

**A LIGHT-TRANSMITTING DISPLAY DEVICE COMPOSED OF
SYNTHETIC RESIN AND A MOLD FOR FABRICATION THEREOF**

BACKGROUND OF THE INVENTION

1. Field of the Invention:

5 The present invention relates to a light-transmitting display device composed of synthetic resin which can suitably be used in an operation switch, a display section, etc. to be installed in an operation panel and the like for an electric appliance, an automobile, and the like; and a mold for production thereof. More particularly, the present invention relates to a light-transmitting display device composed of synthetic resin which is molded by injection molding where resins having different colors (tones) are laminated in an integral manner; and a mold for production thereof.

2. Description of the Related Art:

20 Frequently, an operation panel and the like of an electric appliance or an automobile, for example, includes a display device for indicating an on-state of an operation switch, a display section, and the like. Such a display device is composed of an opaque portion and a light-transmitting display portion provided inside, or surrounded by, the opaque portion. The display portion can easily be recognized by human eyesight when illuminated by a light source disposed behind the display device so that only the front face of the display portion is lit up.

30 In general, such a display device is fabricated by the following method:

First, a light-transmitting resin layer is formed of synthetic resin which easily transmits light, e.g. translucent synthetic resin. A surface of the resin layer is colored with paint of a dark color such as black. Next, a portion of the resultant paint coating is removed by the use of a laser beam, whereby a light-transmitting display portion is exposed. The front face of the display portion is easily recognized by eyesight when light is radiated from behind the resultant display device, since the display portion allows the light to go therethrough.

The display device can also be fabricated by a two-color molding, which proceeds as follows:

A light-transmitting resin layer is formed of light-transmitting resin by a primary molding. Next, by a secondary molding, an opaque resin layer, composed of a dark-color resin, is formed on a surface of the light-transmitting resin layer excluding a portion to become a display portion.

However, the above-mentioned two methods for fabricating a display device have the following problems:

The former method inevitably includes a large number of fabrication steps, and is likely to incur a large production cost, since painting and laser processing are required. On the other hand, the latter method has a problem that a display portion of the shape '0', '8', etc. cannot be fabricated properly, since inner portions of such a display portion, which

are composed of opaque resin, are difficult to form because the inner portions are surrounded by the light-transmitting display portion. More specifically, it is difficult to transfer the dark-color resin to the inside of the light-transmitting display portion after the light-transmitting display portion has been formed by the primary molding.

In order to solve the above-mentioned problems, a method for fabrication of a display device has been proposed which is illustrated below with reference to Figure 4:

Figure 4 is a front view showing a conventional light-transmitting resin display device composed of synthetic resin. As is shown in Figure 4, the display device includes a light-transmitting display portion 30, an inner non-display portion 34, and an outer non-display portion 35. A part of the light-transmitting display portion 30 is disrupted so as to define a disrupted portion 31. Resin is transferred from the outer non-display portion 35 to the inner non-display portion 34 through the disrupted portion 31. According to this method, the disrupted portion 31 is required to have a width of at least 0.4 mm so that the molten resin can pass smoothly therethrough. As a result, when the display portion 30 is of a small size, the disrupted portion 31 becomes comparatively large, making the appearance of the display portion 30 somewhat unnatural as a whole.

Japanese Laid-Open Patent Publication No. 2-22869, for example, discloses a method for solv-

ing the above-mentioned problem, in which a display device is formed by two-color molding. The method is described below, with reference to Figures 5A, 5B, and 6:

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Figures 5A and 5B are sectional views showing an essential portion of a conventional mold used in this method. Figure 6 is a sectional view showing an essential portion of a conventional display device fabricated by this method. As is shown in Figures 5A and 5B, the mold used in this method includes: a primary female mold 41 having a concave portion 43 for forming a light-transmitting display portion 30; a male mold 45 having a pin 46 capable of protruding into/receding from a cavity 44 created between the male mold 45 and the primary female mold 41; and a secondary female mold 42.

First, as is shown in Figure 5A, a primary molding 50 is formed by filling the cavity 44 with light-transmitting resin, with the pin 46 protruding into the cavity 44. Then, as is shown in Figure 5B, the pin 46 is retracted from the cavity 44, whereafter the secondary female mold 42 is installed on the outside of the primary molding 50. Next, opaque resin is injected into a concave portion 48 created between the secondary female mold 42 and the male mold 45, whereby the display device is obtained as a secondary molding shown in Figure 6. In the above-mentioned process, as is seen from Figure 5B, the opaque resin is supplied from an outer concave portion 48a into an inner concave portion 48b via a passage 49 created in the cavity 44 after the pin 46 has receded. Thus, inner and outer

non-display portions 34 and 35 have been formed of the opaque resin. At the same time, a connecting portion 32 is formed of a portion of the opaque resin that was filled in the passage 49.

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As was described earlier, the width of the passage 49 must be relatively small so that the connecting portion 32 is not recognizable by human eyesight. On the other hand, the width of the passage 49 must be large enough for the opaque resin to pass through. Therefore, according to the conventional method, a portion of the light-transmitting display portion 30 is left to protrude from the back face of the display device so as to form a protrusion 33. Since the passage 49 is formed on the back side of the protrusion 33, the connecting portion 32 is prevented from being seen from the front face of the display device.

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However, in the above-mentioned method, the passage 49 runs all the way around the protrusion 33. Because the passage 49 is circuitous, the opaque resin is prevented from flowing therethrough smoothly. In other words, sufficient opaque resin may not be supplied from the outer concave portion 48a to the inner concave portion 48b via the passage 49. This makes it necessary to inject the opaque resin with a relatively high pressure so as to ensure that a sufficient amount of opaque resin is supplied to the inner concave portion 48b.

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SUMMARY OF THE INVENTION

5 A light-transmitting display device composed
of synthetic resin according to the present invention
comprises: a light-transmitting resin layer composed of
light-transmitting resin and an opaque resin layer
composed of opaque resin, the opaque resin layer inte-
grally formed on a surface of the light-transmitting
10 resin layer, wherein a portion of the light-transmit-
ting resin layer penetrates the opaque resin layer; a
light-transmitting resin display portion defined by the
portion of the light-transmitting resin penetrating the
opaque resin layer; an inner non-display portion com-
posed of the opaque resin layer, the inner non-display
15 portion being surrounded by the light-transmitting
display portion; and an outer non-display portion
composed of the opaque resin layer, the outer non-
display portion being disposed on an outside of the
light-transmitting resin display portion, wherein a
20 connecting portion for connecting the inner non-display
portion and the outer non-display portion is integrally
formed of the opaque resin on a back side of the
light-transmitting display portion, and wherein a
curved portion is formed on a back side of the connect-
25 ing portion, the curved portion protruding outside of
the light-transmitting display device.

In one embodiment, the width of the connect-
ing portion is 0.5 mm or less, the width being taken in
30 a direction perpendicular to a direction in which, seen
from a front side of the display device, the connecting
portion intersects the light-transmitting display
portion.

In another embodiment, the light-transmitting resin is milky-white resin and wherein the opaque resin is black resin.

5 A mold for producing a light-transmitting display device composed of synthetic resin according to the present invention comprises: a light-transmitting resin layer composed of light-transmitting resin and an opaque resin layer composed of opaque resin, the opaque
10 resin layer integrally formed on a surface of the light-transmitting resin layer, wherein a portion of the light-transmitting resin layer penetrates the opaque resin layer; a light-transmitting resin display portion defined by the portion of the light-transmitting resin penetrating the opaque resin layer; an inner
15 non-display portion composed of the opaque resin layer, the inner non-display portion being surrounded by the light-transmitting display portion; and an outer non-display portion composed of the opaque resin layer, the outer non-display portion being disposed on an
20 outside of the light-transmitting resin display portion, wherein the mold comprises: a primary female mold having a concave portion for forming the light-transmitting display portion; a male mold for creating a cavity in cooperation with the primary female mold, the
25 cavity being to be filled with the light-transmitting resin; a pin capable of protruding into and receding from the cavity; and a secondary female mold to be installed on an outside of a primary molding, the primary molding being formed by filling the cavity with
30 the light-transmitting resin with the pin protruding into the cavity and by solidifying the light-transmitting resin, and wherein a curved face is formed on an

upper end of the pin which protrudes into the cavity.

5 In one embodiment, the thickness of the pin is 0.5 mm or less, the thickness being taken in a direction perpendicular to a direction in which, seen from a front side of the display device, the pin intersects the light-transmitting display portion.

10 A pin used in a mold for the fabrication of a light-transmitting display device composed of synthetic resin according to the present invention has a curved face formed on the upper end thereof. As a result, a curved portion is formed in a passage formed after the pin has receded from the cavity. Resin which flows
15 through the passage can be smoothly transferred from an outer concave portion to an inner concave portion, since it flows along the curved portion.

20 Thus, the invention described herein makes possible the advantages of (1) providing a light-transmitting display device composed of synthetic resin and having an inner non-display portion which is separated from an outer non-display portion by a display portion, the display device being formed in an integral
25 manner by multi-color molding, (2) providing a mold for integrally forming a display device having an inner non-display portion which is separated from an outer non-display portion by a display portion, without disrupting any parts of the display portion, the display device being formed by multi-color molding, and
30 (3) providing a mold capable of forming a display device using a relatively low pressure, taking advantage of a good flow of resin from an outer concave

portion to an inner concave portion.

5 These and other advantages of the present invention will become apparent to those skilled in the art upon reading and understanding the following detailed description with reference to the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

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Figure 1A is a sectional view showing an essential portion of a mold in operation according to an example of the present invention.

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Figure 1B is a sectional view showing an essential portion of a mold in operation according to an example of the present invention.

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Figure 2 is a plan view showing a light-transmitting resin display device composed of synthetic resin according to an example of the present invention.

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Figure 3A is an enlarged front view showing a pin in a mold shown in Figure 1.

Figure 3B is an enlarged front view showing a modified example of a pin in a mold shown in Figure 1.

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Figure 3C is an enlarged front view showing a modified example of a pin in a mold shown in Figure 1.

Figure 4 is a front view showing a conventional light-transmitting resin display device composed

of synthetic resin.

Figure 5A is a sectional view showing an essential portion of a conventional mold in operation.

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Figure 5B is a sectional view showing an essential portion of a conventional mold in operation.

Figure 6 is a sectional view showing an essential portion of a conventional display device.

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DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, an example of the present invention will be described with reference to Figures 1A, 1B, 2, 3A, 3B, and 3C. Figures 1A and 1B are sectional views showing an essential portion of a mold according to the present example. Figure 2 is a top view showing a light-transmitting resin display device composed of synthetic resin according to the present example.

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Example 1

As is shown in Figure 1A and 1B, the mold includes: a primary female mold 1 having a concave portion 3; a male mold 5 for forming a cavity 4 in cooperation with the primary female mold 1; a pin 6 capable of protruding into and receding from the cavity 4; and a secondary female mold 2.

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The primary and secondary female molds 1 and 2 are so configured as to be capable of moving in a vertical direction. When the primary female mold 1 is disposed upon an upper face of the male mold 5, the

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cavity 4 is created therebetween. The pin 6 is so designed and disposed as to be capable of protruding into and receding from the cavity 4. The thickness of the pin 6 (indicated by the letter 't' in Figure 2) should preferably be 0.5 mm or less, and more preferably be within the range of 0.3 mm to 0.4 mm. The pin 6 has a curved face 7 on the upper end thereof, which protrudes into the cavity 4.

The curved face 7 may have any of the configurations shown in Figures 3A to 3C, which are enlarged front views showing exemplary configurations for the pin 6. In any of Figures 3A to 3C, the curved face 7 has no angular corners. The curved face 7 shown in Figure 3A has a substantially uniform curvature. The curved face 7 shown in Figure 3B consists of a vertical face 6a and a bottom face 6b. The curved face 7 shown in Figure 3C consists of a tapered face 6c and a bottom face 6b. However, the curved face 7 may have configurations other than those shown in Figures 3A to 3C.

First, as is shown in Figure 1A, a primary molding (light-transmitting resin layer) 10 (shown in Figure 1B) is formed by filling the cavity 4 with light-transmitting resin, with the pin 6 protruding into the cavity 4 and abutting with an inside face of the primary female mold 1, and by solidifying the light-transmitting resin. As is shown in Figure 1B, the secondary female mold 2 is so configured as to be capable of being installed on and covering the light-transmitting resin layer 10. Then, the primary female mold 1 is detached from the male mold 5, whereafter the secondary female mold 2 is clamped on the upper face of

the male mold 5. After the pin 6 is retracted from the cavity 4, opaque resin is injected into a concave portion 8 created between the secondary female mold 2 and the light-transmitting resin layer 10. In a portion of the cavity 4 where the pin 6 was situated before the retraction, a passage 9 is created which connects an outer concave portion 8a and an inner concave portion 8b. The opaque resin is supplied from the outer concave portion 8a to the inside of the inner concave portion 8b via the passage 9. As a result, inner and outer non-display portions 23 and 24 are formed of the opaque resin. Thus, the display device is obtained as a secondary molding as shown in Figure 2.

As is seen from Figure 2, the display device includes the light-transmitting resin layer 10 and an opaque resin layer 20 integrally formed on a surface of the light-transmitting resin layer 10. A portion of the light-transmitting resin layer 10 penetrates the opaque resin layer 20 in a direction vertical to the front face of the display device. Thus, a light-transmitting display portion 11, which is composed of the light-transmitting resin layer 10, is formed on a portion of the surface of the opaque resin layer 20. More specifically, the opaque resin layer 20 is composed essentially of the inner non-display portion 23, which is completely surrounded by the light-transmitting display portion 11, and the outer non-display portion 24, which is disposed on the outside of the light-transmitting display portion 11.

A connecting portion 21 composed of the opaque resin is integrally formed on the back side of the light-transmitting display portion 11 so as to connect the inner non-display portion 23 and the outer non-display portion 24. In other words, the connecting portion 21 is formed in the portion of the cavity 4 where the pin 6 was before the retraction thereof. On the back side of the connecting portion 21 is formed a curved portion 22 (shown in Figure 1B), which is formed in accordance with the curved face 7 of the pin 6.

The connecting portion 21 may have any width t . However, the width t should preferably be relatively small so that the connecting portion 21 cannot be recognized through the display portion 11 when the display device is seen from the front.

By disposing a light source on the back-face side of the display device thus obtained (i.e. the side where the light-transmitting resin layer 10 is chiefly formed), and activating the light source, the light-transmitting display portion 11 can be recognized as a bright portion, as seen from the front side of the display device, since light emitted from the light source is transmitted through the display portion 11. Since the connecting portion 21 formed across the display portion 11 on the back side thereof has only a small width, the light is hardly interrupted by the connecting portion 21. As a result, the display portion 11 conducts a clear display.

As for the light-transmitting resin used in the present invention, it can be made of any material

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as long as it transmits light. Resin in which a desired dye or pigment is added can be used. For example, the light-transmitting display portion 11 may be composed of milky-white resin, or resin having any other color. In cases where light-transmitting resin in which a fluorescent dye or pigment is added is used, the display portion 11 emits fluorescent light when the light source is turned on. As a result, a vivid display can be provided even in cases where the configuration of the display portion 11 consists of fine lines; as the connecting portion 21 formed of the opaque resin has substantially no influence on the display.

As for the opaque resin, there is no limitation to the color thereof. For example, black-colored resin can be used.

The overall configuration of the display device is not limited to that described above; the display device can have any shape, such as a plate-like shape or any three-dimensional shape, as long as it is possible to form the display device.

Various other modifications will be apparent to and can be readily made by those skilled in the art without departing from the scope and spirit of this invention. Accordingly, it is not intended that the scope of the claims appended hereto be limited to the description as set forth herein, but rather that the claims be broadly construed.

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What is claimed is:

1. A light-transmitting display device composed of synthetic resin, the display device comprising:

5 a light-transmitting resin layer composed of light-transmitting resin and an opaque resin layer composed of opaque resin, the opaque resin layer integrally formed on a surface of the light-transmitting resin layer, wherein a portion of the light-transmitting resin layer penetrates the opaque resin layer;

10 a light-transmitting resin display portion defined by the portion of the light-transmitting resin penetrating the opaque resin layer;

15 an inner non-display portion composed of the opaque resin layer, the inner non-display portion being surrounded by the light-transmitting display portion; and

20 an outer non-display portion composed of the opaque resin layer, the outer non-display portion being disposed on an outside of the light-transmitting resin display portion,

25 wherein a connecting portion for connecting the inner non-display portion and the outer non-display portion is integrally formed of the opaque resin on a back side of the light-transmitting display portion, and wherein a curved portion is formed on a back side of the connecting portion, the curved portion protruding outside of the light-transmitting display device.

30 2. A light-transmitting display device according to claim 1, wherein the width of the connecting portion is 0.5 mm or less, the width being taken in a direction perpendicular to a direction in which, seen from a



front side of the display device, the connecting portion intersects the light-transmitting display portion.

5 3. A light-transmitting display device according to claim 1, wherein the light-transmitting resin is milky-white resin and wherein the opaque resin is a black resin.

10 4. A mold for producing a light-transmitting display device composed of synthetic resin, the display device comprising:

15 a light-transmitting resin layer composed of light-transmitting resin and an opaque resin layer composed of opaque resin, the opaque resin layer integrally formed on a surface of the light-transmitting resin layer, wherein a portion of the light-transmitting resin layer penetrates the opaque resin layer;

20 a light-transmitting resin display portion defined by the portion of the light-transmitting resin penetrating the opaque resin layer;

an inner non-display portion composed of the opaque resin layer, the inner non-display portion being surrounded by the light-transmitting display portion; and

25 an outer non-display portion composed of the opaque resin layer, the outer non-display portion being disposed on an outside of the light-transmitting resin display portion,

wherein the mold comprises:

30 a primary female mold having a concave portion for forming the light-transmitting display portion;



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a male mold for creating a cavity in cooperation with the primary female mold, the cavity being to be filled with the light-transmitting resin;

5 a pin capable of protruding into and receding from the cavity; and

a secondary female mold to be installed on an outside of a primary molding, the primary molding being formed by filling the cavity with the light-transmitting resin with the pin protruding into the cavity and
10 by solidifying the light-transmitting resin,

and wherein a curved face is formed on an upper end of the pin which protrudes into the cavity.

15 5. A mold according to claim 4, wherein the thickness of the pin is 0.5 mm or less, the thickness being taken in a direction perpendicular to a direction in which, seen from a front side of the display device, the pin intersects the light-transmitting display portion.

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