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[54] **CHANNEL MULTIPLIER ASSEMBLY AND METHOD OF MANUFACTURE THEREOF**

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[52] **U.S. Cl.** ....**315/12,** 313/105, 250/213 BT
[51] **Int. Cl.** **N01j 29/41**
[58] **Field of Search** 331/95, 65

[56] **References Cited**

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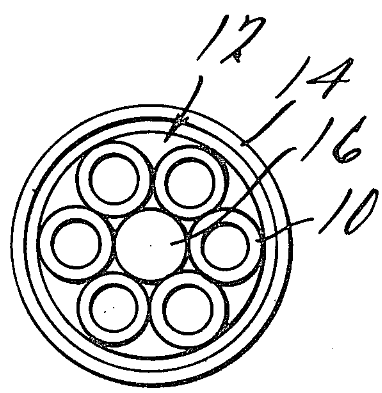
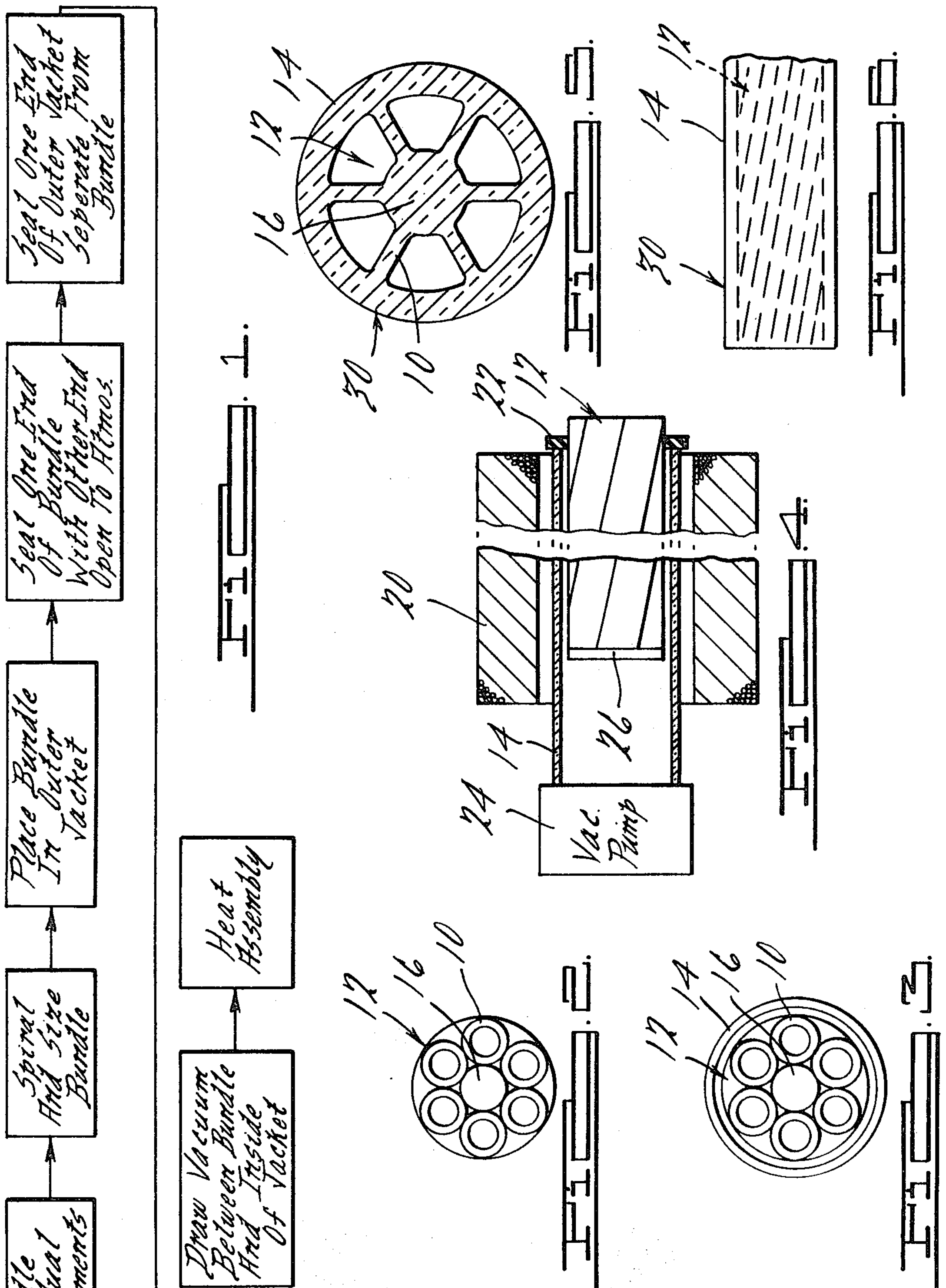
[57] **ABSTRACT**

A bundle of individual channel multipliers stacked to form a multiplier array, the individual channels being fabricated of a lower temperature softening glass and the bundle being inserted into a higher temperature softening glass tube, the walls of the individual channels being expanded to fill the interstices within the higher softening temperature tube.

2 Claims, 6 Drawing Figures





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CHANNEL MULTIPLIER ASSEMBLY AND METHOD OF MANUFACTURE THEREOF

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates generally to a channel multiplier array and a method of producing the array, and more particularly to a method of expanding the individual channels within an outer glass jacket to fill the interstices between the individual channels and between the channels and the outer tube and the resulting apparatus.

Early uses of electron multipliers involved the provision of a plurality of individual glass channels formed of straight-through tubes, the individual channels being stacked in a bundle to form an array. This array was utilized, for example, to multiply the number of electrons introduced at the input end of the channel multiplier array by means of secondary emission of electrons from the interior surface of the channels. Thus, an electron introduced into one end of the channel multiplier will successively strike the interior wall of the individual channels, knocking off secondary electrons to increase the number of output electrons relative to the number of input electrons.

However, it has been found that spurious outputs are produced by ion, in the case of an electron multiplier array, or photon feedback, these phenomena involving the feedback of ions or photons from the output end of the channel multiplier array to the area of the input end, the ion feedback producing a direct secondary multiplication effect and the photons causing the release of electrons from a photocathode surface. This feedback effect has been eliminated by several methods, one of which is described in copending application of Messrs. William Balas and Bagdasar Deradoorian, Ser. No. 772,527 filed Nov. 1, 1968 for Spiraled Channel Multiplier Assembly and Method of Assembly. In accordance with the disclosure of the aforementioned copending application, a plurality of individual channels are formed into a bundle and fed through a heating oven for drawing the channels to a particular size. During the drawing process, the bundle is given a twist by rotating either the feed or the pull apparatus under controlled conditions to impart a predetermined spiral to the bundle. Thus, the array is simultaneously sized and spiraled by means of a single machine.

However, in providing a bundle of channel multiplier elements in the form of an array, it has been found that the open area ratio or the ratio of the useful area to the total area available in the array may be substantially increased by the expansion of the walls of the elements within the confines of an outer tube. In accordance with the present invention, the bundle of individual channels may be formed as described in the copending application and the resultant spiraled array may be placed inside an outer glass tube, the tube being formed of a high temperature softening material relative to the material of the individual channels. Thus, when the assembly is heated, the outer jacket glass will soften at a temperature which is higher than the softening temperature of the individual channel multiplier elements.

In accordance with a preferred form of the present invention, a channel multiplier array is sealed at one end thereof and the other end remains open to the atmosphere. The interstitial space and the space between the array and the outer jacket is sealed at one end and the vacuum is drawn at the other end thereof. The entire assembly is then heated and the difference in pressure between atmosphere and the vacuum being drawn causes the walls of the channel multiplier bundle to move outwardly thus decreasing the wall thickness, filling the interstitial spaces and generally increasing the useful or open area of the array relative to the total area. In this way the collection efficiency of each individual channel multiplier element and the resultant array is greatly increased.

By use of the present invention, a spiraled channel multiplier array may be made cylindrical by fabricating a spiral array, inserting the array within a circular outer jacket and expanding the array to fill the interstitial spaces within the jacket. With a round exterior periphery, a plurality of the channel multiplier arrays may be bundled together to form an array assembly which is relatively compact, has a relatively high open area ratio and an increased efficiency.

Accordingly, it is one object of the present invention to provide an improved channel multiplier array.

It is another object of the present invention to provide an improved channel multiplier array wherein the individual channels are spiraled to eliminate feedback effects.

It is further object of the present invention to provide an improved channel multiplier array assembly, the assembly being made up of a plurality of channel multiplier arrays.

It is still a further object of the present invention to increase the open area ratio or ratio of open area to total area in a channel multiplier array or a channel multiplier array assembly.

It is still another object of the present invention to improve channel multiplier arrays by decreasing the wall thickness of the individual channel while maintaining the total mechanical strength of the array.

It is still a further object of the present invention to provide an improved method of filling the interstitial spaces in a channel multiplier array.

Further objects, features and advantages of this invention will become apparent from a consideration of the following description, the appended claims and the accompanying drawing in which:

FIG. 1 is a schematic diagram illustrating a preferred method of forming a channel multiplier array in accordance with the present invention;

FIG. 2 is an end elevation illustrating a bundle of individual channel multipliers;

FIG. 3 is an end elevation illustrating the bundle of channel multipliers after it has been placed inside the high temperature softening glass tube;

FIG. 4 is a diagram schematically illustrating an apparatus for practicing the method of the present invention;

FIG. 5 is a sectional view illustrating the resultant channel multiplier array in cross section; and

FIG. 6 is an elevation view illustrating the side of the channel multiplier array of FIG. 5.

Referring now to the drawings, there is illustrated a preferred method of forming a multiplier array incorporating the features of the present invention. Particularly, a plurality of individual channel elements **10**, which may number from two to several depending on the diameter of elements and the total diameter, are formed in a bundle **12** so that each individual channel element **10** is positioned within the bundle in the same relative position with respect to all of the other elements within the bundle at each point along the linear length of the channel elements. The bundle of channel elements is placed in an apparatus such as that described in conjunction with the above referenced copending application.

In accordance with the aforementioned application, the bundles are placed in a sizing and spiraling assembly whereby the bundle is inserted into and extends through an oven to heat the bundle and draw the elements to size. The feed portion or the pull portion of the apparatus, as described in the aforementioned application, may be twisted to form a spiral in the bundle and eliminate ion or photon feedback from the multiplier assembly after it has been placed into use. After the bundle **12** has been formed and sized, it is placed in an outer jacket **14** of glass or other material as is illustrated in FIG. **3** of the drawings. It is to be noted that in FIGS. **2** and **3** a core **16** or cane has been placed in the interior portion of the individual bundles and the individual elements may be spiraled about the cane **16** in a manner known in the art. However, if the method of the copending application is utilized, the cane or support element may be eliminated, thus increasing the efficiency of the array.

The outer jacket **14** is formed of a higher temperature softening glass than the glass from which the elements **10** have been fabricated to permit the entire assembly to be heated to a temperature above that at which the bundle **12** will soften but below that at which the outer jacket **14** will soften.

The entire assembly, including bundle **12** and outer jacket **14** is placed in a heater **20** (FIG. **4**) which may take the form of an electrical coil to heat the channel element assembly. However, prior to positioning the bundle in the heater **20**, one end of the outer jacket **14** is sealed by some suitable method, for example by placing the ring **22** of temperature resistant material at one end thereof and surrounding the bundle **12**. The ring **22** is to the outer jacket **14** and to the inner bundle **12**, care being taken to preclude the sealing of the right end of bundle **12**. The opposite end of the tube **14** is interconnected with a vacuum pump which is capable of evacuating the space between the bundle **12** and shell **14**.

Further, the end of bundle **12** which is positioned between the seal **22** and the vacuum pump **24** is also sealed to preclude the evacuation of the volume within the inside diameter of the individual elements of the bundle **12**. The other end of the bundle **12**, the right end in the assembly illustrated, is left open to the atmosphere.

Upon completion of the assembly illustrated in FIG. **4**, the vacuum pump is actuated to evacuate the volume described above and the heater assembly **20** is energized to soften the bundle **12**. When the temperature reaches the softening point of the bundle **12**, the pressure differential across the wall of the individual channel elements within bundle **12** will cause the elements to expand and fill the interstitial spaces between the elements of the bundle **12** and between the bundle **12** and the exterior jacket **14**. The resultant channel multiplier array is illustrated in FIGS. **5** and **6**.

As is seen from FIG. **5**, the walls of the individual element have expanded outwardly to combine and fuse with the outer jacket **14** and form an integral mass therewith. Similarly, the interior walls have expanded to meet the interior walls of other elements and also have expanded to meet the cane element **16**, in the situation where a cane is utilized, the spaces therebetween are completely filled. In this way a channel multiplier array has been formed which has a high ratio of a useful area to total area at a cross section thereof, thus increasing the efficiency of the channel multiplier array. Also, the exterior surface of the array is cylindrical to facilitate assembling several arrays and increasing the overall efficiency of the final assembly.

While it will be apparent that the embodiments of the invention herein disclosed are will calculated to fulfill the objects of the invention, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. A channel multiplier array comprising a central core of a plurality of integrally formed individual channels fused together and having an interior electron emitting surface and fabricated of a first temperature softening material and an outer jacket surrounding said central core and fused thereto, fabricated of a second higher temperature softening material.

2. The improvement of claim **1** wherein said central core further includes a centrally disposed core fused to said plurality of fused individual channels.

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