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R. A. WARREN

3,469,015

CONDUCTIVE PANEL

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FIG. 4.

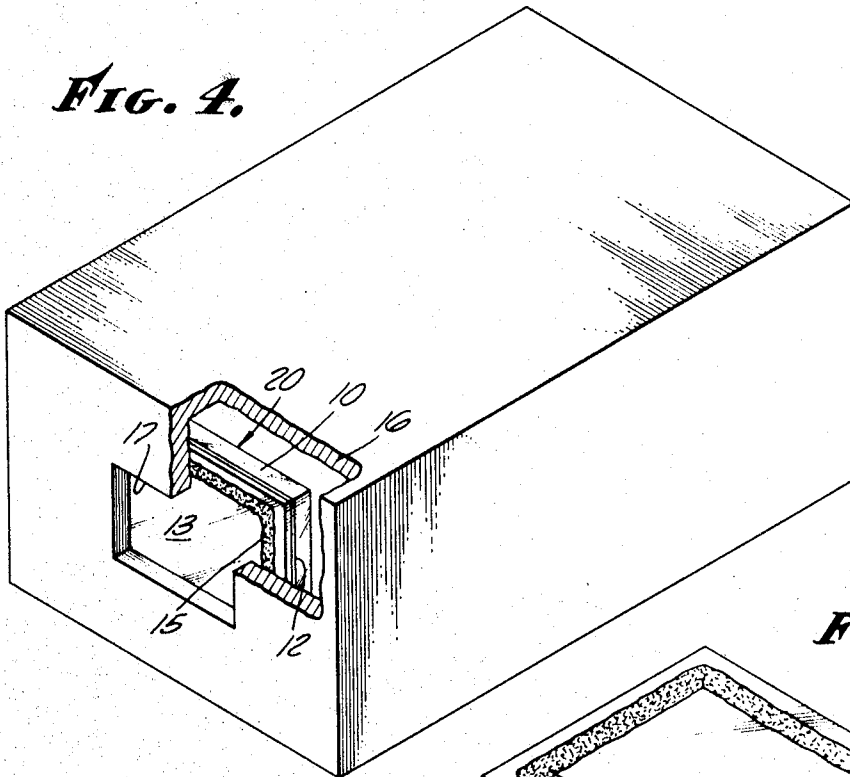


FIG. 3.

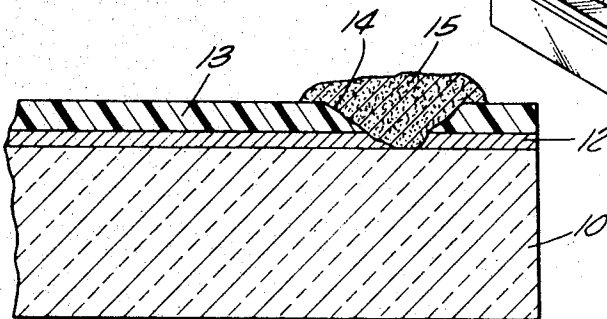
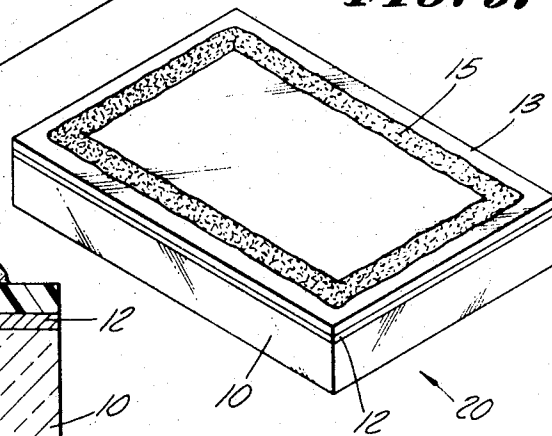


FIG. 1.

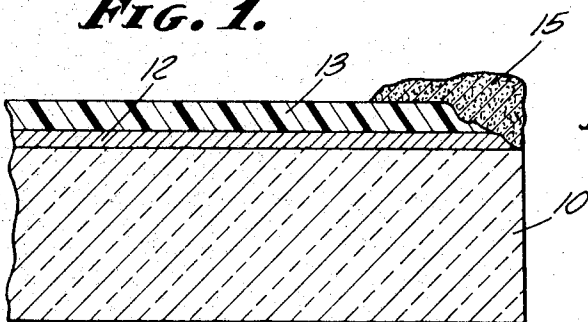


FIG. 2.

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CONDUCTIVE PANEL

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10 Claims

ABSTRACT OF THE DISCLOSURE

A transparent panel having an internal conductive film to which a bus bar attachment is made after fabrication of the panel.

BACKGROUND OF THE INVENTION

There are many types of electrical and electronic apparatus that by their operation radiate radio frequency electromagnetic waves that interfere with the proper operation of other electrical or electronic apparatus unless either the emitting apparatus or the receiving apparatus is properly shielded. Where such apparatus can be completely enclosed in a metallic housing, this housing when grounded provides the necessary shielding. However, if it is necessary to provide visual observation of the apparatus then a suitable window must be formed in the housing. If this window is covered by a conventional glass or clear plastic panel, a break in the shielding is formed which permits entrance or exit of the undesired radio frequency radiation.

To overcome this problem, there have been provided transparent radio frequency interference panels which include a conductive film together with bus bars for making contact thereto and which complete the shielding effect of the housing. Such panels are conventionally constructed by forming the bus bars on a transparent substrate such as glass or a clear plastic and then depositing the conductive film so as to make good electrical contact to the bus bars. The bus bars are then masked and a protective coating applied over the area of the substrate on which the conductive film has been deposited. The masking is then removed so that contact can be made between the bus bars and the metallic housing.

The process of constructing these panels as just described is quite expensive and time-consuming due partly to the masking step that is required. This masking step also has a deleterious effect on the optical quality of the panel because conventional masking materials contain contaminants that contaminate the protective coating and create optical distortion. This method also has the disadvantage of requiring that each panel for any given application be individually constructed so that the bus bar configuration will be correct and thus requires the repetition of the various coating and depositing operations for each panel. The individual nature of each panel also requires that a large inventory be kept in order that orders be promptly filled and thus further contributes to the overall cost.

SUMMARY OF THE INVENTION

The present invention greatly simplifies the construction of such panels and considerably reduces their cost by permitting the bus bar attachment to the conductive film to be made after the rest of the panel is completely fabricated, thereby eliminating the masking steps previously required. This later attachment of the bus bar not only improves the optical quality of the panel but also permits the various deposition and coating steps to be performed on large sheets of substrate. These large sheets can then be cut into the desired sizes and shapes or can be stored

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whole with the desired panels cut off when needed. Both the processing costs and the inventory costs can thus be substantially reduced. These advantages are realized by depositing a suitable bus bar material such as silver paste in a channel or groove of a desired configuration formed in the completed panel by removing an angled section of the protective coating and conductive film so as to expose a relatively wide area section of the film for contact with the bus bar material. By depositing an amount of bus bar material sufficient to protrude above the surface of the panel, a conductive ridge is formed which can be brought into engagement with the metal housing completely around the opening therein to be covered by the panel, thereby in effect making a complete electrical seal and assuring continuity of shielding.

It is therefore an object of the present invention to provide a bus bar attachment to the conductive film of a transparent panel after the panel has been otherwise completely fabricated.

BRIEF DESCRIPTION OF THE DRAWING

FIGURE 1 is a cross-sectional view of a first embodiment of the bus bar attachment of the present invention;

FIGURE 2 is a cross-sectional view of a second embodiment of the bus bar attachment of the present invention;

FIGURE 3 is a perspective view of a radio frequency interference panel constructed in accordance with the present invention; and

FIGURE 4 is a perspective view, partly broken away, of a housing equipped with the radio frequency interference panel of the present invention.

DESCRIPTION OF THE INVENTION

Turning now to FIGURE 1, there is shown a partial sectional view of a radio frequency interference panel constructed in accordance with the present invention. A substrate 10 of clear plastic or glass has deposited thereon a thin transparent conductive film 12. The conductive film 12 can be any of a number of well-known materials, such as finely divided metal particles. The techniques of applying such films are well known in the art and form no part of the present invention.

A protective coating 13 is disposed over the thin conductive film 12 to prevent it from being scratched or otherwise electrically or optically damaged. Suitable materials for this protective coating and the respective thicknesses necessary are also known to those skilled in the art.

As can be seen, in the panel of the present invention no provision is initially made for forming bus bars by means of which contact may be made to the conductive film 12. After the fabrication of the various layers described has been completed, the panel can be stored for as long as necessary in any desirable size. When a particular panel size is decided upon, a suitable sized piece is selected and an angled groove 14 is formed in the desired pattern or configuration so as to expose the conductive film 12. The groove or channel 14 may be formed in any suitable manner but it has been found that it can conveniently be formed by the scraping action of a sharp tool, such as a razor knife. This scraping action has a tendency to gall and delaminate the protective coat away from the conductive coat exposing an angled area of the conductive film along each edge of the groove. It has been found that the greater the angle of the groove, the better is the resulting contact, apparently because of the increased surface of the conductive film exposed by the angle of cut. Care must be taken when the groove is formed that the substrate is not damaged either mechanically or optically. The bus bar material 15 is now applied to the groove 14

by silk screening, spraying, painting, dipping, or the like. The material 15 may be of silver paste, consisting of a mixture of silver flake and binder resin. The solvent system in the bus bar material must be compatible with and must not attack the resin used in the protective coating 13 in order to secure a stable electrical contact with the conductive film 12. As shown, sufficient bus bar material 15 is used so that it protrudes above the surface of the protective coating 13. This makes contact to an external element easier but is not necessary.

Turning now to FIGURE 2, a sheet indentical to that shown in FIGURE 1 is illustrated. In FIGURE 2, however, a groove is not formed in the upper surface of the panel but rather the edge is chamfered and the bus bar material 15 then applied. The chamfering step can also be accomplished by the use of a knife or other sharp tool and need not be done until immediately before the panel is ready to be shipped.

Turning now to FIGURE 3, there is shown a perspective view of the complete panel 20 made in the manner described. The panel shown is rectangular with the groove 14 formed therein in a rectangular pattern. The bus bar material 15 is deposited in the channel 14 and extends above the surface of the panel. Such a panel is used in the manner shown in FIGURE 4. In FIGURE 4, a housing 16 of sheet metal or the like is provided with an opening 17 through which the apparatus positioned in the housing may be observed. The panel 20 of FIGURE 3 is positioned over the opening 17 with the ridge of bus bar material 15 engaging the metal of the housing 16 completely around the opening 17, thus forming an electrical seal and integrating the conductive film 12 into the shield formed by the metal of the housing 16, thereby completely shielding the apparatus contained in the housing 16.

While the invention has been described in connection with a radio frequency interference panel, it should be understood that the bus bar attachment of the present invention is also useful with other types of panels containing conductive films to which electrical contact must be made. Examples of such panels are transparent electrically heated panels such as those used for aircraft windshields or the like, electrostatic drain panels, and electroluminescent panels. The invention may be embodied in other specific forms not departing from the spirit or central characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

I claim:

1. An electrical panel comprising: a base of nonconductive material; a layer of conductive material formed on said base; a layer of nonconductive material formed on said layer of conductive material, said layer of nonconductive material and said layer of conductive material having an angled cut formed therein exposing an angled surface of said layer of conductive material; and a body of conductive bus bar material deposited in said cut and engaging said layer of conductive material to permit external electrical contact to be made thereto.

2. The panel of claim 1 wherein said cut comprises a groove formed in the surface of said panel.

3. The panel of claim 1 wherein said cut is formed on the edge of said panel.

4. An electrical panel comprising: a base of transparent nonconductive material; a thin transparent film of conductive material deposited on said base; a layer of transparent nonconductive material formed on said conductive film and having an upper surface, said layer of nonconductive material and said conductive film having an elongated angled groove formed therein with the wide portion

of said groove being at said upper surface, said groove intersecting said conductive film exposing an elongated, angled surface of said film on each side of said groove; and a body of conductive bus bar material deposited in said groove and intimately engaging said exposed surfaces of said film to permit external electrical contact to be made thereto.

5. The panel of claim 4 wherein said groove is continuous.

6. The panel of claim 4 wherein said body of bus bar material extends above said upper surface.

7. An electrical panel comprising: a base of transparent nonconductive material; a thin transparent film of conductive material deposited on said base; a layer of transparent nonconductive material formed on said conductive film and having an upper surface, said layer of nonconductive material and said conductive film having an elongated angled cut formed along at least one end thereof, said cut intersecting said conductive film exposing an elongated, angled surface of said film along said cut; and a body of conductive bus bar material deposited on said cut and intimately engaging said exposed surface of said film to permit external electrical contact to be made thereto.

8. The panel of claim 7 wherein said body of bus bar material extends above said upper surface.

9. A radio frequency interference panel covering an aperture in a conductive housing comprising: a base of transparent nonconductive material; a thin transparent film of conductive material deposited on said base; a layer of transparent nonconductive material formed on said conductive film and having an upper surface, said layer of nonconductive material and said conductive film having a continuous angled cut formed therein, said cut intersecting said conductive film exposing an elongated, angled surface of said film; and a body of conductive bus bar material deposited in said cut and intimately engaging said exposed surface of said film and extending above said upper surface, the area of said film and said bus bar material being at least equal to the area of said aperture with said bus bar material making electrical contact with said conductive housing.

10. A radio frequency interference panel covering an aperture in a conductive housing comprising: a base of transparent nonconductive material; a thin transparent film of conductive material deposited on said base and covering an area of said base larger than said aperture; a layer of transparent nonconductive material formed on said conductive film and having an upper surface, said layer of nonconductive material and said conductive film having a continuous angled groove formed therein with the wide portion of said groove being at said upper surface, said groove intersecting said conductive film exposing an elongated, angled surface of said film on each side of said groove, said groove including an area of said conductive film larger than said aperture; and a body of conductive bus bar material deposited in said groove and intimately engaging said exposed surface of said film and extending above said upper surface with said bus bar material making electrical contact with said conductive housing at points around said aperture.

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DARRELL L. CLAY, Primary Examiner

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174—68.5; 219—522; 338—308, 309, 314, 327