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D. A. DETLOFF

2,959,880

ILLUMINATED PANEL AND METHOD OF FABRICATING SAME

Filed June 30, 1954

fig. 1.

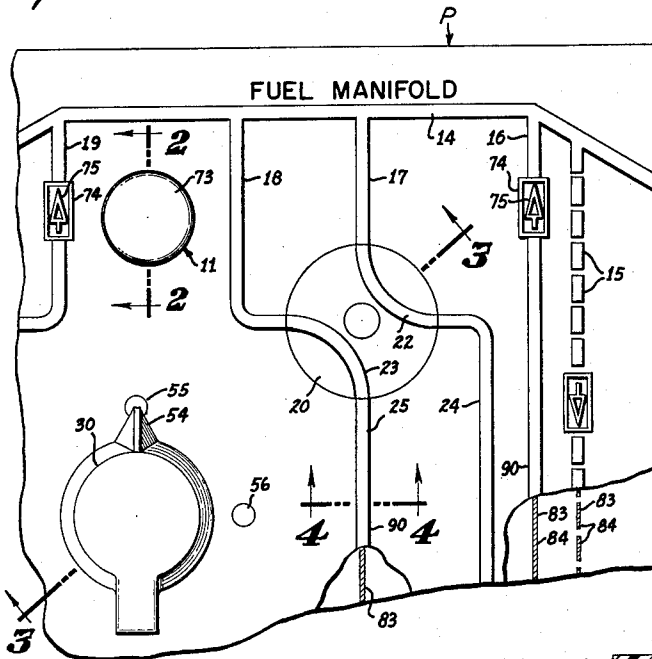


fig. 4.

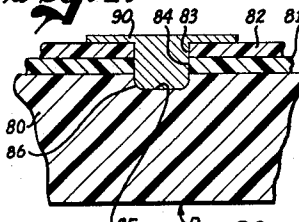


fig. 5.

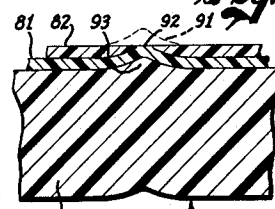


fig. 6.

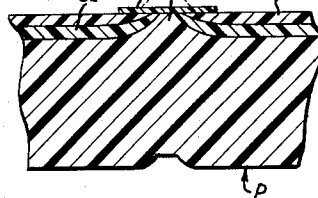


fig. 3.

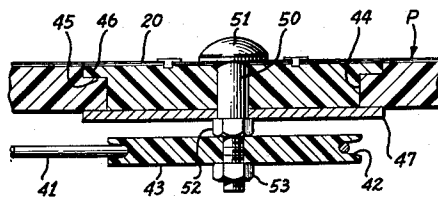
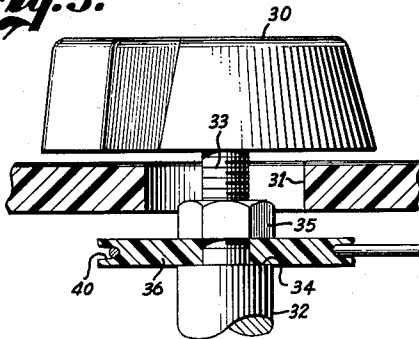
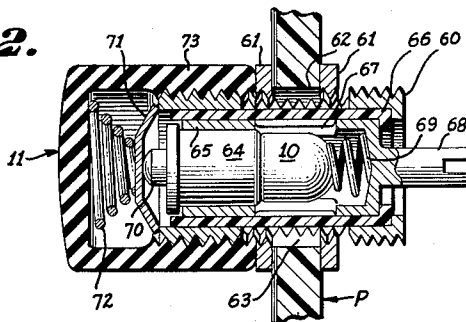


fig. 2.



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1

2,959,880

ILLUMINATED PANEL AND METHOD OF FABRICATING SAME

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9 Claims. (Cl. 40—130)

This invention relates to panels having designs thereon comprising such components as indicia, letters, numerals, and other markings, which designs are visible both by reflected light and by light transmitted through the material of the panel. Transilluminated panels of this character are commonly used for instrument boards and panel boards on aircraft.

In general, a panel of the type to which the invention pertains comprises a laminated plate having a relatively thick inner or back layer of light-transmitting material suitable for transillumination and having an outer or front layer of opaque material which has cut-outs conforming to the desired design. In one construction, an intermediate layer of light-reflecting translucent material underlies the outer opaque layer and this intermediate layer is exposed through the cut-outs to provide the design.

One prior art procedure for fabricating such a panel comprises the steps of: bonding together three sheets of thermoplastic material corresponding to the desired three layers to form a unified plate; applying heat and pressure to displace selected portions of the plate outward to form a relief pattern; and shaving material from the relief pattern to make cut-outs in the outer opaque layer and to expose the outwardly displaced portions of the intermediate light-reflecting translucent layer. If all of the elements of the design are relatively narrow, the result of this procedure is a well-defined clean-cut design formed by the material of the intermediate layer as exposed through the cut-outs of the outer opaque layer. For example, a design consisting solely of such elements as narrow index marks, scale marks, relatively small letters and relatively small numerals, will have the desired sharpness of definition.

It has been found, however, that this prior art procedure does not produce satisfactory designs when the design elements are relatively wide. Since the finished design is formed by removing the relief portions, the finished design boundaries are formed by the intersection of the outwardly offset portions of the opaque layer with the plane to which the relief design is cut back by removal of material and such a line of intersection inevitably wavers along the edge of a wide design area. The wavering line of demarcation arises from the fact that in the process of forming the relief design, the material of the intermediate layer fails to flow outward uniformly in response to the applied heat and pressure in regions along the edges of wide design areas.

It is also difficult to control the thickness of the intermediate layer that remains when the relief pattern is shaved to create a wide portion of a design. The intermediate layer is not displaced outwardly with such a degree of precision and uniformity in the production of the relief pattern as to make possible the shaving away of a uniform thickness of the intermediate layer over a design area of any substantial width.

The invention meets this problem of sharply defining relatively wide design areas by affording a different pro-

2

cedure which involves cutting out portions of at least the outer opaque layer in accord with the desired design and then applying an additional outer layer of light-reflecting translucent material in accord with the design. The elements of the applied outer layer are superimposed on the corresponding elements of the cut-out design and are wider than the corresponding elements of the cut-out design so that the clean-cut margins of the applied layer overlap the margins of the cut-out design areas. As a result, the margins of the cut-out areas are not visible when the design is viewed by reflected light and the diffusion of the transmitted light by the additional layer of translucent material makes irregularities in the edges of the cut-out area unnoticeable when the design is viewed by transmitted light.

The new procedure provides an added advantage in that it makes it possible to provide desirably wide design areas for easy visibility by reflected light, and at the same time, to provide desirably narrow design areas for illumination by transmitted light. Thus the invention resolves a certain conflict between, on the one hand, the requirement for boldly depicted design areas for observation by reflected light and, on the other hand, the requirement for minimum radiation of light from a panel board under conditions of darkness.

If desired, the intermediate layer of light-reflecting translucent material may be omitted in some practices of the invention. A feature of the preferred practice of the invention, however, is the inclusion of the intermediate light-reflecting translucent layer for the purpose of depicting the narrower elements of the design by the above described prior art procedure. In this practice of the invention, the over-all design required on the finished panel may be considered as actually divided into a first design having relatively wide design elements and a second design having relatively narrow design elements. The first design is produced by providing cut-out elements in the outer opaque layer and then applying wider elements of the additional layer of light-reflecting translucent material to overlap the cut-out elements by liberal margins. The second design composed of the narrow design elements is produced by first forming a corresponding relief design and then shaving the relief design to cut out narrow portions of the opaque layer to expose corresponding narrow portions of the intermediate translucent layer.

In one practice of the invention involving two such designs, heat and pressure are applied to form two corresponding relief designs having wide elements and narrow elements respectively. Material is then removed from both the relief designs to provide the two required cut-out designs. The relief design for the relatively narrow design elements protrudes by a relatively small dimension so the operation of shaving this design results in cut-outs in the outer opaque layer but merely skims the intermediate translucent layer so that the finished design is in the exposed areas of the intermediate layer. The other relief design composed of the wider design elements protrudes by a greater dimension in this particular practice of the invention so that shaving of the second relief design cuts out the intermediate translucent layer in addition to the outer opaque layer.

In another practice of the invention, the design having wider design elements is produced by engraving the multiple-ply plate instead of subjecting the plate to heat and pressure for the production of a relief design. The engraving may be of relatively light depth to penetrate to less than the full thickness of the intermediate translucent layer if desired. In the preferred practice of the invention, however, the engraving extends through both the outer opaque layer and the intermediate translucent layer, and in addition penetrates the relatively thick inner or back layer to form recesses therein corresponding to

the cut-out portions of the two outer layers. An important advantage of recessing the back plate in this manner is that the recesses provide transilluminated areas that increase the visibility of the design in darkness. The design is then completed by applying the additional layer of light-reflecting translucent material to cover and overlap the cut-outs for the wider design elements.

The features and advantages of the invention may be understood from the following description considered with the accompanying drawing.

In the drawing, which is to be considered as merely illustrative:

Figure 1 is a fragmentary face view of a panel embodying one practice of the invention, portions of the two outer layers of the panel being broken away;

Figure 2 is a section taken as indicated by the line 2-2 of Figure 1 showing a lamp mounted for transillumination of the panel;

Figure 3 is a section taken as indicated by the line 3-3 of Figure 1;

Figure 4 is a section taken as indicated by the line 4-4 of Figure 1, showing how the design of relatively wide elements may be created;

Figure 5 is a view similar to Figure 4 showing how the second design of relatively narrow elements may be produced; and

Figure 6 is a section similar to Figure 5, illustrating an alternate practice of the invention for producing the design that has relatively wide elements.

The drawing shows by way of example, how the invention may be embodied in a panel, generally designated by the letter P, which is employed as indicating means in conjunction with a fuel system on an aircraft. In a fuel system represented by the panel, fuel is supplied to a fuel manifold from a plurality of fuel tanks or cells positioned at different points on the aircraft and the route of fuel flow through the piping of the system must be changed to switch from one fuel source to another. The purpose of the panel P is to indicate the state of the fuel system with respect to the adjustment of valves controlling the route of the fuel flow. The panel P is transilluminated by a lamp bulb 10 (Figure 2) in a lamp housing, generally designated by numeral 11 (Figures 1 and 2), so that the design of markings on the outer face of the panel may be viewed either by reflected light from external sources, or may be viewed by transillumination.

The markings on the face of the panel P include a relatively wide line 14 representing the fuel manifold. Pipes connected to the fuel manifold are represented on the panel by a broken line 15 and by continuous lines 16, 17, 18, 19. A rotary disk 20 incorporated in the panel construction represents a 4-way valve in the fuel system and has a pair of spaced arcuate lines 22 and 23 thereon to represent paths of fuel flow through the valve.

In the rotary position of the rotary disk 20 shown in Figure 1, the 4-way valve represented by the disk connects the two pipes represented by lines 17 and 18 with a corresponding pair of pipes represented by lines 24 and 25 respectively. At the alternate position of the disk, rotated approximately 90 degrees clockwise from the position shown in Figure 1, the arcuate line 22 on the disk interconnects lines 24 and 25 and the arcuate line 23 interconnects lines 17 and 18 to indicate the corresponding functional relationship between the pipes and the 4-way valve at its alternate position.

The actual 4-way valve (not shown), that is represented by the rotary disk 20, is controlled by a knob 30 on the panel P. The knob 30 covers a circular aperture 31 in the panel P and may be made of any suitable material either translucent or opaque. The knob 30 is mounted on the outer end of an operating shaft 32 that controls the 4-way valve. The operating shaft 32 is reduced in diameter to provide a reduced end portion 33 and a radial shoulder 34. The reduced end portion 33 is

threaded to receive a suitable nut 35 which co-operates with the radial shoulder 34 to clamp a disk 36 on the operating shaft in a fixed manner.

The disk 36, which may be made of suitable plastic material, has a circumferential groove 40 to receive a suitable belt member 41 that engages a similar circumferential groove 42 on the periphery of a second similar disk 43. It is apparent that the second disk 43 will rotate in unison with the knob 30. The second disk 43 is adapted to actuate the previously mentioned rotary panel disk 20 which represents the 4-way valve actuated by the operating shaft 32.

As shown in Figure 3, the rotary panel disk 20, which is of the same construction and material as the panel P, is rotatably mounted in a circular aperture 44 that is recessed to form an outwardly directed shoulder 45. The panel disk 20 is formed with a circumferential radial shoulder 46 which rests against the shoulder 45 to keep the panel disk from shifting in one axial direction. A thin circular plate 47, which is attached to the inner side of the panel disk 20 prevents axial movement of the panel disk in the opposite direction. In the construction shown, a pin 50, having an outer head 51 extends through the panel disk 20 and the circular plate 47 axially thereof and is threaded at its inner end to carry a pair of nuts 52 and 53. Nut 52 co-operates with the head 51 of the pin to clamp the circular plate 47 against the inner side of the rotary disk 20 and the two nuts 52 and 53 cooperate to clamp the second peripherally grooved disk 43 on the pin 50.

At the positions of the knob 30 and the rotary panel disk 20 shown in Figure 1, a pointer 54, extending radially from the knob 30 and integral therewith, is positioned at a first index spot 55 on the panel P. At the alternate position of the rotary panel disk 20, and, of course, at the corresponding alternate position of the 4-way valve represented by the panel disk, the pointer 54 of the knob 30 registers with a second index spot 56.

The lamp housing 11 may be of any suitable construction for the purpose. In the well-known construction shown in the drawing, the housing includes a metal barrel 60 that is peripherally threaded to receive a pair of thin nuts 61 that co-operate to clamp the housing to the panel P with the housing extending through a circular aperture 62 in the panel. The metal barrel 60 has a series of circumferentially spaced slots 63 positioned to direct light into the panel edgewise of the aperture 62 for transillumination of the panel. The base ferrule 64 of the lamp which forms one of its two contacts is embraced by an inner metal sleeve 65 which is electrically connected with one side of the lamp circuit and is insulated from the metal barrel 60 by a liner 66 of suitable conducting material. The metal sleeve 65 has circumferentially spaced windows 67 which register with the circumferentially spaced slots 63 of the metal barrel 60 to permit light to escape from the housing.

The metal sleeve 65, which has a terminal portion 68 adapted for electrical connection with the lamp circuit, serves to confine a suitable spring 69 that presses the lamp bulb 10 endwise to hold the end contact 70 of the lamp bulb against a dished metal disk 71. The dished metal disk 71 is pressed by a second stronger spiral spring 72 against the rim of the metal barrel 60. Thus the second contact 70 of the lamp bulb is electrically connected with the lamp circuit through the dished metal disk 71 and the metal barrel 60. The portion of the lamp housing that extends forward or outward from the panel is covered by an opaque plastic cap 73 that screws onto the metal barrel 60.

As heretofore indicated, the present invention is directed to the problem of providing the overall design of markings on the panel P for observation both by reflected light and by transillumination. The invention is especially directed to the problem of providing the design elements that are relatively wide, a different technique be-

5

ing contemplated for the wider design elements than for the relatively narrow design elements. Thus in the application of the invention to the construction of the panel P shown in Figure 1, the markings on the panel are considered as constituting two separate designs.

One of the two designs includes all of the relatively broad design elements and therefore comprises the following design elements shown in Figure 1: the line 14 representing the fuel manifold; the broken line 15 branching from the manifold line; the continuous lines 16, 17, 18 and 19 also branching from the manifold line; the two arcuate lines 22 and 23 representing the flow passages through the 4-way valve; the two lines 24 and 25 representing pipes connected to the 4-way valve; and the two index spots 55 and 56 associated with the knob 30.

The second of the two designs which is made up of narrow design elements, includes all the small lettering on the panel P, such as the lettering spelling out "fuel manifold." This second design also includes such elements as the small rectangle 74 and the small arrows 75 therein which indicate directions of flow through various pipes such as the pipes represented by the lines 16 and 19.

One construction and method of fabrication suitable for providing the first design of relatively broad design elements may be understood by referring to Figure 4. The panel P, shown in cross-section in Figure 4, comprises a 3-ply laminated plate. The base lamination is a relatively thick layer 80 of suitable light-transmitting or semitransparent plastic material such as methyl methacrylate which is commonly sold under the trade names "Plexiglas" and "Lucite." Bonded to this inner or back layer 80 is an intermediate relatively thin layer 81 of suitable light-reflecting translucent material and bonded, in turn, to the intermediate layer 81 is an outer or front relatively thin layer 82 of opaque material. Both of these layers 81 and 82 may be made essentially of a vinyl or polyvinyl resin such as polyvinyl chloride with suitable plasticizers included. Thus, the 3-ply laminated plate that forms the body of the panel P is made entirely of thermoplastic material in the preferred practice of the invention. Since all of the three layers are thermoplastic, the three layers may be bonded together simply by the application of heat and pressure in a manner well-known in the art.

The design comprising the relatively wide design elements may be provided by first engraving the 3-ply plate with the pattern of engraving conforming to the desired design, but with the engraved line much narrower than the lines that are desired to be visible by reflected light. Thus, as shown in Figure 1, relatively narrow lines are engraved on the outer side of the 3-ply plate and as shown in Figure 4, the engraving not only extends through the outer or front layer 82 and the intermediate layer 81, but also penetrates the inner or back layer. Thus, the engraving results in relatively narrow slots or cut-outs 83 in the outer layer 82, corresponding cut-outs 84 in register therewith in the intermediate layer 81, and finally corresponding recesses 85 in the back layer 80 in register with the cut-outs.

It is the cut-outs 83 and 84, together with the recesses 85, that permit transillumination of the wider design elements. It is not necessary for the engraving to penetrate completely through the intermediate layer 81, but such penetration is desirable because the resulting recesses 85 extend into the interior of the back layer 82 and the bottom corners 86 of the recesses are illuminated by the lamp bulb 10, to make the corresponding design marks visible by transillumination. Preferably, the corners 86 are rounded as shown to produce a desirable optical effect.

The next step for providing the relatively broad elements of the first design is to apply an additional layer 90 of suitable translucent material to cover the cut-outs and recesses. The additional layer 90 extends laterally

6

both directions from the cut-outs to provide the width of the design elements desired for clear visibility by reflected light. Thus, as shown in Figures 1 and 4, the additional layer 90 is substantially wider than the cut-outs and recesses to provide the desired relatively broad design elements. The particular additional layer 90 that is shown in Figure 4 provides the broad mark 25 of Figure 1.

This layer 90 of additional light-reflecting translucent material is shown in Figure 4 as completely filling the groove provided by the cut-outs 83 and 84 together with the corresponding recess 85, but the additional layer need not completely fill the groove. The additional layer 90 may comprise ordinary white paint, if desired, or may comprise any translucent mixture of plastic material or other material. If a number of panels are to be produced, the additional layer 90 may be applied to each panel by a stencil technique.

Since the application of the additional layer 90 may be easily controlled within close dimensions, it is a simple matter to form the various relatively wide design elements with clean-cut well-defined edges. The engraving also provides clean-cut demarcations, but since the areas that are lighted by transillumination are relatively narrow, clean-cut demarcation of the cut-outs 83 and 84 and the recesses 85 is not important, especially because the additional translucent layer 90 diffuses the transmitted light.

The second design made up of relatively narrow design elements may be provided by a well-known technique illustrated by Figure 5. In this technique which is set forth at length in the Sullivan Patent 2,602,036, the 3-ply thermoplastic plate is subjected to heat and pressure in a suitable mold that causes viscous flow of the three laminations to form the desired design in relief. Thus Figure 5, which may represent a cross-section of the letter "T" in the word "manifold" in Figure 1, shows how a relatively narrow design element may be formed in relief by outward offsetting of the materials of the three layers 80, 81 and 82. The relief protrusion which is represented by the dotted line 91 in Figure 5, is then shaved away to the level of the outer surface of the outer opaque layer 82. The degree of outward protrusion of the two layers 82 and 81 to form the relief pattern is such then when the relief pattern is shaved away, a gap or cut-out 92 is formed in the outer opaque layer 82, to expose the intermediate light-reflecting translucent layer 81. Preferably, the protrusion in making the relief pattern is of such degree that only a portion of the intermediate layer is skimmed off when the relief pattern is removed, the result being shown in Figure 5. If desired, however, a gap or cut-out may also be formed in the intermediate layer 81.

Since the intermediate layer 81 is light-reflecting as well as translucent, the exposure of relatively narrow portions of the intermediate layer in the construction shown in Figure 5, provides the desired relatively narrow design elements for observation by reflected light. The same design elements are visible, however, by transillumination and the local convex offset 93 of the material of the inner or back layer 80 provides a local lens effect that greatly improves the lighting of the narrow design elements by transillumination.

From the foregoing description, it is clear that the first design of relatively wide markings is provided by the design construction and fabrication procedure illustrated by Figure 4, and that the accompanying second design of relatively narrow markings is provided by the design construction and method of fabrication illustrated by Figure 5.

If desired, the relatively wide design elements on the panel P may be provided by a construction and method of fabrication illustrated by Figure 6. In this modified practice of the invention, the step of subjecting the 3-ply thermoplastic plates to heat and pressure in a suitable

mold is used not only to provide a relief pattern for the narrow design elements, but also to provide a relief pattern for the wider design elements.

In Figure 6, which corresponds to Figure 4, the relatively wide design element comprising the wide line 25 in Figure 1, is provided by first forming the relatively wide design elements in relief as indicated by the dotted line 95. The relief design of relatively wide elements is then shaved away flush with the normal outer surface of the outer opaque layer 82. In this instance, the degree of protrusion of the 3-ply material to provide the relief design is relatively great so that when the relief design is shaved away, cut-outs are formed in both layers 81 and 82 as may be seen in Figure 6. An outer layer 96 of light-translucent material is then applied to the surface of the 3-ply plate to cover the cut-outs, the outer layer having the width desired for visibility by reflected light. One advantage of this second procedure for providing the relatively wide design elements is that the material of the back layer 80 is formed with a local convex offset 97 that is more pronounced than the offset 93 in Figure 5 and therefore results in a more effective lens effect for improving the transillumination of the wide design elements.

It will be noted in Figure 6, as well as in Figure 4, that the outer layer that is added to provide a relatively wide design element for observation by reflected light, stands out from the plane of the outer surface of the outer opaque layer 82 and therefore is more readily visible at relatively low angles with respect to the surface of the panel than prior art markings which are flush with the outer surface.

It is not necessary in the procedure illustrated by Figure 6, to make the relief protrusion so pronounced that cut-outs are formed in the intermediate layer 81. If desired, the relief may be less pronounced so that the intermediate layer 81 will be merely skimmed in the shaving process, instead of completely penetrated.

My description in specific detail of preferred practices of the invention, by way of example and to illustrate the principles involved, will suggest various changes, substitutions and other departures from my disclosure that properly lie within the spirit and scope of the appended claims.

I claim:

1. A method of fabricating a panel having a design thereon visible by both reflected light and by light transmitted through the material of the panel, including the steps of: forming a unitary laminated plate of plastic material having a relatively thick inner light-transmitting layer and an outer relatively thin, substantially opaque layer with said outer layer having cut-outs of the pattern of said design; and superimposing on said laminated plate a layer of light-reflecting, translucent material of the pattern of said design, the superimposed pattern being applied to the cut-out pattern and the elements of the superimposed pattern being made wider than the corresponding elements of the cut-out pattern.

2. A method of fabricating a panel having a design thereon visible by both reflected light and by light transmitted through the material of the panel, including the steps of: forming a unitary laminated plate of thermoplastic material having a relatively thick inner light-transmitting layer, an intermediate, relatively thin, translucent layer, and an outer relatively thin, substantially opaque layer; removing portions of said intermediate and outer layers to form cut-outs therein of the pattern of said design; and applying light-reflecting translucent material to said cut-outs and to adjacent portions of the face of said outer layer to form an additional layer conforming to the pattern of said design with the elements of the applied design wider than the corresponding elements of the cut-out design.

3. A method of fabricating a panel having a design thereon visible by both reflected light and by light trans-

mitted through the material of the panel, including the steps of: forming a unitary laminated plate of plastic material having a relatively thick inner light-transmitting layer and an outer relatively thin, substantially opaque layer; engraving said plate through said outer layer into said inner layer to form grooves conforming to the pattern of said design; and applying a light-reflecting translucent material to cover said grooves and to cover adjacent portions of the outer surface of said outer layer to form a superimposed pattern of said design with the elements of the superimposed design wider than the corresponding elements of the groove pattern and with the superimposed pattern of material protruding from the outer surface of said unitary plate.

4. A method of fabricating a panel having a design thereon visible by both reflected light and by light transmitted through the material of the panel, including the steps of: forming a unitary laminated plate of thermoplastic material having a relatively thick inner light-transmitting layer, an intermediate relatively thin translucent layer and an outer relatively thin, substantially opaque layer; subjecting said unitary plate to heat and pressure to displace selected portions of the plate outward from the outer face of the plate to form a relief pattern conforming to said design, with the full thickness of both said intermediate layer and said outer layer extending through the plane of the outer face of the plate into the relief pattern; removing the material of said relief pattern thereby forming a similar pattern of cut-outs in said intermediate and outer layers; and applying a light-reflecting translucent material to said cut-outs and to adjacent portions of the face of said outer layer to form an additional layer conforming to the pattern of said design, with the elements of the applied design wider than the corresponding elements of the cut-out design.

5. A method of fabricating a panel having a first design thereon of relatively wide design elements and having a second design thereon of relatively narrow design elements, said two designs being visible both by reflected light and by light transmitted through the material of the panel, said method including the steps of: forming a unitary laminated plate of thermoplastic material having a relatively thick inner light-transmitting layer, and intermediate relatively thin, translucent layer, and an outer relatively thin, substantially opaque layer; engraving said plate through said outer and intermediate layers to form grooves conforming to the pattern of said first design; applying a light-reflecting translucent material to said grooves and to cover adjacent portions of the outer surface of said outer layer to form a superimposed pattern of said first design with the elements of the superimposed pattern wider than the corresponding elements of the groove pattern and with the superimposed pattern of material protruding from the outer surface of said unitary plate; applying heat and pressure to displace narrow portions of the plate outward from the plane of the outer surface of said outer opaque layer to form a relief pattern conforming to said second design; and removing material from said relief pattern to expose the portions of the material of said intermediate layer conforming to said second design.

6. A panel of the character described having a design thereon for observation either by reflected light or by light transmitted through the material of the panel, comprising: a unitary laminated plate of plastic material having an inner relatively thick layer of light-transmitting material and an outer relatively thin layer of opaque material, said opaque layer having cut-outs therein conforming to said design; and an additional layer of light-reflecting translucent material conforming to said design, said additional layer covering said cut-outs and extending over adjacent portions of said opaque layer whereby the elements of the design formed by said additional

layer are wider than the corresponding elements of the design formed by said cut-outs, and whereby the wider elements protrude from the plane of the outer surface of said opaque layer.

7. A panel as set forth in claim 6, in which the material of said light-transmitting layer extends through said cut-outs to the plane of the outer surface of said outer opaque layer.

8. A panel as set forth in claim 6, in which said inner layer has recesses registered with said cut-outs and in which said added layer extends into said cut-outs and into said recesses.

9. A panel as set forth in claim 8 in which said

recesses are of curved cross-sectional configuration at the bottom corners thereof.

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