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SEARCH ROOM

SUBSTITUTE FOR MISSING XR

March 22, 1966 G. A. GRANITSAS ET AL 3,241,934

METHOD FOR MAKING ELECTRON IMAGE TRANSFER DEVICE

Filed March 20, 1961 2 Sheets-Sheet 1

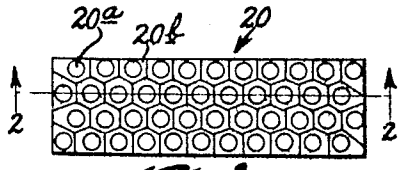


Fig. 1

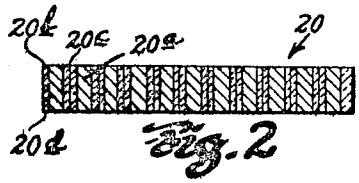


Fig. 2

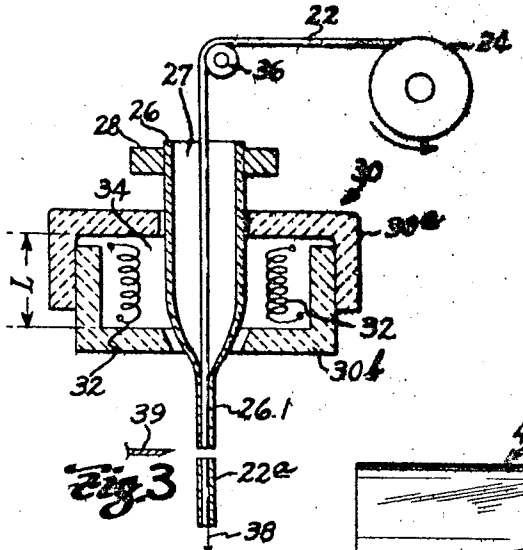


Fig. 3

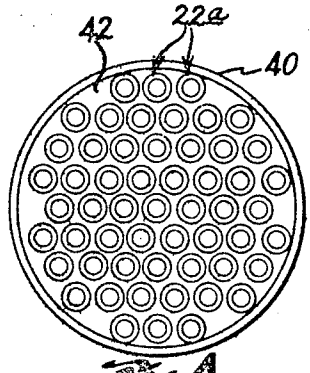


Fig. 4

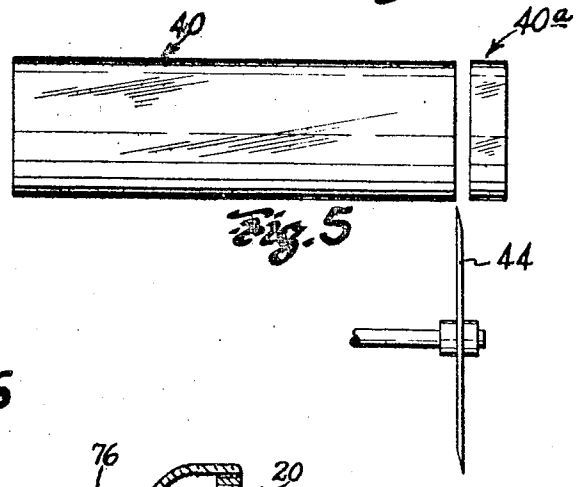


Fig. 5

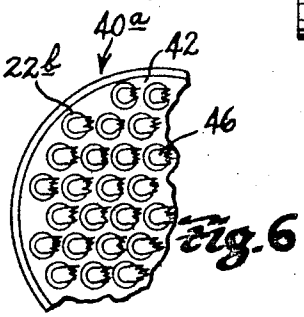


Fig. 6

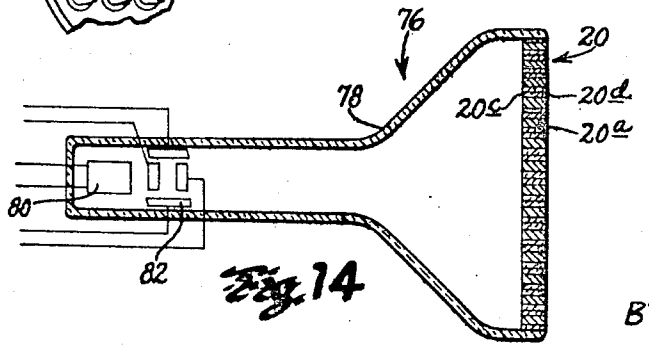


Fig. 14

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METHOD FOR MAKING ELECTRON IMAGE TRANSFER DEVICE

Filed March 20, 1961 2 Sheets-Sheet 2

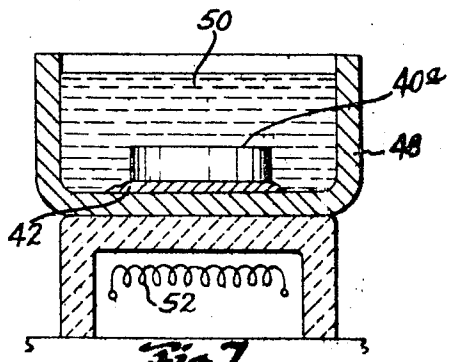


Fig. 7

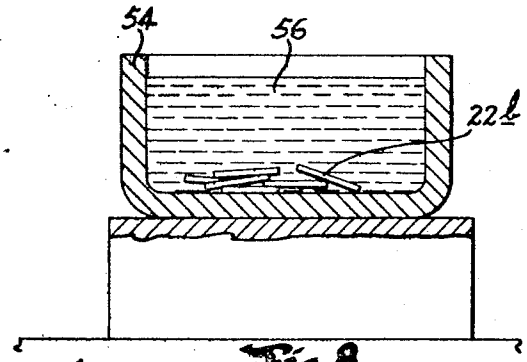


Fig. 8

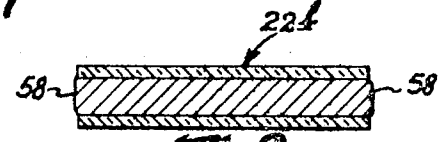


Fig. 9

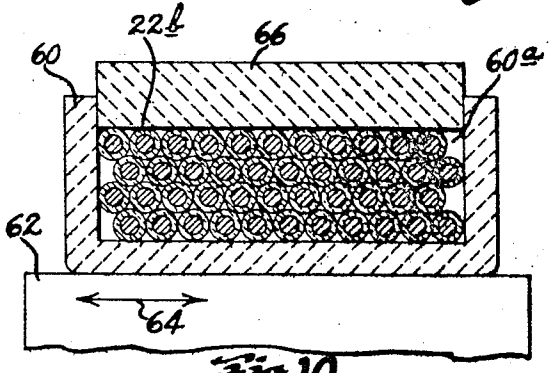


Fig. 10

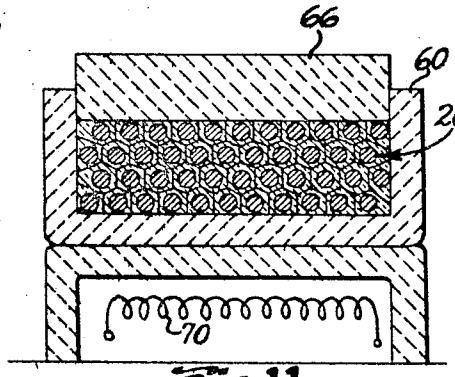


Fig. 11

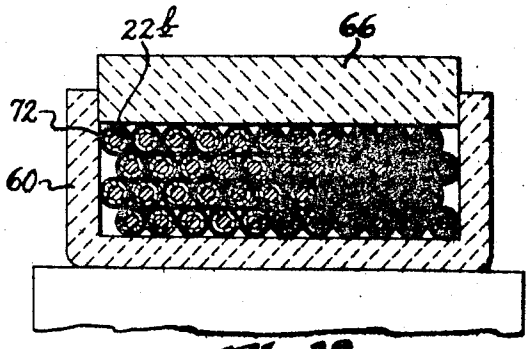


Fig. 12

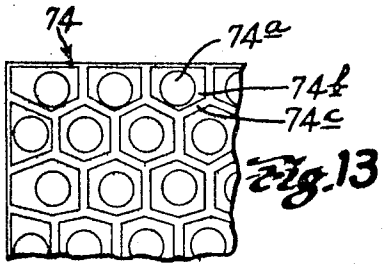


Fig. 13

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METHOD FOR MAKING ELECTRON IMAGE TRANSFER DEVICE

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3 Claims. (Cl. 65—3)

The field of this invention is that of electron image transfer devices, and the invention relates, more particularly, to a novel and improved electron image transfer device comprising a multiplicity of metallic conductive members which are arranged in spaced, side-by-side relation extending through a dielectric matrix and to novel and improved methods for manufacturing such a device.

The electron image transfer device with which this invention is concerned can be utilized, for example, as the faceplate of a cathode-ray tube. In such an application, the image transfer device can be positioned at one end of a cathode ray tube in sealing relation to the tube envelope so that correponding, spaced ends of the device conductors present a mosaic pattern upon which an electron charge image or trace can be described by an electron gun within the tube. The device conductors which extend through the faceplate can each receive an electron charge as the charge image is described upon the device and can then transmit respective electron charges to the outer side of the faceplate for reproducing said charge image in mosaic form exteriorly of the tube. The electron charge image reproduced on the outer side of the tube faceplate can then be recorded in a xerographic printing process for example. An image transfer device of this character must incorporate a very large number of relatively small diameter conductive members which are accurately spaced and insulated from each other in order to provide adequate resolution in an electron charge image transmitted by the device. Further, the device must have sufficient strength so that a relatively thin device can serve as a cathode ray tube faceplate, and individual conductive members must be securely mounted within the device to adapt the device for sealing a tube.

It is an object of this invention to provide novel and improved electron image transfer devices and novel and improved methods for manufacturing such devices. It is another object of this invention to provide an electron image transfer device having a multiplicity of metallic conductive members arranged in accurately spaced side-by-side relation extending through a dielectric matrix and to provide novel and improved methods for manufacturing such a device.

It is a further object of this invention to provide an electron image transfer device having a multiplicity of metallic conductive members accurately arranged and securely mounted in spaced side-by-side relation within a suitably strong glass matrix, and to provide novel and improved methods for manufacturing such a device. In another aspect, an object of this invention is to provide an electron image transfer device having a multiplicity of metallic conductive members arranged in accurately spaced side-by-side parallel relation within a glass matrix and having ground means disposed between said members for preventing charge transfer between said members, and to provide novel and improved methods for manufacturing such a device.

It is also an object of this invention to provide fiber-like metallic conductive members having dielectric coatings which are adapted to be assembled in side-by-side bundled relation for forming an electron image transfer device of the character above described. An additional object of this invention is to provide such fiber-like members having an oxidized layer on the member surface adhering the members to said coatings in airtight relation and to provide novel and improved methods for manufacturing such members. A further object of this invention is to provide such coated members having coatings which are stressed in compression for additional strength and to provide novel methods for making such members. Another object of this invention is to provide such coated members which are adapted to be assembled in said side-by-side bundled relation with the coatings thereof fused together in airtight relation for forming an electron image transfer device in which said fiber-like conductive members are arranged in accurately spaced relation to each other.

Other objects and advantages of the image transfer devices and methods for manufacturing such devices as provided by this invention will appear in the following detailed description of preferred embodiments of the methods and devices, the description referring to the drawings in which:

FIG. 1 is a plan view of the device provided by this invention;

FIG. 2 is a section view along line 2—2 of FIG. 1;

FIG. 3 is a diagrammatic side elevation view showing the manufacture of fiber-like, metallic, conductive members having dielectric coatings according to this invention;

FIG. 4 is an end elevation view of a bundle of said conductive members illustrating a step in processing of said members;

FIG. 5 is a side elevation view of said bundle of conductive members illustrating a further step in processing of said members;

FIG. 6 is a partial end elevation view of a group of fiber-like conductive members after processing as shown in FIGS. 4 and 5;

FIG. 7 is a diagrammatic section view illustrating a further step in processing of said fiber-like conductive members;

FIG. 8 is a diagrammatic section view illustrating a subsequent step in processing of said fiber-like conductive members;

FIG. 9 is a section view along the axis of a fiber-like conductive member processed as shown in FIG. 8;

FIG. 10 is a diagrammatic end elevation view illustrating a step in assembly of said fiber-like conductive members for making the electron image transfer device of this invention;

FIG. 11 is a diagrammatic end elevation view similar to FIG. 10 illustrating a final step in the process of this invention;

FIG. 12 is a diagrammatic side elevation view similar to FIG. 10 illustrating an alternative process of this invention;

FIG. 13 is an enlarged, partial side elevation view similar to FIG. 12 illustrating the device of this invention which has been manufactured in accordance with the process shown in FIG. 12; and

FIG. 14 is a side elevation view illustrating use of the electron image transfer device of this invention in a cathode-ray tube faceplate.

Referring to the drawings, **20** in FIGS. 1 and 2 indicates an electron-image transfer device as provided by this invention, the device embodying metallic, electrically-conductive members **20*a*** which are arranged in spaced, side-by-side, preferably parallel relation extending through a dielectric matrix **20*b***. For convenience of illustration, only a small number of the conductive members **20*a*** have been shown but it will be understood that a multiplicity of relatively small diameter conductive members would preferably be incorporated in the device **20** according to this invention. The metallic conductive members **20*a***, which are insulated from each other by

the matrix material **20***b*, form mosaic patterns at corresponding ends and thereby define respective electron-image-receiving faces **20***c* and **20***d*.

In manufacturing an image transfer device of this character according to the methods of this invention, a metallic, conductive wire or filament **22**, preferably of a material such as stainless steel which is adapted to be oxidized when heated, can be provided on a rotatably mounted reel **24** as shown in FIG. 3. A round filament is illustrated herein but a filament of any other cross-sectional configuration can be used within the scope of this invention. Preferably the filament is of a relatively small diameter or transverse dimension between 0.001 and 0.010 inch. A tube **26** of suitable dielectric material which is adapted to be drawn and to be fused to the filament **22**, preferably a glass tube, is then mounted in a conventional tube-feeding mechanism **28** to be fed axially through a glass-drawing furnace **30** such as is diagrammatically indicated in FIG. 3. As shown, the glass furnace can include electrical heating coils **32** or any other suitable heat source for heating the tube **26** to the drawing temperature of the tube material at least at one end **26.1** of the tube as the tube is fed through the refractory chamber **34** of the furnace. Preferably the refractory chamber of the furnace has a selected length L, or the furnace is formed in two adjustable sections **30***a* and **30***b* as shown to permit varying of the length L of the refractory chamber for a purpose which will be explained below.

The wire or filament **22** can be passed over suitable guide means such as the guide roll **36**, if desired, and can be drawn through the tube **26** in the direction of the arrow **38**. The leading end **26.1** of the tube which has been heated to drawing temperature is then collapsed into engagement with the filament **22** so that drawing of the filament in the direction indicated is adapted to draw material from the tube **26** against the surface of the filament for forming a coating thereon in conventional manner.

In this regard, it should be noted that a metallic member such as the filament **22** will form a highly adherent, airtight seal to a glass coating formed on the member only where the surface of the member has been oxidized to a certain controlled extent prior to coating. That is, a certain degree of oxidation of the filament **22** prior to coating of the filament is desirable for adhering the coating to the filament but excessive oxidation of the filament surface will seriously impair the quality of the bond which can be formed between the filament and coating. Where heating of the tube **26** to permit drawing of the tube is conducted in the manner above described, the filament **22** will also be heated as it moves through the tube so that, where an air or other oxidizing atmosphere exists within the tube **26** as at **27**, the surface of the filament **22** will tend to oxidize. It is an important part of this invention to regulate oxidation of the filament **22** as it is drawn within the tube **26** so that the filament is adapted to form a highly adherent, airtight seal to the glass coating subsequently formed thereon.

It will be understood that the volume of air within the tube **26**, the length of the tube through which the filament must be drawn, and the drawing temperature to which the tube is heated will be important factors in determining the extent to which the filament **22** is oxidized in the above described coating process. That is, a greater volume of air in the tube **26**, a greater length of tube **26** in which the filament will be exposed to heated air, and a greater tube drawing temperature are each adapted to result in a greater degree of oxidation of the filament **22** as the filament is drawn through the tube. Equally important factors in determining the extent of oxidation of the filament will be the speed at which the filament **22** is drawn through the tube **26** and the length of the refractory chamber **34** in which the tube **26** is heated. That is, if the filament drawing speed is reduced and the length

of the refractory chamber **34** is increased, greater oxidation of the filament can occur as the filament is heated within the tube **26**. In regard to these latter factors, it will be understood that that drawing speed of the filament **22** will normally be regulated relative to the volume of dielectric material embodied in the tube **26** and to the speed at which the tube is advanced into the furnace **30** for determining the thickness of the coating of the tube material which will be formed on the filament in well known manner. However, the physical size and rate of advance of the tube **26** can be conveniently selected to require a particular drawing speed for the filament **22**, thereby to determine the extent to which the filament is oxidized in passing through the tube **26**. The length L of the refractory chamber **34** can also be selected, or can be adjusted as indicated in FIG. 3, to assist in controlling the oxidation of the filament **22** so that the filament is adapted to form an airtight seal to a glass coating formed on the filament.

For example, the filament **22** can comprise the stainless steel material which is commercially identified as No. 430 stainless steel and can be 0.003 inch in diameter. The tube **26** can be of 0.060 inch inside diameter and 0.085 inch wall thickness and can be approximately four feet in length, the tube embodying a soda-lime glass having a preferred drawing temperature of 1300° F. Preferably the glass material of the tube **26** has a coefficient of thermal expansion which is slightly smaller than that of the material embodied in the filament **22**. Where the tube **26** is advanced into the furnace **30** having a refractory chamber length L of seven inches at a rate of 1.2 inches per minute and where the filament **22** is drawn through the tube at a rate of 35 feet per minute for forming a glass coating of 0.005 inch thickness on the filament, the filament will be oxidized to a sufficient extent for forming a highly-adherent airtight seal to said coating. Due to the difference in coefficients of thermal expansion of the tube and filament materials, the glass coating formed on the filament will be stressed in compression as the coated filament cools, thereby to provide a strong hard coating on the filament.

When the filament **22** has been oxidized and coated with the dielectric material of the tube **26**, the coated filament is permitted to cool and is then cut by a conventional means **39** into easily handled lengths **22***a*. For example, the coated filament can be cut into lengths of a few feet. The coated filament lengths **22***a* can then be disposed in side-by-side bundled relation within a glass tube **40** as shown in FIG. 4, and can be potted therein with a low melting metallic alloy or other suitably strong, low-melting material **42** such as Babbitt metal, lead solder, or the low-melting alloys sold under the trademarks Cerro-Bend and Cerro-Soft by Cerro de Pasco Company of Camden, New Jersey. The tube **40** and the coated filament lengths **22***a* potted therein can then be cut transversely of the longitudinal axes of the lengths by a diamond-tipped cutting wheel **44** or other conventional means as shown in FIG. 5 to provide one or more thin discs **40***a* which each embody very short lengths **22***b* of the coated filament therein. As the filament lengths are supported during this cutting by the low-melting alloy **42** surrounding the lengths, the dielectric coatings on the filament lengths can be cleanly cut without tending to crack or shatter as will be understood. However, as shown in FIG. 6, the ends of the metallic filament **22** embodied in the filament lengths **22***b* will tend to be wiped in the direction in which the filament lengths are cut to form elongated burrs **46** and the like thereon.

The discs **40***a* can then be heated for melting the alloy or other surround **42** and for separating the very short filament lengths **22***b* embodied in the discs. For example, where the alloy **42** comprises the low-melting alloy sold commercially under trademark Cerro-Bend, which alloy is adapted to melt at a temperature of approximately 140° F., a receptacle **48** filled with water **50** can be heated as

is diagrammatically indicated by the heating coil **52** in FIG. 7 and the discs **40***a* can be immersed therein for melting the alloy **42** and for separating the short filament length **22***b* therefrom.

The ends of the short filament lengths **22***b* which are separated from the discs **40***a* will have burrs **46** and the like at each end. Where such burrs extend radially outward beyond the periphery of the dielectric coatings on said lengths, the burrs will prevent stacking of the filament lengths in compact side-by-side relation in the manner contemplated by this invention. Thus, it is desirable to remove such burrs as the next step in the process of this invention. Accordingly, a receptacle **54** is filled with an acid or acid solution **56** as shown in FIG. 8 and the filament lengths **22***b* are disposed therein, the acid or solution being selected to react with the exposed ends of the metallic filament material embodied in the lengths **22***b* for etching said material without reacting with or etching the glass or other cladding formed on the filament lengths. For example, where the filament **22** is formed of No. 430 stainless steel as above described, the etchant **56** can comprise a combination of concentrated hydrochloric and nitric acid, preferably in ratio of 3 parts of hydrochloric acid to 1 part nitric acid, which is adapted to etch the ends of the metallic filament as shown at **58** in FIG. 9. Preferably the filament lengths **22***b* are permitted to remain in the solution **56** for a suitable period of time, approximately 10 minutes for the stainless steel filament lengths previously described, whereby the ends of the metallic filaments therein are sufficiently etched, as at **58**, so that burrs **46** on the filament ends no longer extend outside the periphery of the coatings of the filament lengths. That is, the burrs **46** are preferably etched from the ends of the filament lengths **22***b* to a sufficient extent so that the filament length can be conveniently stacked in parallel relation. Filament lengths **22***b* having etched ends are then assembled in compact, side-by-side, preferably parallel, bundled relation so that corresponding ends of the lengths cooperate to define image-receiving faces. For example, as shown in FIG. 10, a channel-shaped member **60** of a suitable refractory material such as is disclosed in U.S. Patent No. 2,440,187 or 2,764,491 is mounted upon the work table of a coping-saw-type vibrator **62** or the like and the filament lengths **22***b* are arranged therein in side-by-side relation extending through the member channel **60***a*. Then the vibrator is actuated for vibrating the refractory member **60** in the direction indicated by the arrow **64** for compacting the coated filament lengths therein. A cover member **66**, which is also of said refractory material and which is adapted to move within the channel of the member **60**, is then placed over the bundle of filament lengths for compressing the lengths transversely of their longitudinal axes and for holding them in position within the member **60**. The bundle of filament lengths **22***b* as compressed in said refractory members can then be placed in a conventional glass furnace as diagrammatically indicated by the heating coil **70** in FIG. 11 and can be heated to the fusing temperature of the coating material formed on the lengths **22***b* so that said coatings are fused together into airtight relation in well known manner for forming the image-transfer device **20** as shown in FIGS. 1 and 11. It should be understood that the assembly of the filament lengths **22***b* and the fusing thereof can be accomplished in any conventional manner within the scope of this invention. It will be noted that the ends of the conductive member **20***a* terminating in the device faces **20***c* and **20***d* are etched and therefore may be slightly recessed from the planes of said faces. The faces **20***c* and **20***d* can be polished, abraded or otherwise treated in conventional manner for reducing recessing of the conductor ends if desired. Such abrading or polishing is also effective to remove all trace of the burrs **46** which may remain in the ends of the filament lengths embodied in the device **20**, thereby assuring that burrs on adjacent filament lengths **22***b* do not touch or tend to short out each other.

As will be understood, the portions of the metallic filament **22** embodied in the filament lengths **22***b* will form the conductive members **20***a* of the device **20** and the dielectric coating of the filament lengths **22***b* will form the matrix **20***b* of the device **20**.

After fusing of the filament lengths **22***b* in the manner desceribed, the device **20** can be removed from the refractory members **60** and **66** in well-known manner. In this regard, it should be noted that the refractory material suggested for use in members **60** and **66** should not tend to stick to an excessive degree to heat-softened glass which may form the coatings of the filament lengths fused therein. However, if desired, the refractory members can be coated with gold foil or the like or can be adapted to avoid re-entrant surfaces in contact with the elements to be fused therein in well-known manner for facilitating removal of the device **20** therefrom.

In an alternative embodiment of this invention, the process of this invention can be carried out as far as the step illustrated in FIGS. 8 and 9 in the manner previously described. That is, coated filament lengths **22***b* can be formed and can be etched for removing burrs **46** and the like. The etched filament lengths **22***b* provided by such process steps can then be coated with a metallic conductive material **72** as shown in FIG. 12. The coating of the filament lengths **22***b* can be achieved by painting or spraying or in any other conventional manner, only a relatively thin conductive coating of a few microns thickness being required on the lengths for the purpose of this invention. Preferably the conductive outer coatings formed on the filament lengths are comprised of a material having a fusing temperature which is close to that of the dielectric coating material provided on the lengths. For example, where the filament lengths **22***b* embody glass dielectric coatings having a fusing temperature on the order of 1250° F., the outer conductive coating can be formed therein with a brazing material such as silver solder having a flow point of approximately 1300° F.

The etched filament lengths **22***b* having a conductive outer coating **72** can then be assembled and compacted within refractory members **60** and **66** in the same manner as has been described with reference to FIG. 10. See FIG. 12. This assembly can then be heated to the fusing temperature of the conductive and dielectric coatings of the filament lengths in the manner described with reference to FIG. 11 for fusing the conductive coatings **72** of the lengths into airtight relation to form the image transfer device **74** as shown in FIG. 13. In this device, it can be seen that the portions of the filament **22** embodied in the lengths **22***b* will form conductors **74***a* which are disposed in spaced side-by-side parallel relation each surrounded by a dielectric material **74***b*, formed by the dielectric coating of the lengths **22***b*. In addition, the conductive outer coatings **72** on the filament lengths **22***b* embodied in the device **74** combine to form an integrated conductor **74***c* which surrounds and electrically isolates each of the device conductors **74***a*. The conductor **74***c* can serve as a ground terminal for the electron image transfer device **74** for preventing capacitive coupling and the like between adjacent conductors **74***a* therein when such conductors hold an electrical charge image as will be described.

The electron image transfer device **20**, for example, can be employed as a faceplate for a cathode ray tube **76** as shown in FIG. 14. The device **20** can be attached in sealing relation to the cathode tube envelope **78** in any conventional manner and can be adapted to present the device face **20***c* to receive an electron image or trace described by an electron gun **80** and deflecting means **82** in conventional manner. As will be understood, the conductors **20***a* of the faceplate are each adapted to receive a charge from the electron beam projected by the gun **80** and are adapted to transmit said charge through the individual conductors for reproducing the charge image

in mosaic form upon the face **20***d* of the faceplace exteriorly of the cathode-ray tube. Such a charge image formed on the face **20***d* can then be employed for recording the image, for example in a xerographic printing process, in well known manner.

Although particular embodiments of the device and method of device manufacture provided by this invention have been described for the purpose of illustration, it must be understood that this invention includes all modifications and equivalents thereof which fall within the scope of the appended claims.

Having described our invention, we claim:

1. A method for making an electron image transfer device comprising the steps of providing a metallic, conductive filament having a glass coating, cutting the coated filament into lengths, providing a glass tube of relatively large diameter, assembling said lengths of coated filament in side-by-side relation within the tube, potting these lengths of coated filament within the tube with a low melting metallic alloy, cutting the tube and coated filament lengths therein transversely of the axes of the lengths for providing selected equal lengths of said coated filament, melting said alloy for separating said selected length of coated filament, etching the ends of said selected lengths to remove at least the portions of the filament embodied therein which extend outside the periphery of the coating in said selected lengths, assembling said selected lengths in compact side-by-side parallel relation, heating said selected lengths to the fusing temperature of said coating material, and compressing said selected lengths for fusing said selected lengths together in outright relation to each other.

2. A method for making an electron image transfer device comprising the steps of providing a filament of metallic, conductive oxidizable material, providing a glass tube, inserting the filament into the tube, heating a selected portion of the tube to the drawing temperature of the tube material so that the filament is heated in the atmosphere within the tube to oxidize the outer surface of said filament, collapsing said tube into engagement with said filament at one end of said heated tube portion, moving said filament through said heated tube portion at a speed selected in accordance with the characteristics of said heated tube portion atmosphere so that said outer filament surface is continuously oxidized to a desired extent as it is moved through said atmosphere and so that said tube is elongated and drawn against said oxidized filament surface to form an adherent glass coating on said filament, cooling the coated filament, cutting the coated filament into selected lengths, etching the ends of said lengths to remove at least the portions of the filament embodied therein which extend outside the periphery of the coatings in said lengths, assembling said lengths in compact side-by-side parallel relation to form a bundle, and heating said lengths to the fusing temperature of said coating material for fusing said coated filament lengths together.

3. A method for making an electron image transfer device using metallic, conductive filament having glass coatings thereon, said method comprising the steps of providing a preformed filament of metallic conductive oxidizable material, providing a glass tube, inserting the filament into the tube, heating a selected portion of the tube to the drawing temperature of the tube material so that the filament is heated in the atmosphere within the tube to oxidize the outer surface of said filament, collapsing said tube into engagement with said filament at one end of said heated tube portion, drawing said preformed filament through said heated tube portion atmosphere at a selected speed so that said outer filament surface is continuously oxidized to a desired extent within said tube atmosphere and so that said tube is elongated and drawn against said oxidized filament surface to form an adherent glass coating on said filament cooling the coated filament, cutting the coated filament into selected lengths, assembling said lengths in compact side-by-side parallel relation to form a bundle, and heating said lengths to the fusing temperature of said coating material for fusing said coated filament lengths together.

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