C. wherein the support structure and response element remained until completely dehydrated.

At substantially the same time a lead glass envelope, designated as 0120 Glass by the Corning Glass Works of Corning, New York, was placed in a furnace having about the same dry nitrogen atmosphere flowing therethrough. This atmosphere was maintained at a temperature in the range of 350° C. to 450° C. and preferably about 400° C. until the envelope was completely dehydrated.

Upon dehydration of the glass envelope, the metal supporting structure, and the affixed response element, the envelope was transferred through an interconnecting tube containing a dry nitrogen atmosphere and brought into contact with the supporting structure. Further, the contacting surfaces formed a jointure for the sealing thereof and the response element was enclosed between the envelope and the supporting structure.

Following, the jointure was encircled by an RF coil and radiated RF heat was applied thereto. At the same time pressure was exerted on the envelope to provide an intimate relationship at the envelope-supporting structure jointure thereby enhancing the sealing process. Further, the envelope was forced into contact with the response element to provide a path for the conduction of heat therefrom. Moreover, the volume of atmosphere entrapped intermediate the envelope and support structure was reduced.

Upon completion of the seal, the RF heat was discontinued, the pressure exerted on the envelope withdrawn, and the cooling blast interrupted. Thereupon, the encircling RF coil was removed from around the jointure and the completed device discharged from the furnace.

Thus, there has been provided a structure and a manufacturing process which is unique and possesses a host of advantages over prior structures and processes. The improved metal supporting structure acts as a "heat sink" for the conductions of heat from the response element not only during manufacture but during operational use as well. Further, the need for critical control of temperature during the sealing process and during application of

the device is substantially reduced. Moreover, the heat conductive path provided by contact between the envelope and response element as well as the cooling blast of dry and inert atmosphere permit the use of an increased amount of heat for the sealing process. Additionally, the use of RF heat enhances the sealing process and reduces the period required for seal formation. Furthermore, the provision of a photoconductive device sealed in a dry and inert atmosphere without first requiring evacuation permits the use of inexpensive manufacturing equipment and is adapted to automated techniques.

While there has been shown and described what is at present considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention as defined by the appended claims.

What is claimed is:

1. A process adapted to the manufacture of photoconductive devices comprising:
   - firing an envelope and a supporting structure in a dry and inert atmosphere at a temperature and for a period sufficient to cause dehydration thereof, said envelope having at least a light-frequency transparent portion and said supporting structure having a light-frequency responsive element thereon;
   - contacting said envelope and supporting structure at a jointure position to provide enclosure therebetween of said responsive element and alignment thereof with said transparent portion, said contact being provided without the removal of said envelope and supporting structure from a dry and inert atmosphere;
   - forcing said envelope against said responsive element to provide a heat conduction path therefrom and a reduction of volume intermediate said envelope and said supporting structure;
   - heating said contacting envelope and supporting structure at said jointure position to cause the sealing thereof; and
   - discharging said envelope and support structure with the light-frequency responsive portion sealed therebetween from said dry and inert atmosphere.

2. A process adapted to the manufacture of photoconductive devices comprising:
   - firing an envelope and a cup-shaped supporting structure in a dry and inert atmosphere at a temperature and for a period sufficient to cause dehydration thereof, said envelope having at least a light-frequency transparent portion and said cup-shaped supporting structure having a light-frequency responsive element thereon;
   - contacting said envelope and cup-shaped supporting structure at a jointure position to provide enclosure therebetween of said responsive element and alignment thereof with said transparent portion, said contact being provided without the removal of said envelope and cup-shaped supporting structure from a dry and inert atmosphere;
   - forcing said envelope against said responsive element to provide a heat conduction path therefrom and a reduction of volume intermediate said envelope and said cup-shaped supporting structure;
   - heating said contacting envelope and cup-shaped supporting structure at said jointure position to cause the sealing thereof; and
   - cooling said responsive element during the sealing of said envelope and cup-shaped supporting structure by directing a blast of dry and inert atmosphere into said cup-shaped supporting structure in the vicinity of said responsive element; and
   - discharging said envelope and cup-shaped support structure with the light-frequency responsive portion sealed therebetween from said dry and inert atmosphere.

3. A process adapted to the manufacture of photoconductive devices comprising:

firing an envelope and a cup-shaped metal supporting structure in a dry and inert atmosphere at a temperature and for a period sufficient to cause dehydration thereof, said envelope having at least a light-frequency transparent portion and said cup-shaped metal supporting structure having a light-frequency responsive element thereon;

contacting said envelope and cup-shaped metal supporting structure to provide enclosure therebetween of said responsive element and alignment thereof with said transparent portion, said contact being provided without the removal of said envelope and cup-shaped metal supporting structure from a dry and inert atmosphere;

forcing said envelope against said responsive element to provide a heat conduction path therefrom and a reduction of volume intermediate said envelope and said cup-shaped metal supporting structure;

heating said envelope and cup-shaped metal supporting structure in the area of contact therebetween to cause the sealing thereof, said heating provided by

the application of RF energy to said area of contact;

cooling said responsive element during the sealing of said envelope and cup-shaped metal supporting structure by directing a blast of dry and inert atmosphere into said cup-shaped metal supporting structure in the vicinity of said responsive element; and

discharging said envelope and cup-shaped metal supporting structure with the light-frequency responsive portion sealed therebetween from said dry and inert atmosphere.

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