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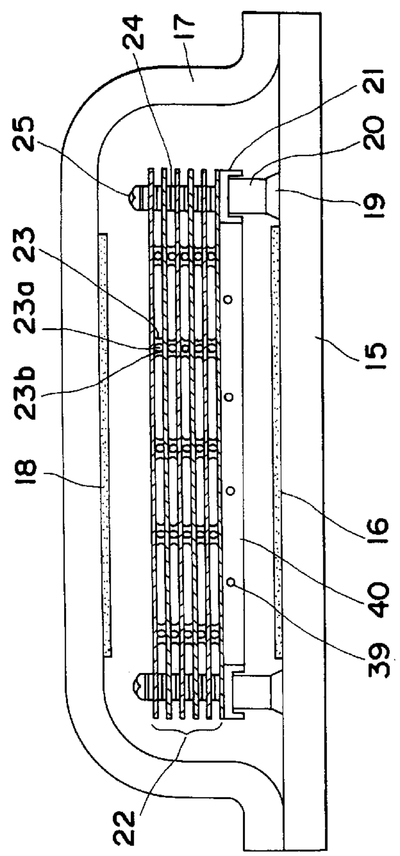
(54) Display device and method of production.

(57) An image display device includes an electron beam generating unit (39), an electrode unit (22) comprised of a plurality of laminate electrodes having a plurality of openings for deflecting and converging the electron beams, and an image forming unit (17,18) for forming an image by making the electron beams collide against a phosphor in a vacuum vessel (15,17). The laminate electrodes are laminated together at their intermediate portions by means of adhesion spacers (23) and peripherally fixed mechanically by means of insulating spacers (24) via a fixing base unit (21). Each adhesion spacer (23) is composed of a spacer core (23a) having a spacer function and an adhesion frit (23b) having an adhesion function. Preferably an oxide ceramic insulating thin film (27 in Fig.3) is formed on at least one surface of a metal base plate (26 in Fig.3) of the insulating spacer (24) by a spray coating method and a crystal frit thin film (34 in Fig.7) is formed on the other surface of the metal base plate (32 in Fig.7 or Fig.8(b)). The thickness dl of the adhesion spacer (23) and the initial thickness d2 of the insulating spacer (24) are in a relation of d1 ≦ d2 (look at Fig.8(a)) and, on heating, excess softened frit (34 in Fig.8(b)) is squeezed out to ensure that the thickness of d1 and d2 are equal.

Fig. 2



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The present invention relates to a display device for use in a color television receiver or the like display and a method of producing the same, and more in particular to a thin flat-shaped display device having a small size in depth employing a plurality of linear cathodes for generating electron beams in a cathode ray tube.

As a display device for a color television image display or the like, a cathode ray tube type one has been mainly used. However, any conventional cathode ray tube has a large size in depth in comparison with its screen size, which makes it difficult to obtain a thin flat-shaped display device. As a thin flat-shaped display device, an EL (electro-luminescence) display device, a plasma display device, a liquid crystal display device, and the like have been recently developed and some of them have been put on a market. However, any of the display devices is insufficient in regard of performance such as brightness, contrast and color reproducibility in comparison with the cathode ray tube type one, and has not been implemented as a satisfactory display device.

Generally, in a technique for implementing a flat-shaped display device of a cathode ray tube type having a small size in depth, a plurality of electron beams emitted from a plurality of linear cathodes are deflected in the vertical and horizontal directions by means of electrodes to be projected to a phosphor screen which is divided into a plurality of segments in the vertical and horizontal directions for successively illuminating R, G, and B phosphor elements every segment.

The following describes a conventional image display device of a cathode ray tube type with reference to Figs. 10 to 12.

Fig. 10 shows a perspective view of an essential portion of a conventional image display device. The display device is mainly comprised of a rear vessel plate 2 on which a back electrode 1 is disposed as indicated by dotted lines in the figure, a plurality of linear cathodes 3 serving as an electron beam generating source, an electrode unit portion 4, and a phosphor plate 5 disposed on a faceplate 6 having a pan-shaped portion serving as a phosphor screen.

The electrode unit portion 4 is composed of a plurality of electrode plates 4a, 4b, 4c, and 4d for controlling the movement of electron beams. Each electrode plate is formed with a plurality of circular or rectangular slit holes 7 arranged for allowing the electron beams to pass therethrough. The electrode plates are fixed to each other by means of adhesion spacer members 8 at their intermediate portions except the areas of the slit hole alignment, where the electrode plates are fixed in a lamination form apart from each other at a specified interval for isolation between adjacent two electrodes. It is to be noted here that, although four electrode plates are depicted in the figure, there are provided six electrode plates in practical use.

On the peripheries such as four corners of each electrode plate, a plurality of ceramic insulating spacers 10 are provided to be secured in the above-mentioned specified gaps for isolation between each adjacent electrode plates when the electrode plates are fixed to be coupled to a fixing unit 9. A setscrew 11 is inserted through the spacers 10 passing through all of the electrode plates to be fastened each other to thereby assemble the electrode unit portion 4 which is securely fixed to the fixing unit 9. The fixing unit 9 is coupled to the rear vessel plate 2 via a plurality of fixing posts (not shown).

When specified electric voltages are respectively applied to the back electrode 1, electron beam control electrodes 4a through 4d, and phosphor plate 5 while flowing a specified electric current through the linear cathodes 3, electron beams are generated from the linear cathodes 3 toward the electron beam control electrode 4a. When the electron beams pass through the slit holes 7 formed in each of the electron beam control electrodes 4a, 4b, 4c, and 4d, the electron beams are controlled, converged, and deflected by the specified voltage applied to each electrode and then the resultant electron beams collide against the phosphor plate 5 to which a high voltage is applied, thereby illuminating the phosphor plate 5 to display an image.

In the above place, the aforementioned electric insulating property of the spacers 10 is assured by using a ceramic sintered mold part 12 each having a tapped hole of a specified diameter as shown in Figs. 11 (a) and 11 (b). On the other hand, the fixing unit 9 is composed of a metal plate 13 and a plurality of ceramic sintered plates 14 formed on the surface thereof to which the electrode 4a is in contact as shown in Fig. 12. The ceramic sintered plates 14 are made of the same material as that of the insulating spacer 10.

The conventional image display device is constructed in accordance with the following processes.

In the first step, mainly three component assemblies such as an electrode unit portion, front vessel portion and rear vessel portion are prepared. For preparing the electrode unit portion, each electrode unit is composed of two electrodes among a plurality of electron beam control electrodes, where the two electrodes are fixed by means of the adhesion spacer members 8 in such a manner that the electrodes are isolated from each other with a specified space of approximately 400 $\mu m \pm 10\ \mu m$. Similarly, a plurality of electrode units are coupled together by means of the adhesion spacer members to thereby implement the electrode unit portion.

The front vessel portion is prepared by securing the phosphor plate 5 onto the inner surface of the pan-shaped portion of the faceplate 6.

For preparing the rear vessel portion, a plurality of fixing posts are provided at specified positions on the inner surface of the rear vessel plate 2 having a back electrode 1 provided thereon. A pair of fixing unit 9 is coupled to the fixing posts to form a frame body. The frame body is provided with a plurality of linear cathodes 3 stretched therein by a cathode stretching means (not shown) to thereby implement the rear vessel portion.

The prepared rear vessel portion and the electrode unit portion are coupled together in such a manner that the electrode unit portion is disposed on the ceramic sintered plates 14 which have been formed on the fixing unit 9. In this process, the ceramic insulating spacer members 10 are inserted in each space between each adjacent laminated electrodes and secured to specified positions of the peripheries of the electrodes in such a manner that the setscrew 11 is inserted through the ceramic insulating spacers 10 to fasten all of the electrodes to be fixed to the fixing unit 9. Thus, the electrode unit portion is mechanically fixed to the rear vessel portion via the fixing unit 9 using the setscrew 11. Thereafter, the pan-shaped front vessel portion is fitted to the rear vessel portion so that a high vacuum condition inside the fitted vessel is maintained by hermetically sealing the peripheral portions thereof.

The image display device constructed as mentioned above assures fundamental image display performances, however, it has the following problems.

In preparing the electrode unit portion 4, a pair of electron beam control electrodes are positioned with a space by means of the adhesion spacers 8 interposed therebetween, and adhesion frits attached to the adhesion spacers 8 are melted and solidified in a kiln to thereby assemble the electrode unit. Then, a plurality of electrode units are similarly coupled to be positioned by means of the adhesion frit to assemble the electrode unit portion 4. In the above case, since the ceramic insulating spacers 10 are provided to be positioned at the peripheries in each space between each adjacent electrodes in the process of fixing the electrode unit portion to the rear vessel portion via the fixing unit 9. Therefore, it is difficult to temporarily fix the insulating spacers 10 to be precisely positioned without detachment from the specified positions.

Furthermore, in the process of fixing the electrode unit portion 4 to the rear vessel plate 2 via the fixing unit 9 by means of the setscrews 11, the ceramic sintered insulating spacers 10 and the ceramic sintered films 14 formed on the fixing unit 9 are both relatively thin film of approximately 400 μm as shown in Figs. 11 (a), 11 (b), and 12. Moreover, since the ceramic member per se is brittle and breakable, the ceramic spacers 10 and plates 14 of the fixing unit 9 are easily damaged by a dynamic load exerted thereon due to the fastening mechanism using the setscrews, which causes drawbacks such that their insulating properties are not assured and that the slit holes 7 of the electron beam control electrodes are clogged by fragments of a damaged spacer or insulating films to result in a defective image display and so forth. Such a phenomenon of damage significantly occurs especially when a vibration or an impact is applied to the body of the image display device, which is due to the mechanical weakness of the ceramic sintered mold parts.

The ceramic sintered mold parts each requires a high cost, which has been a cause of increasing the cost of the image display device itself.

According to a first aspect of this invention a display device having a cathode ray tube comprising:

means for generating electron beams in the cathode ray tube;

means for displaying an image by making the electron beams collide against a phosphor plate; and

an electrode unit for deflecting and converging the electron beams generated by said electron beam generating means, which is comprised of a plurality of laminate electrodes fixed to each other by means of adhesion spacers interposed between two adjacent electrodes at their intermediate portions in the cathode ray tube, each electrode having a plurality of openings formed therein for passing through the electron beams, said electrode unit being provided with insulating spacers between each adjacent two electrodes at their peripheries,

is characterised in that each insulating spacer comprises an insulating film formed on at least one surface of a metal plate.

According to a second aspect of this invention, a method of producing a display device in accordance with the first aspect of this invention comprises the steps of:

preparing an electrode unit portion by fixing a plurality of electrodes to each other by means of adhesion spacers in a kiln while oxide ceramic insulating spacers are secured in the gaps between each adjacent electrode in the process of assembling the electrode unit portion;

preparing a front vessel portion by securing a phosphor plate to the inner surface of a pan shaped portion of a face plate;

preparing a rear vessel portion having a plurality of fixing posts provided at specified positions on the inner surface of a rear vessel plate having a back electrode provided thereon;

coupling a fixing base unit having a ceramic insulating film formed thereon to the fixing posts to form a frame body which is provided with a plurality of linear cathodes stretched therein by a cathode stretching means to thereby implement the rear vessel portion;

coupling the prepared rear vessel portion and the electrode unit portion together in such a manner that the electrode unit portion is disposed on the ceramic insulating film of the fixing base unit; and,

fitting together the pan shaped front vessel portion with the rear vessel portion so that a high vacuum condition inside the fitted vessels is maintained by hermetically sealing of the peripheral portions thereof.

Preferably the display device further comprises a fixing base unit to which the electrode unit of the laminate electrodes is mechanically fixed.

In the display device of the present invention, each insulating spacer may have further a crystal frit glass film which is formed on the other surface of the metal base, and the thickness d1 of the adhesion spacer and a pre-fixation thickness d2 of the insulating spacer are in a relation of $d1 \leqq d2$.

According to a feature of the present invention, the insulating spacer is constructed by providing an oxide ceramic insulating layer having a thickness of several hundred micrometers by a spray coating method on at least one surface of a thin metal base, while the fixing base unit is constructed by providing an insulating layer on a surface of a metal plate by the same method as that of the insulating spacer. The above arrangement assures improved impact resistance characteristics by virtue of the elasticity of the metal and the specific properties of the spray coating film structure against the conventionally problematic dynamic load applied thereto. Thus, the arrangement assures a complete insulation and achieves formation of a film of several hundred micrometers thick in a short time at a low cost. By forming a crystal frit glass on the other surface of the insulating spacer, the thickness of the insulating spacer is adjusted to reduce the error in thickness between the insulating spacer and the adhesion spacer.

A preferred embodiment of the present invention will now be described and contrasted with the prior art with reference to the accompanying drawings, in which:-

Fig. 1 is a sectional view of an image display device in accordance with an embodiment of the present invention;

Fig. 2 is a sectional view taken along the line a-a indicated by the arrow in Fig. 1;

Fig. 3 (a) is a schematic view of an insulating spacer according to the first embodiment;

Fig. 3 (b) is a sectional view of the insulating spacer shown in Fig. 3 (a);

Fig. 4 (a) is a schematic view of a fixing base unit according to the embodiment;

Fig. 4 (b) is a sectional view of the fixing base unit shown in Fig. 4 (a);

Fig. 4 (c) is a sectional view of another example of a fixing base unit;

Fig. 5 is a schematic view showing a spray coating method employed in the present embodiment;

Fig. 6 is an explanatory view showing a step of coating an insulating film in the spray coating method;

Fig. 7 (a) is a schematic view of an insulating spacer in accordance with another preferred embodiment of the present invention;

Fig. 7 (b) is a sectional view of the insulating spacer shown in Fig. 7 (a);

Figs. 8 (a) and 8 (b) are explanatory views for comparing the influence of the thickness of an insulating spacer when having an adhesion frit or not;

Fig. 9 is a view schematically illustrating a method of producing an insulating spacer directly on an electrode by a spray coating method according to the present invention;

Fig. 10 is a perspective view of an essential portion of a conventional image display device;

Figs. 11 (a) and 11 (b) are schematic views of a conventional insulating spacer; and

Fig. 12 is a perspective view of a conventional fixing base unit.

The following describes a preferred embodiment of an image display device in accordance with the present invention with reference to the drawings.

Fig. 1 shows a sectional view of an image display device in accordance with an embodiment of the present invention. Fig. 2 shows a sectional view taken along the line a-a indicated by the arrow in Fig. 1.

Referring to Fig. 1, reference numeral 15 denotes a rear vessel plate composed of a flat glass plate, which has a back electrode plate 16 disposed on the inner surface thereof. The rear vessel plate 15 is covered with a pan-shaped faceplate 17 serving as a front vessel plate disposed thereon to be fitted at their peripheral portions so that a high vacuum condition inside the fitted vessel is maintained by hermetically sealing at their peripheral portions, enclosing various electrode components and the like. The inner surface of the faceplate 17 facing the back electrode 16 is provided with a phosphor plate 18. The rear vessel plate 15 is provided with a plurality of securing posts 19 fixed thereon, and each securing post is provided with a metal member 20 mounted on the top thereof. Further a fixing base unit 21 is mounted on the metal member 20, and an electrode unit portion 22 is mounted on the fixing base unit 21.

Referring to Fig. 2, the electrode unit portion 22 is composed of a plurality of electrode beam control electrodes 22a, 22b, 22c, 22d, 22e, and 22f which are isolated from each other at specified intervals in a face-to-face lamination manner by providing a plurality of adhesion spacers 23 interposed at their intermediate portions between each adjacent two electrodes in a similar manner to that of the conventional structure as shown in Fig. 10. Each adhesion spacer 23 is composed of a spacer core 23a having a spacer function and an adhesion frit 23b having an adhesion function, so that each adjacent two electrodes are isolated by means of the spacer core 23a while the adjacent two electrodes are adhered by means of the adhesion frit 23b.

Each of the electrodes 22a through 22f is formed with a plurality of slit holes through which electron beams are passed similarly to the conventional example shown in Fig. 10. In the space between the back electrode 16 and the electron beam control electrode 22a, there are provided a plurality of linear cathodes 39 which are stretched in the lengthwise direction of the electrode 22a via a linear cathode stretching member 40 which is positioned as apart from the back electrode 16 by a specified distance.

At each periphery of the electrodes, insulating spacers 24 are provided for isolation between each adjacent two electrodes. Each insulating spacer 24 has a tapped hole having a specified inner diameter of about 5 millimeters and an outer diameter of about 8 millimeters as shown in Figs. 3(a) and 3(b). Thus, the electrode unit portion 22 is constructed by coupling the electrode beam control electrodes 22a through 22f with the adhesion spacers 23 and the insulating spacers 24 inserted therebetween. A fastening setscrew 25 is transversely inserted through each periphery of all the electrodes 22a through 22f passing through the tapped hole of the insulating spacers 24 and the fixing base unit 21, so that the electrode unit portion 22 is coupled to the metal member 20 on the securing post 19 via the fixing base unit 21 by means of the setscrew 25.

After securely providing the electrode unit portion and various components on the rear vessel plate 15, the pan-shaped faceplate 17 is covered over the rear vessel plate 15 to be fitted at their peripheral portions so that a high vacuum condition inside the fitted vessels is maintained by hermetically sealing.

Figs. 3 (a) and 3 (b) show the structure of the insulating spacer 24 which is comprised of a thin metal plate 26 and an insulating film 27 formed thereon. The thin metal plate 26 has a thickness of about 200 μm and the insulating film 27 is required to have a fairly great thickness of about 200 μm in order to assure its insulating property, thus the total thickness being about 400 μm.

In the display device of the present embodiment, an oxide ceramic film is formed as the insulating film 27 by a spray coating method. The thin metal plate 26 is made of an invar (Fe-Ni alloy) material which is also used as a material of electrodes because invar has a small thermal expansion factor. The oxide ceramic material of the insulating film 27 is made of, for example, white alumina. It is to be noted here that other oxide materials such as gray alumina, spinel, mullite, and cordierite may be used as the oxide ceramic insulating film 27.

On the other hand, as shown in Figs. 4 (a) and 4 (b), the fixing base unit 21 is comprised of a processed metal plate 28 and an oxide ceramic insulating film 29 formed on the surface thereof which is to be contacted with the electron beam control electrode 22a. The insulating film 29 is formed by the spray coating method in the same manner as that used for making the insulating spacer 24.

In the above place, the processed metal plate 28 is made of stainless steel, and the oxide ceramic insulating film 29 is directly formed on the metal plate 28 as shown in Fig. 4 (b). Otherwise, the insulating film 29 may be formed on the metal plate 28 by way of interposing an intermediate thin metal plate 30 as shown in Fig. 4 (c). In this case, the intermediate metal plate 30 is made of such as invar or the like material. It is to be noted here that, when the insulating film 29 is formed on the metal plate 28 or 30, the material of the metal plate and the material of the oxide ceramic film are not limited to the above mentioned examples.

The spray coating method employed in the present embodiment is schematically shown in Fig. 5.

Referring to Fig. 5, an arc discharge 43 is generated in accordance with an anode-to-cathode voltage supplied by a D.C. source between an anode 41 and a cathode 42 to thereby heat an operation gas 44 fed from a gas inlet in the rear portion thereof. The heated gas is spouted through a nozzle to generate a high temperature plasma jet 45. A solid state minute particles of powdery spray coating material 46 is fed into the high temperature plasma jet 45 to be melted. The melted fine particles 47 of the coating material 46 each having a diameter in a range of several micrometers to one hundred and several tens micrometers are impinged against a surface of a substrate 48 at a high speed of several tens meter per second to several hundreds meter per second, thereby laminating flat-shaped minute particles 49 on the surface of the substrate 48 to form a coating film on the substrate.

In the spray coating process as mentioned above, the heat of the plasma jet 45 is utilized not only for melting the spray coating material 46 but also for increasing the temperature of the peripheries of the material and also heating the substrate 48. Consequently, in the case where the substrate 48 is a thin plate such as an electron beam control electrode as described in the present embodiment, there may be possibly formed an undesirable thermal deformation such as wrapping or bending in the electrode after the spray coating film is formed.

In order to eliminate such an undesirable thermal deformation in the substrate 48, a cooling gas 51 is supplied through a nozzle 50 to a peripheral substrate portion 48a about the spray coated film 49 so that the peripheral portion 48a which is heated by an excessive heating region 52 of the plasma jet 45 is effectively cooled, thereby suppressing the undesirable thermal deformation in the substrate 48.

Moreover, when an oxide ceramic film for isolation is formed on the metal plate by the spray coating method, the difference of the thermal expansion factors between the metal plate and the oxide ceramic material is so large that it is difficult to form the ceramic coating film on the metal plate with a strong adhesive property.

Accordingly, in the spray coating process of the present embodiment, there is coated a nichrome metal film 53 of approximately 20 μm thick on the metal substrate 48 in the first step as shown in Fig. 6. Thereafter, an oxide ceramic insulating film 54 is formed on the nichrome film 53. By this arrangement, the adhesion force between the metal substrate 48 and the nichrome spray-coated film 53 is first assured. Then the adhesion force of the oxide ceramic film 54 to the nichrome film 53 is enhanced by taking advantage of roughness of the surface of the spray-coated nichrome film. Thus, a spray coated insulating film is formed on the metal substrate maintaining a strong adhesion force as a whole.

In the present embodiment, although the insulating film is formed by a plasma spray coating method, other spray coating methods such as gas spray coating method and the like can be employed for forming an insulating film on a thin metal plate without causing thermal deformation in the metal plate. In such spray coating methods, the film forming speed is faster compared to those obtained in other film forming methods. Especially, when a comparatively thick insulating film of several hundreds μm thick is formed for assuring sufficient insulation as described in the present embodiment, the spray coating method is an optimum film forming process.

By virtue of the insulating film 27 of the insulating spacer 24 and the insulating film 29 of the fixing base unit 21 as formed by the spray coating method mentioned above, the essential electrically insulating functions of the spacer 24 of the electrode unit and the fixing base unit 21 are also sufficiently assured. Furthermore, by virtue of the elasticity of the metal and the fact that the spray-coated film as shown in Figs. 3, 4 and 6 has a laminated structure having a semi-tightness, a resistance to a vertical load applied to the film is intensified and a stress applied to the film is relieved. Consequently, the drawback of the conventional ceramic sintered mold parts can be solved in regard of the possible dielectric deficiency and defective image reproduction due to the possible damage of the insulating spacer by an applied dynamic load in the process of screwing the setscrews. And more particularly, the damage of the insulating spacer and the ceramic sintered mold parts can be suppressed at the time of application of an impact and so forth occurred when the display device is dropped. Moreover, since the spray-coated film is tightly coupled with the metal plate, even if there arises a crack inside the spray-coated film, the film is not teared off from the metal plate, preventing the dispersion of the pieces of the film. Consequently, the impact resistance characteristics can be improved, eliminating the defects due to the damage of the insulating film.

The following describes a further preferred embodiment of an insulating spacer 24 in accordance with the present invention with reference to Figs. 7 (a) and 7 (b). A purpose of this embodiment is to prevent the removal or tear-off of the insulating spacer from the electrode plate by intensifying the adhesion property of the insulating spacer 24 in the electrode unit when assembling the electrode unit portion 22. Another purpose of this embodiment is to prevent destroy of the adhesion spacer 23 by adjusting the thickness of the insulating spacer 24 with respect to the thickness of the adhesion spacer 23. The purposes of the embodiment are attained by providing a crystal adhesion frit in addition to the oxide ceramic insulating film on the thin metal plate of the insulating spacer.

Referring to Figs. 7 (a), 7 (b) and 8 (a), 8 (b), an insulating spacer 24' is composed of a thin metal plate 32, an oxide ceramic insulating film 33 and a crystal adhesion frit 34 having a low melting point, where the oxide ceramic insulating film 33 is formed in a specified thickness on one surface of the thin metal plate 32 by a spray coating method, while the crystal adhesion frit 34 is formed on the other surface of the metal plate 32 likewise by the spray coating method. In this embodiment, the insulating film 33 is approximately 200 μm thick, while the adhesion frit 34 is approximately 80 μm thick, so that the total thickness of the insulating spacer 24' is made to be slightly greater than or equal to the thickness of the adhesion spacer 23 which fixes the electron beam control electrodes by means of the adhesion frit 23b at intermediate portions of the electrodes at specified intervals as described before with reference to Fig. 2. In this example, the crystal adhesion frit 34 may be formed also by a printing method instead of a spray coating method.

In more detail, as shown in Fig. 8 (a), in the case where the insulating spacer 24' is not provided with an adhesion frit, the dimensions of the gap between the electrodes is defined only by the thickness d1 of the adhesion spacer 23. Therefore, when the thickness d2 of the insulating spacer 24' for insulating the periphery of the electrodes is slightly smaller than the thickness d1 of the adhesion spacer 23 (i.e., in the relation of $d1 > d2$), a bending moment 35 is generated with an end of the adhesion spacer 23 as a fulcrum to produce a fragment due to damage 36 at the end of the adhesion spacer 23 as shown in Fig. 8 (a). On the contrary, when in the relation of $d1 < d2$, a force for separating the spacer 23 from the electrode 22' is exerted. In order to solve the above-mentioned problems, it is required to delicately control the thickness of the insulating spacer 24' in accordance with the adhesion spacer 23. Therefore, it is quite difficult to delicately control the thickness of the insulating film through film formation by the spray coating method or the like.

In view of solving the above difficulty, the crystal adhesion frit 34 is formed on one surface of the metal plate 32 in such a manner that the total thickness of the insulating spacer 24' is made slightly greater than or equal to the thickness of the adhesion spacer 23.

In the preferred embodiment, the insulating spacers are securely provided in the gaps between each adjacent electrodes in the process of assembling the electrode unit portion 22 by fixing the electrode plates 22a through 22f with the adhesion spacers 23, which is distinct from the conventional way of assembling the electrode unit portion where the insulating spacers are inserted in the gaps of the electrodes after the electrode unit portion has been assembled.

In more detail, according to the preferred embodiment, in the process of fixing the electrode plates with the adhesion spacers in a kiln, the insulating spacers 24' are arranged in the gaps at the specified peripheral positions of the electrodes. Then the crystal adhesion frit 34 of the insulating spacer 24' is melted in the procedure of increasing the temperature inside the kiln to thereby adjust the thickness of the insulating spacer with respect to the thickness d1 of the adhesion spacer 23. In the above place, the total prefixation thickness d2 of the insulating spacer 24' is made slightly greater than or equal to the thickness d1 of the adhesion spacer 23, i.e., in a relation of $d1 \leqq d2$, where d2 being in a degree within a range of approximately 1.2 times larger than or equal to d1, which the degree of the difference between the thicknesses d1 and d2 can be absorbed in the spray coating process to adjust the thickness performing a stable coupling of the electrodes. Then an excess frit part 37 is forced out to achieve the desired thickness d2 of the insulating spacer as to be $d2 = d1$, and thereafter the adhesion frit 34 is solidified in this desired condition of the thickness of the insulating spacer.

The crystal adhesion frit 34 may be made of a general glass material having a low melting point substantially the same as the frit glass 23b of the adhesion spacer 23 in the premise that the adhesion frit 34 is melted and solidified in the procedure of increasing the temperature up to approximately 480 °C in the kiln to be adhered to the surface of the metal plate 32.

Consequently, the aforementioned problems due to the dimensional erroneous difference or nonuniformity are solved to allow an image display device having excellent function and reproducibility to be achieved. Although the crystal frit 34 can be formed by either a printing method or a spray coating method, it is of course preferred to select the spray coating method in terms of uniformity in process.

Fig. 9 shows further another embodiment of the present invention.

This embodiment shows a method for forming an insulating spacer 24" directly on a surface of an electrode 22" without providing a thin metal plate part processed in a specified shape and omitting a process of mounting the insulating spacer between the electrodes. In this embodiment, the part and processes are eliminated and instead the spacer 24" is formed by moving a spray coating torch 38 in spots. The spacer 24" is formed by a masking method with a mask conforming to the shape of a spacer though the mask is not shown.

The present method can simplify the total process and remarkably reduce the cost of the material, thus producing a great effect.

According to the present invention described as above, the following effects can be achieved.

The insulating spacer is constructed by providing an oxide ceramic insulating layer having a thickness of several hundred micrometers by the spray coating method on at least one surface of a thin metal base, while the fixing base unit is constructed by providing an insulating layer on a metal base surface by the same method. The above arrangement assures improved impact resistance characteristics by virtue of the elasticity of the metal and the specific properties of the spray coating film structure with respect to the conventionally problematic applied dynamic load, which assures a complete insulation and achieves elimination of defects of image quality, maintaining a high speed film formation at a low cost. By forming a crystal frit glass on the other surface of the insulating spacer, the thickness of the insulating spacer is adjusted to reduce the error in thickness between the insulating spacer and the adhesion spacer to consequently allow a producing method with a sufficient margin and, on the whole, an image display device producing method with high productivity to be provided.

Claims

1. A display device having a cathode ray tube comprising:

    means (30) for generating electron beams in the cathode ray tube;

    means (17, 18) for displaying an image by making the electron beams collide against a phosphor plate; and

    an electrode unit (22) for deflecting and converging the electron beams generated by said electron beam generating means, which is comprised of a plurality of laminate electrodes (22a through 22f) fixed to each other by means of adhesion spacers (23) interposed between two adjacent electrodes at their intermediate portions in the cathode ray tube, each electrode having a plurality of openings formed therein for passing through the electron beams, said electrode unit being provided with insulating spacers (24) between each adjacent two electrodes at their peripheries,

characterised in that each insulating spacer (24) comprises an insulating film (27) formed on at least one surface of a metal plate (22, 26, 32).

2. A display device as claimed in claim 1, wherein said insulating film (27) of the insulating spacer (24) is formed principally of oxide ceramic material having a thickness of several hundred micrometers.

3. A display device as claimed in claim 1 or 2, wherein said insulating spacer (24) comprises an oxide ceramic insulating film (33) formed on one surface of the metal plate and a crystal adhesion frit (34) formed on the other surface of the metal plate.

4. A display device according to any one of the preceding claims, further comprising an electrode fixing base unit (21) to which the electrode unit of the laminate electrodes (22) is mechanically fixed, wherein said electrode fixing base unit is comprised of a metal plate (28) and an oxide ceramic insulating film (29) formed on one surface thereof facing said electrode unit.

5. A method of producing a display device as defined in claim 4, comprising the steps of:

preparing an electrode unit portion by fixing a plurality of electrodes (22) to each other by means of adhesion spacers (23) in a kiln while oxide ceramic insulating spacers (24) are secured in the gaps between each adjacent electrode in the process of assembling the electrode unit portion;

preparing a front vessel portion by securing a phosphor plate (18) to the inner surface of a pan shaped portion of a face plate (17);

preparing a rear vessel portion having a plurality of fixing posts (20) provided at specified positions on the inner surface of a rear vessel plate (15) having a back electrode (16) provided thereon;

coupling a fixing base unit (21) having a ceramic insulating film (29) formed thereon to the fixing posts (20) to form a frame body which is provided with a plurality of linear cathodes (3) stretched therein by a cathode stretching means to thereby implement the rear vessel portion;

coupling the prepared rear vessel portion and the electrode unit portion together in such a manner that the electrode unit portion is disposed on the ceramic insulating film (29) of the fixing base unit; and,

fitting together the pan shaped front vessel portion (17) with the rear vessel portion (15) so that a high vacuum condition inside the fitted vessels is maintained by hermetically sealing of the peripheral portions thereof.

6. A method as claimed in claim 5, wherein in the step of preparing the electrode unit portion, the ceramic insulating spacers (24) are secured to specified positions of the peripheries of the electrodes (22) in such a manner that a set screw (25) is transversely inserted through the periphery of all the electrodes (22a through 22f) passing through the insulating spacers (24) and the fixing base unit (21), so that the electrode unit portion (22) is coupled to the rear vessel portion via the fixing base unit (21) by means of the set screw (25).

7. A method as claimed in claims 5 or 6, or a display device according to any one of claims 1 to 4, wherein said oxide ceramic insulating film (27 or 29) is formed on the metal plate by a spray coating method.

8. A method or device according to claim 7, wherein a crystal adhesion frit (34) is formed on the other surface of the metal plate (32) by a spray coating method.

9. A method as claimed in claim 8, wherein, in the process of fixing the electrode plates with the adhesion spacers (23) in a kiln, after the insulating spacers (24) are arranged in the gaps at the specified peripheral positions of the electrodes, then the crystal adhesion frit (34) of the insulating spacer (24) is melted in the procedure of increasing the temperature inside the kiln to thereby adjust the thickness of the insulating spacer (24) with respect to the thickness of the adhesion spacer (23) so that they are equal.

10. A method according to claim 9, wherein the total pre-fixation thickness (d2) of the insulating spacer (24) is made slightly greater than to the thickness (d1) of the adhesion spacer (23).

11. A method or device according to any one of the preceding claims, wherein said oxide ceramic insulating film is formed on a metal film such as a nichrome film (53) after the metal film has been formed on the metal plate.

12. A method or device according to any one of the preceding claims, wherein the metal plate on which the insulating film is formed is part of an electrode (22).

13. A method or device according to any one of claims 1 to 11, wherein the insulating spacer (24) includes a metal base plate (26) made, for example, of an invar (Fe-Ni alloy) material.

14. A method of implementing an electrode unit portion for use in a display device comprising the steps of:

making insulating spacers each being made by forming an oxide ceramic insulating film on at least one surface of a metal plate by a spray coating method with a specified thickness; and

fixing a plurality of electrodes to each other by means of adhesion spacers in a kiln while said oxide ceramic insulating spacers are securely provided in the gaps between each adjacent electrodes in the process of assembling the electrode unit portion.

Fig. 1

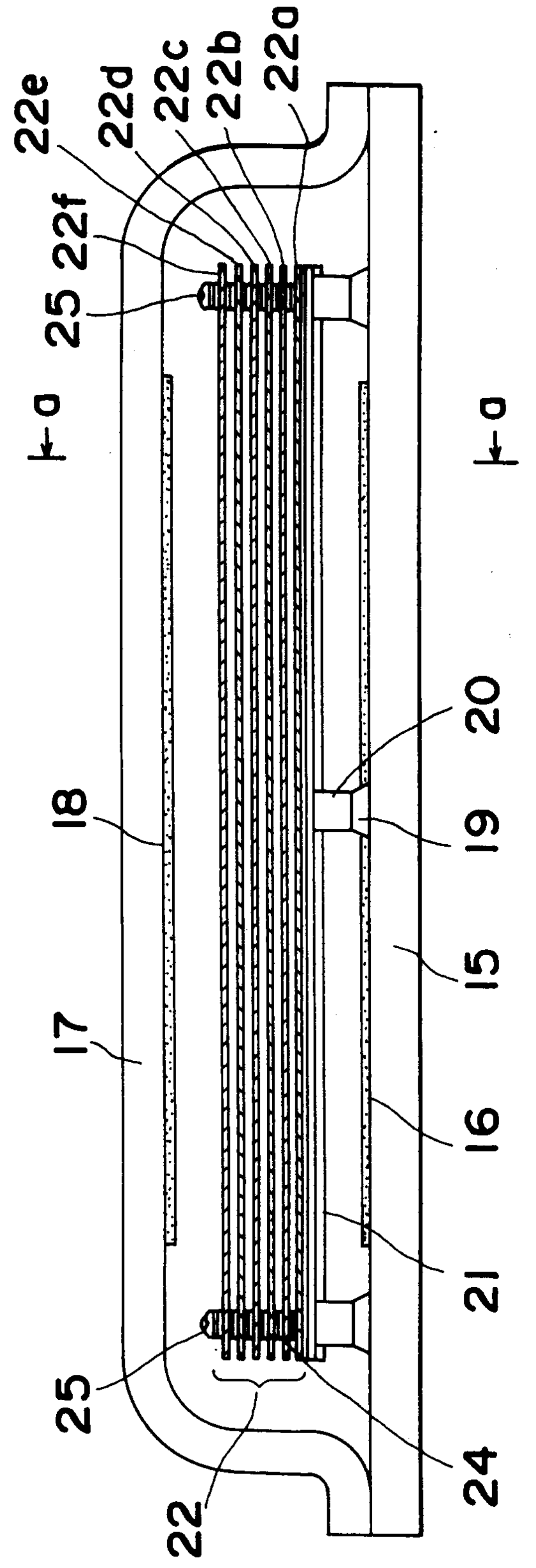


Fig. 2

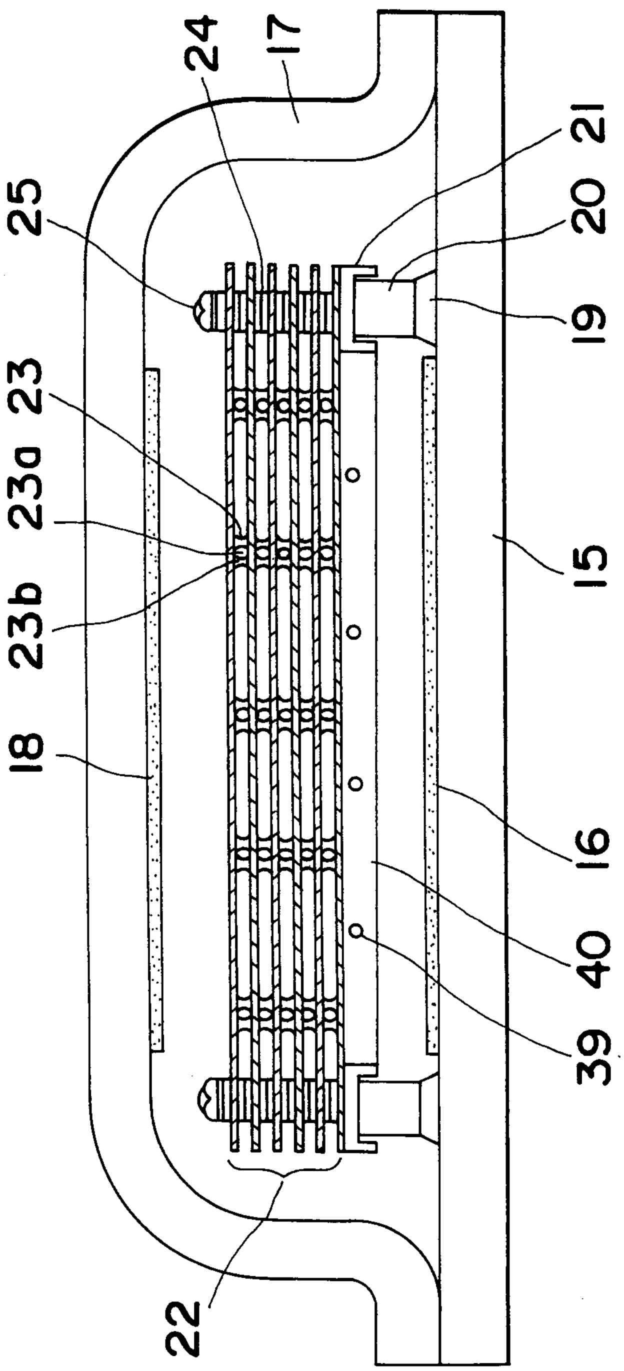


Fig. 3(a)

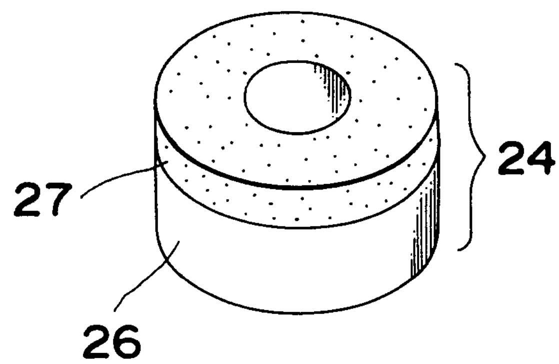
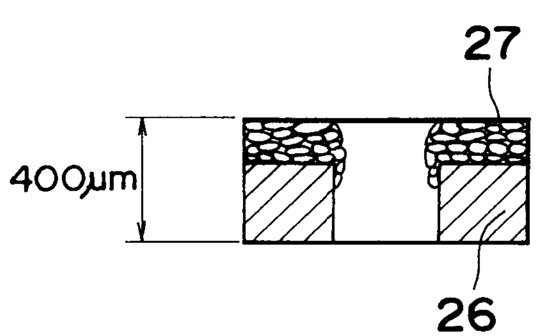


Fig. 3(b)



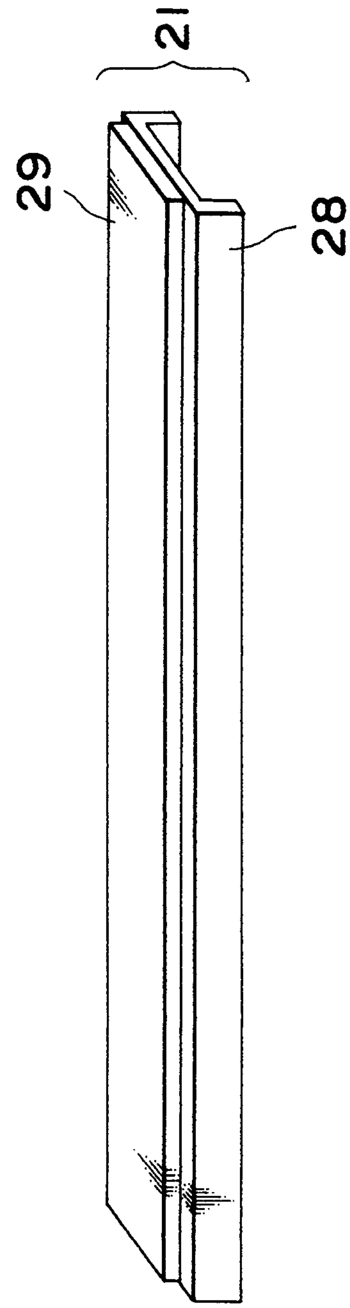


Fig. 4 (a)

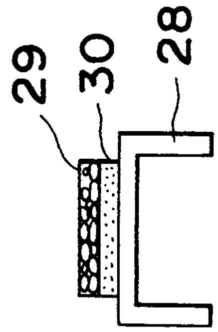


Fig. 4 (c)

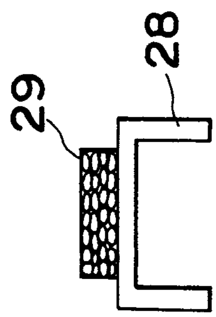
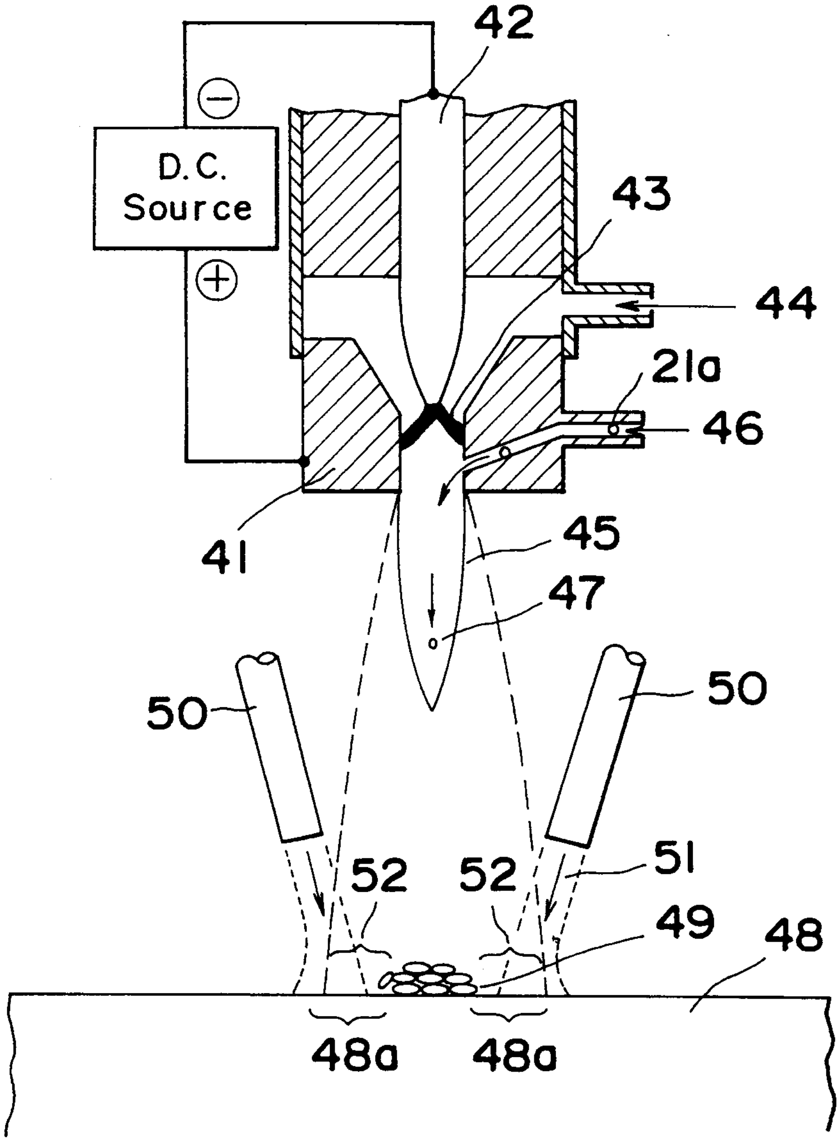


Fig. 4 (b)

Fig. 5


D.C.
Source
42
43
44
21a
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41
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47
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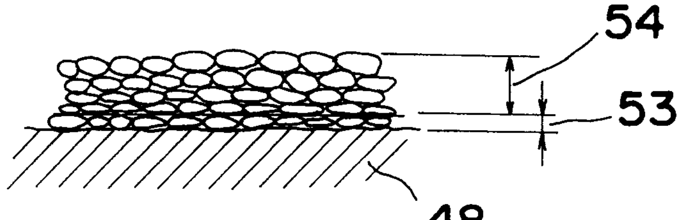
48a
48a

Fig. 6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53
48

Fig. 7(a)

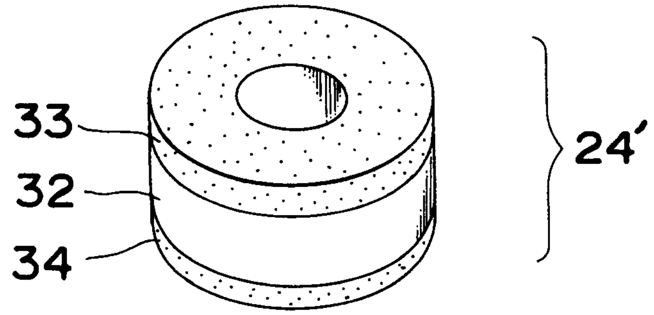


Fig. 7(b)

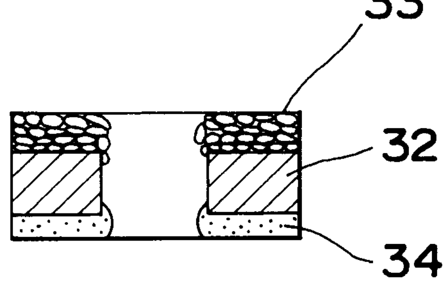


Fig. 8 (a)

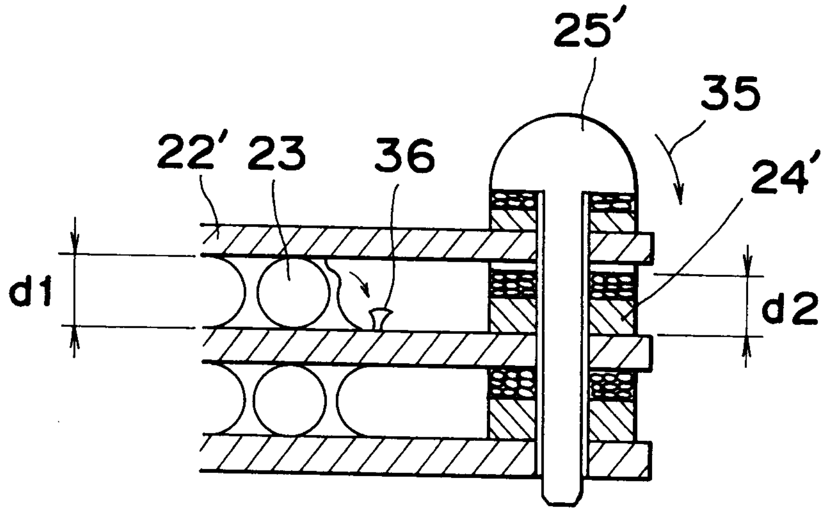


Fig. 8 (b)

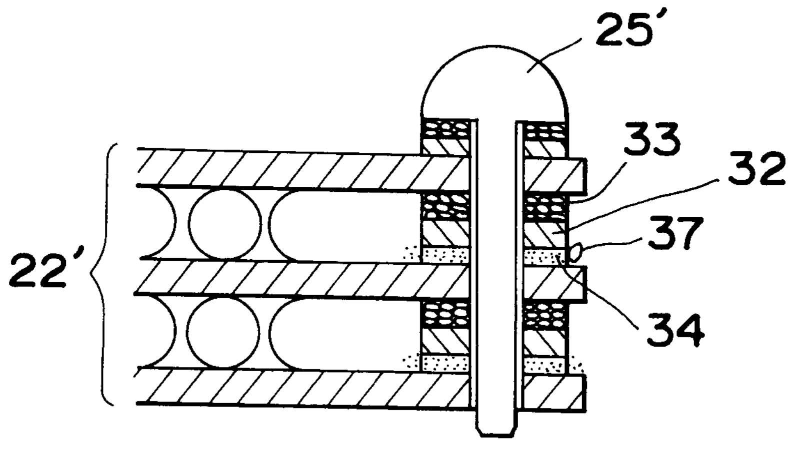


Fig. 9

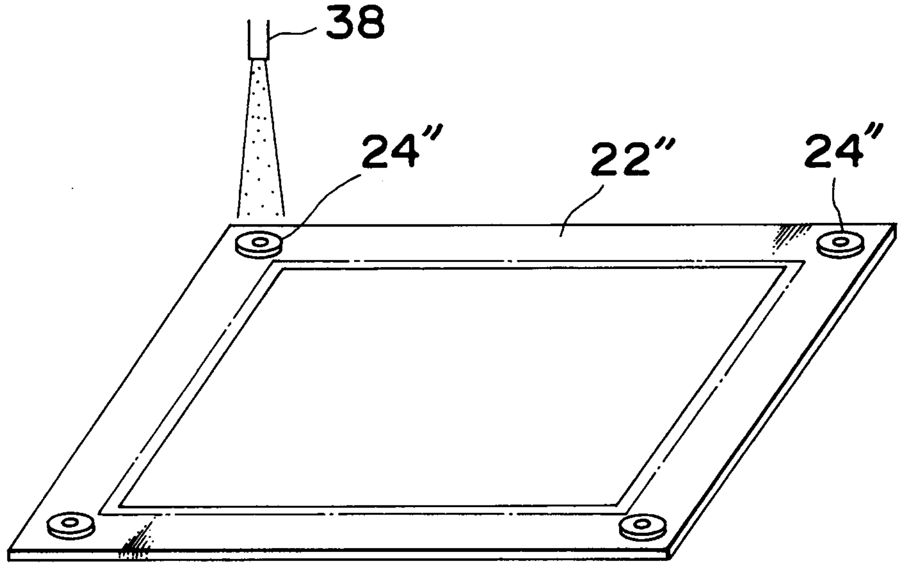


Fig. 10 (Prior Art)

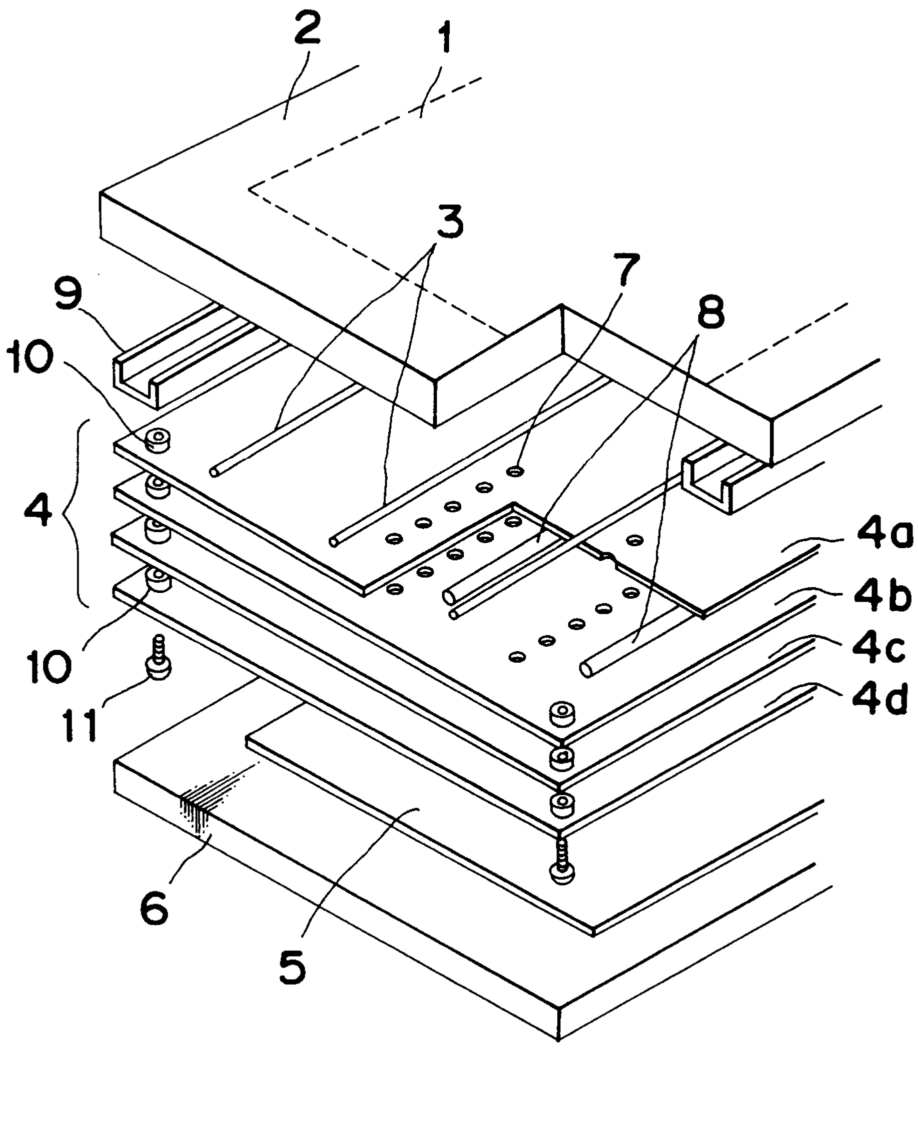


Fig. 11(a) (Prior Art)

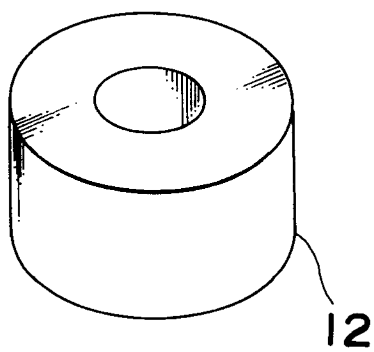


Fig. 11(b) (Prior Art)

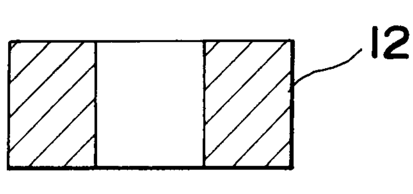
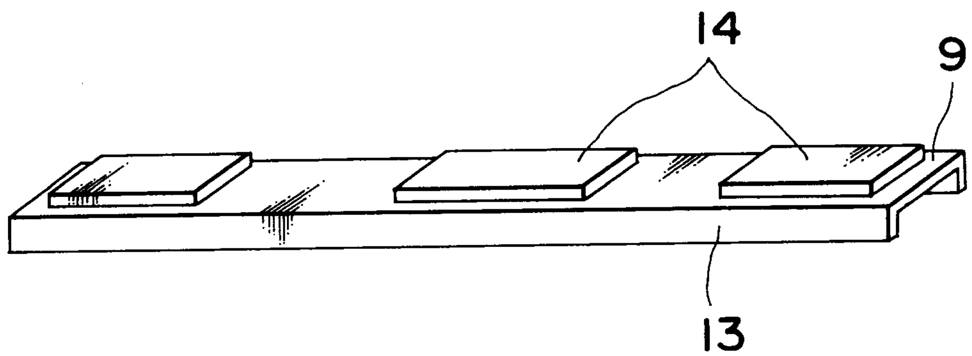


Fig. 12 (Prior Art)



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 94300842.5

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US - A - 4 160 310 (MANNS) * Column 3, lines 32-57; column 5, lines 6-40; column 6, lines 19-24; claims 5,6; fig. 7-9 *	1-3, 12,13	H 01 J 9/02 H 01 J 31/12 H 01 J 29/04
Y		14	
Y	US - A - 4 804 887 (MIYAMA) * Column 7, line 6 - column 8, line 3 *	1-4,13	
A		5,6,14	
Y	US - A - 5 134 338 (SHIRATORI) * Column 5, lines 21-34; column 8, lines 24-46 *	1-4,13	
A		5,6	
Y	EP - A - 0 439 066 (MATSUSHITA) * Totality *	14	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)
H 01 J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	11-05-1994	HAWEL

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document