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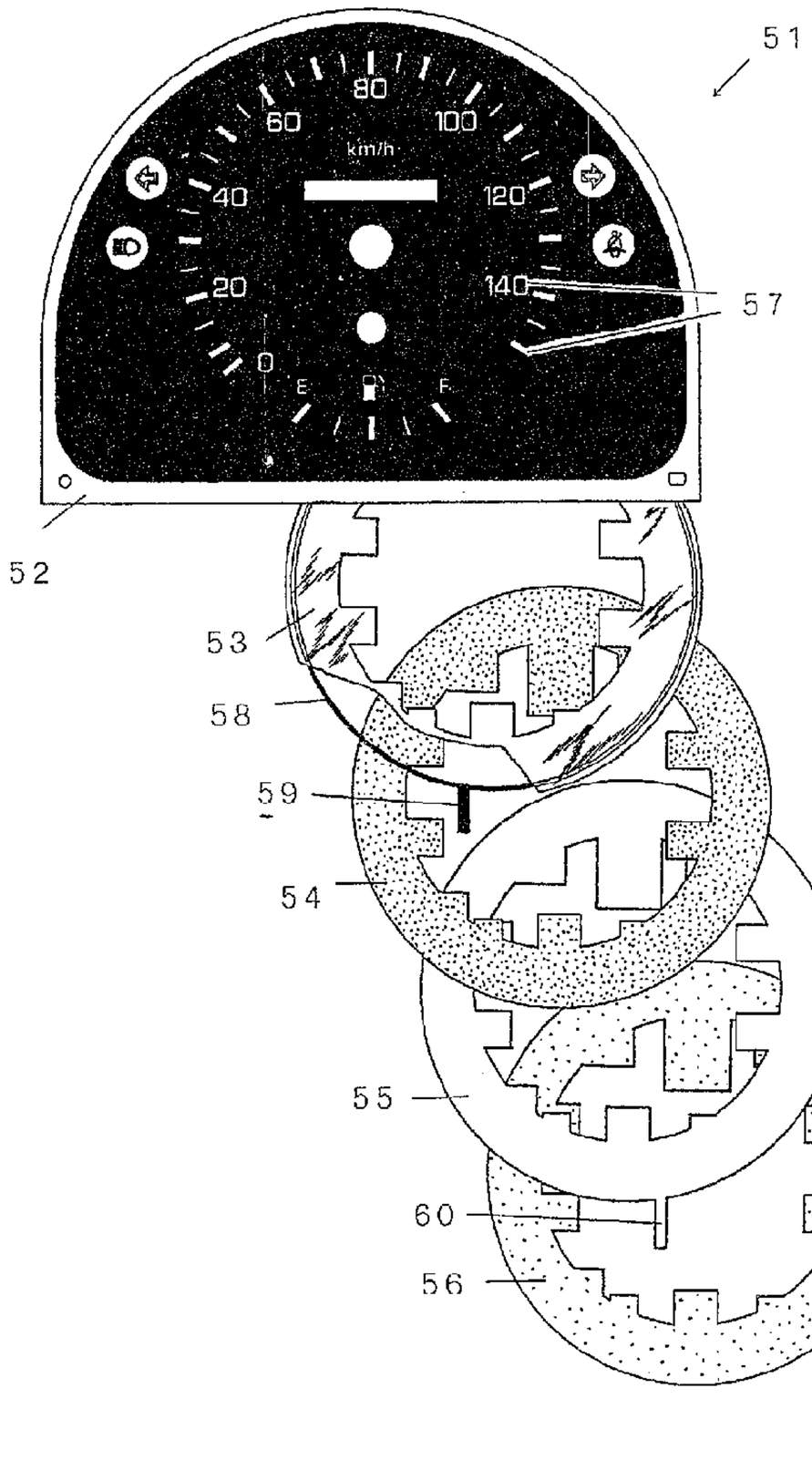
(54) **TABLEAU D'AFFICHAGE**

(54) **DISPLAY PANEL**



(57) A display panel integrated with an EL (electroluminescent lamp) can be obtained by printing the EL at the back of a light permeable substrate, and covering the front surface of the substrate and the rear face of the EL with a moisture proof film for insulating and protecting the EL from the surroundings, or by covering the substrate and the EL entirely and printing an indication mark on the surface of the moisture proof film. The arrangement simplifies the production of the display panel as compared with the prior method of attaching an EL as an independent member to the display panel after its manufacture.

ABSTRACT

A display panel integrated with an EL (electroluminescent lamp) can be obtained by printing the EL at the back of a light permeable substrate, and covering the front surface of the substrate and the rear face of the EL with a moisture proof film for insulating and protecting the EL from the surroundings, or by covering the substrate and the EL entirely and printing an indication mark on the surface of the moisture proof film. The arrangement simplifies the production of the display panel as compared with the prior method of attaching an EL as an independent member to the display panel after its manufacture.

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DISPLAY PANEL

The present invention concerns a display panel in which an indication mark is illuminated by light emission from the rear face, and, in particular, it relates to a display panel suitable to use as a plate for an indication instrument.

For instance, in an automobile dashboard indicator, marks such as scales or numerical figures printed on the front surface of a plate can be seen clearly at night or in a dark circumstance. Specifically, a light permeable substrate is adopted for the plate, and it is so formed that an indication mark in the form of a negative indication (the mark appears bright) or a positive (opposite to the negative) indication. An illumination source comprising lamps is disposed at the back of the plate. For example, refer to U.S. Patent Nos. 4,878,387 issued November 7, 1989 to M. Muramatsu and 5,047,761 issued September 10, 1991 to G. Sell.

In such an indicator, the brightness of the indication mark is not uniform, depending on the distance from the illumination source and it is difficult to see. Further, in view of the heat generation by the illumination source, an expensive heat resistant material has to be used for the casing containing the indicator. Further, since the gap has to be large between the illumination source and the casing in view of the heat generation, the size of the casing is enlarged.

As a countermeasure for overcoming such problems, an electroluminescent lamp panel (hereinafter referred to as "EL") is sometimes disposed at the back of the face plate (for example, refer to U.S. Patent No. 5,036,249 issued July 30, 1991 to M.J. Pike-Biegunski and Japanese Utility Model Laid-Open Sho 62-40518 and Sho 62-124510).

The foregoing problems can be solved by adopting an EL for the illumination of the plate. However, when the EL is at the back of the plate, the relative position of the EL and the plate has to be aligned accurately for satisfactory illumination of the indication mark on the plate by the EL emission. In addition, since the EL is thin and easy to flex

and hence distort, it has to be protected from the surrounding conditions, such as external vibrations, and a rigid rear frame has been attached at the back of the EL for instance. Accordingly, the assembling operation between the plate and the EL or the plate, the EL and the rear frame becomes complicated enough to make production troublesome.

An object of the present invention is to overcome the foregoing problem and to provide a display panel integrated with an EL and, particularly, a display panel suitable to use as a plate for use in an indicator.

In accordance with one aspect of the present invention there is provided a display panel comprising: a light permeable substrate having an indication mark on the surface thereof; and a light permeable front electrode, a light emission layer, a back electrode and an insulating layer successively formed at the back of the light permeable substrate; wherein (i) the light permeable front electrode, the light emission layer, the back electrode and the insulating layer are formed by screen printing and (ii) the insulating layer insulates said front electrode, said light emission layer and said back electrode from the surrounding atmosphere.

In accordance with another aspect of the present invention there is provided a display panel comprising: a light permeable substrate having an indication mark on the surface thereof; and a light permeable front electrode, a light emission layer, a back electrode and an insulating layer successively formed at the back of the light permeable substrate; wherein: the light permeable front electrode, the light emission layer, the back electrode and the insulating layer are formed by screen printing; the back of the light permeable substrate has a first surface portion and a second surface portion, and the light permeable front electrode is formed to be in contact with only the first surface portion; and the insulating layer insulates said front electrode, said light emission layer and said back electrode from the surrounding atmosphere and is formed so as (i) to entirely

cover side surfaces of the light permeable front electrode, the light emission layer, and the back electrode and a back surface of the back electrode, and (ii) to be in contact with only the second surface portion of the back of the light permeable substrate.

IN THE DRAWINGS:

Fig. 1 is a perspective view partly cut away of a first embodiment according to the present invention;

Fig. 2 is a cross sectional view of a portion of the embodiment described above;

Fig. 3 is a cross sectional view of a portion of a second embodiment according to the present invention;

Fig. 4 is a cross sectional view of a portion of a third embodiment according to the present invention;

Fig. 5 is an exploded perspective view of a fourth embodiment according to the present invention;

Fig. 6 is a cross sectional view of a portion of the embodiment described above; and

Fig. 7 is a back view showing a front electrode and a bus bar formed to a substrate of the embodiment described above.

Figs. 1 and 2 show a first embodiment according to the present invention in which an EL 2 is printed on the rear face of a light permeable substrate 1, the EL being formed by laminating at the back of the substrate 1. Also shown are a moisture absorbing layer 21 (Sumicagel™, nylon or the like), a light permeable front electrode 22 (coating type ITO), a light emission layer 23, an insulation layer 24, a reflective back electrode 25 (Ag foil) and a moisture absorbing layer 26 arranged successively. The front surface of the substrate 1 and the rear face of the EL 2 are covered with a moisture proof film 3 for insulating and protecting the EL from the surrounding atmosphere. Terminals (leads) 22a, 25a for the electrodes 22, 25 are exposed to the outside of the moisture proof film 3, the periphery of the moisture proof film 3 is sealed, and an indication mark 4 of a negative display is printed at the front surface of the moisture film on the front surface of the substrate 1.

Fig. 3 shows a second embodiment in which the moisture proof film 3 in the first embodiment covers the substrate 1 and the EL 2 entirely, an indication mark 4 being printed on the surface of the moisture proof film 3.

Fig. 4 shows a third embodiment in which an indication mark 4 is previously printed on the front surface of the light permeable substrate 1. The EL 2 of the same constitution as that in the first or second embodiment is printed on the back of the substrate 1, and the substrate 1 and the EL 2 are entirely covered by a moisture proof film 3 for insulating and

protecting the EL from the surrounding atmosphere, as in the second embodiment. In the third embodiment, the moisture proof film 3 can cover the front surface of the substrate 1 and the rear face of the EL 2 as in the first embodiment.

According to the first to third embodiments, the light emission layer 23 emits light by application of a predetermined voltage to each of the terminals 22a, 25a for the electrodes 22, 25 and this light emission illuminates the mark 4 from behind.

Thus, according to the first to third embodiments, a face plate with numbers integrated with the EL 2 can be obtained. Accordingly, manufacture of the plate is simplified as compared with the prior art, i.e. manufacturing the EL as an independent member that is later attached to the plate.

Figs. 5, 6 and 7 show a fourth embodiment according to the present invention in which a face plate 51 is formed by successively printing on the back of a light permeable substrate 52, a light permeable front electrode 53 (coating type ITO), a light emission layer 54, and a back electrode 55, followed by drying and, further, forming an insulation layer and then printing and drying an indication mark 57 showing a speed and fuel remaining on the front surface of the substrate 52. The electrode 53, light emission layer 54, electrode 55 and insulation layer 56 correspond to EL 2 (refer to Fig. 1 - 4) of the first to third embodiments.

The substrate 52 is a panel (of about 1.5 mm thickness) made of a resin, for example, a polycarbonate, similar to existent plates for an indicator, and when using an indication mark 57 of negative form, it can be obtained by printing the mark 57 with a white or other light permeable paint and printing other portions with a light impermeable paint of black or other color. A positive indication can be attained by reversing this procedure. In this embodiment, a negative indication mark 57 is formed by the same printing means as for an existent plate, e.g. by printing the indication mark 57 with a white paint 57a while painting other portions with a black paint 57b.

The front electrode 53 is formed by preparing a light permeable conductive material by kneading a metal oxide comprising indium oxide containing tin and adsorbing a dispersant composed of an anionic surface active agent and a binder resin comprising a vinyl acetate resin and adjusting the viscosity by a solvent comprising butyl cellosolve acetate and printing and drying the conductive material in a shape corresponding to the indication mark 57 (about 5 μm thickness). A bus bar 58 comprising a low resistance material of a silver paste is formed by printing and drying so as not to oppose the indication mark 57 at the periphery of the front electrode 53, and a portion of the bus bar 58 is led to the end at the back of the substrate 52 as a terminal 59 (about 5 μm thickness).

The light emission layer 54 is formed by using a fluorescent paste prepared by dispersing a fluorescent material comprising a matrix of zinc sulfide mixed with a copper activator and, as required, a chlorine activator into a thermosetting epoxy resin of low water absorption, and printing and drying the same substantially in the same shape (identical or somewhat greater) as the electrode 53 (about 40 μm thickness).

The back electrode 55 is formed by printing and drying a reflecting conductive material of a silver paste to oppose the front electrode 53 by way of a light emission layer 54 followed by drying, and a portion of the back electrode 55 is led out to the end of the rear face of the substrate 52 as a terminal 60 (about 10 μm thickness). The light emission layer 54 emits light by applying a predetermined voltage between terminals 59 and 60, that is, between electrodes 53 and 55, and the light illuminates the indication mark 57 from behind. It will be apparent that the electrodes 53, 55 and the terminals 59 and 60 have to be designed and formed with care not to cause a short circuit between them.

An insulation layer 56 serves to insulate and protect the front electrode 53, the emission layer 54 and the back electrode 55 from the surrounding conditions, such as moisture or impact shock, which can be achieved by appending a high molecular weight insulation material, such as a thin nylon sheet or a polyethylene naphthalate film, to the back of the substrate 52, excepting for the terminals 59, 60. As shown in Figs. 5 and 6, if a thermosetting polymeric material, such as an epoxy resin incorporated with a spacer material of glass beads, is formed by printing and drying as an insulation material (about 15 μm thickness), the entire thickness and the weight of the plate can be reduced. The entire portion including the front electrode 53 and the insulation layer 56 can be formed by printing and accordingly the production step is simplified more than in the case of using insulation material.

As shown in Fig. 6, the light permeable front electrode 53 is formed to be in contact with a portion of the surface of the back of the light permeable substrate 52. The insulating layer 56 entirely covers the side surfaces of the light permeable front electrode 53, light emission layer 54 and back electrode 55, as well as the back surface of the back electrode 55. The insulating layer 56 is also in contact with a portion of the surface of the back of the light permeable substrate 52 which is outside the back surface portion of the substrate 52 which is in contact with the front electrode 53.

Although not illustrated, it will be effective for improving the light emission performance of the light emission layer 54, if necessary, to interpose a dielectric layer (corresponding to the insulation layer 24 in the first to third embodiments shown in Figs. 1 - 4) between the electrodes 53 and 55. Such a dielectric layer is formed by printing a dielectric paste prepared by dispersing a dielectric material of barium titanate in a thermosetting epoxy resin of low water absorption and drying the same (about 40 μm thickness).

Reference numeral 61 in Fig. 7 denotes an alignment mark printed simultaneously upon printing the front electrode 53 with the identical material and it is disposed at the back of the substrate 52 not opposing to the indication mark 57. The indication mark 57 is formed on the front surface of the substrate 52 by aligning a printing mask (not illustrated) having a pattern for the indication mark 57 as a reference.

Further, an indication member situating at the back of the plate 51 can be illuminated by making the front electrode 53 - back electrode 55 greater than the indication mark 57 and making the back electrode 55 light permeable.

A face plate having the foregoing constitution can be disposed on an indicator (not illustrated) and the terminals 59 and 60 are connected by way of a switch (not illustrated) to a driving circuit (not illustrated). When the switch is turned ON at night or in a dark circumstance, the layer 54 emits light to illuminate the indication mark 57 brightly.

In the fourth embodiment, a plate integrated with an EL can be obtained. Accordingly, manufacture is simplified as compared with the prior art in which the EL was manufactured as an independent member.

Further, since the front electrode 53 and the subsequent members are formed at the back of the substrate 52 for the plate 51, it is possible to improve the emission efficiency while suppressing the decay of emission from the emission layer 54 and to improve the brightness of the indication mark 57 by the application of a voltage as compared with the case of the first to third embodiments.

Further, when the layer 56 for insulating and protecting the front electrode 53, the light emission layer 54 and the back electrode 55 from the surrounding conditions is printed at the back of the substrate 52 of the layer 56, the entire thickness and the weight of the plate 51 is reduced, and the entire portion including the front electrode 53 as far as the insulation layer 56 can be formed by printing. Accordingly the manufacturing step is simplified.

The present invention is also applicable, in addition to each of the above-mentioned embodiments, to display members such as guide plate indicating an emergency exit or a decorative sign board. Further, it will be apparent that the materials used can be selected variously and the color of the light emission can be selected depending on the material of the light emission layers 23, 54.

Furthermore, if the back electrode 25, 55 are made of the same light permeable material as that for the front electrodes 22, 53, light emitted from the light emission layers 23, 54 also illuminates backwards, so that, for instance, an integrating meter (not illustrated) can also be illuminated.

In the present invention, including each of the foregoing embodiments, various appropriate printing methods can be adopted for "printing" such a screen printing method and it also includes a film coating method such as roll coating.

Claims:

1. A display panel comprising:

a light permeable substrate having an indication mark on the surface thereof; and

a light permeable front electrode, a light emission layer, a back electrode and an insulating layer successively formed at the back of the light permeable substrate;

wherein (i) the light permeable front electrode, the light emission layer, the back electrode and the insulating layer are formed by screen printing and (ii) the insulating layer insulates said front electrode, said light emission layer and said back electrode from the surrounding atmosphere.

2. A display panel according to claim 1, wherein the light permeable front electrode is in a shape corresponding to an indication mark.

3. A display panel according to claim 2, wherein said light emission layer has substantially the same shape as the light permeable front electrode.

4. A display panel according to claim 1, wherein the insulating layer is formed by applying an insulating material in liquid form.

5. A display panel according to claim 1, wherein the insulating layer is formed so as to cover surfaces of the light permeable front electrode, the light emission layer, and the back electrode and a back surface of the back electrode.

6. A display panel according to claim 1, wherein the indication mark is formed by screen printing.

7. A display panel according to claim 1, wherein the insulating layer is moisture proof.

8. A display panel comprising:

a light permeable substrate having an indication mark on the surface thereof; and

a light permeable front electrode, a light emission layer, a back electrode and an insulating layer successively formed at the back of the light permeable substrate; wherein:

the light permeable front electrode, the light emission layer, the back electrode and the insulating layer are formed by screen printing;

the back of the light permeable substrate has a first surface portion and a second surface portion, and the light permeable front electrode is formed to be in contact with only the first surface portion; and

the insulating layer insulates said front electrode, said light emission layer and said back electrode from the surrounding atmosphere and is formed so as (i) to entirely cover side surfaces of the light permeable front electrode, the light emission layer, and the back electrode and a back surface of the back electrode, and (ii) to be in contact with only the second surface portion of the back of the light permeable substrate.

9. A display panel according to claim 8, wherein the light permeable front electrode is in a shape corresponding to an indication mark.

10. A display panel according to claim 9, wherein said light emission layer has substantially the same shape as the light permeable front electrode.

11. A display panel according to claim 8, wherein the insulating layer is formed by applying an insulating material in liquid form.

12. A display panel according to claim 8, wherein the indication mark is formed by screen printing.

13. A display panel according to claim 8, wherein the insulating layer is moisture proof.

14. A display panel comprising:

a light permeable substrate having an indication mark on the surface thereof; and

a light permeable front electrode, a light emission layer, a back electrode and an insulating layer formed at the back of the light permeable substrate;

wherein the back of the light permeable substrate has a first surface portion and a second surface portion, and the light permeable front electrode is formed to be in contact with only the first surface portion and the insulating layer is formed to be in contact with only the second surface portion of the back of the light permeable substrate.

15. A display panel according to claim 14, wherein said light permeable front electrode and said light emission layer are substantially in a shape corresponding to the indication mark.

16. A display panel according to claim 14, wherein the insulating layer is formed by applying an insulating material in liquid form.

17. A display panel according to claim 14, wherein the indication mark is formed by screen printing.

18. A display panel according to claim 14, wherein the insulating layer is moisture proof.

19. A display panel according to claim 14, wherein the light permeable front electrode, the light emission layer, the back electrode and the insulating layer are successively formed by screen printing.

20. A display panel according to claim 14, wherein the insulating layer is formed to entirely cover side surfaces of the light permeable front electrode, the light emission layer, and the back electrode and a back surface of the back electrode and insulates said front electrode, said light emission layer and said back electrode from the surrounding atmosphere.

Fig. 1

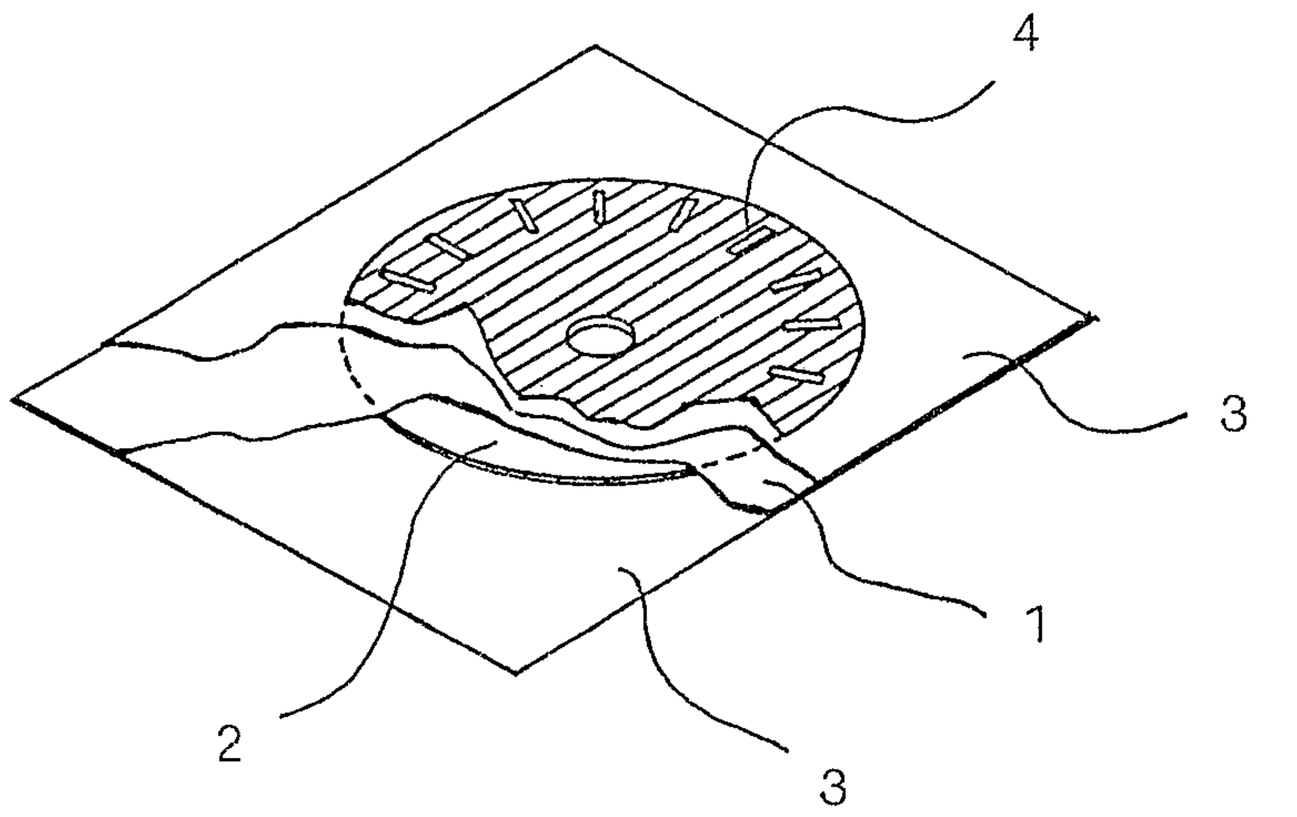

Fig. 2

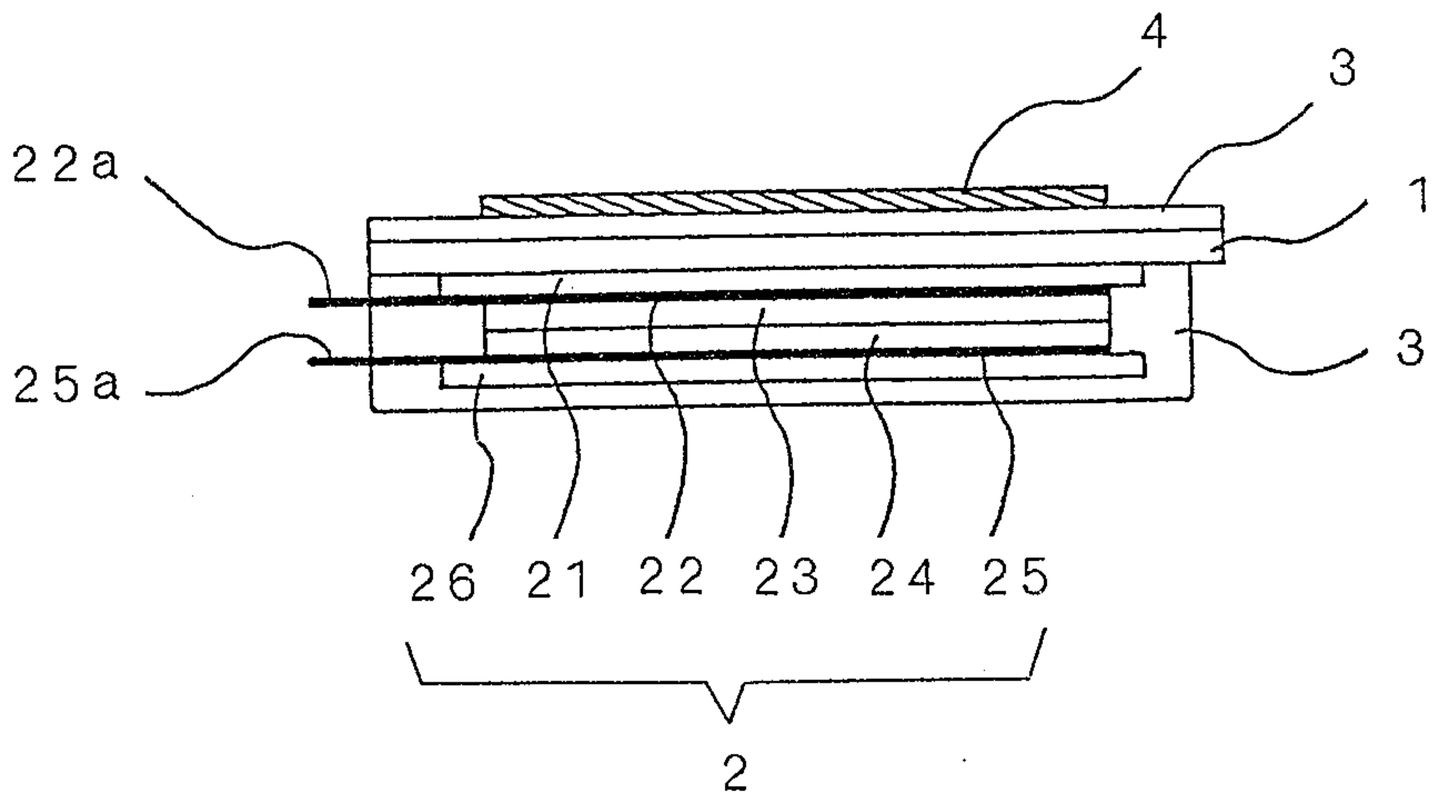

Fig. 3

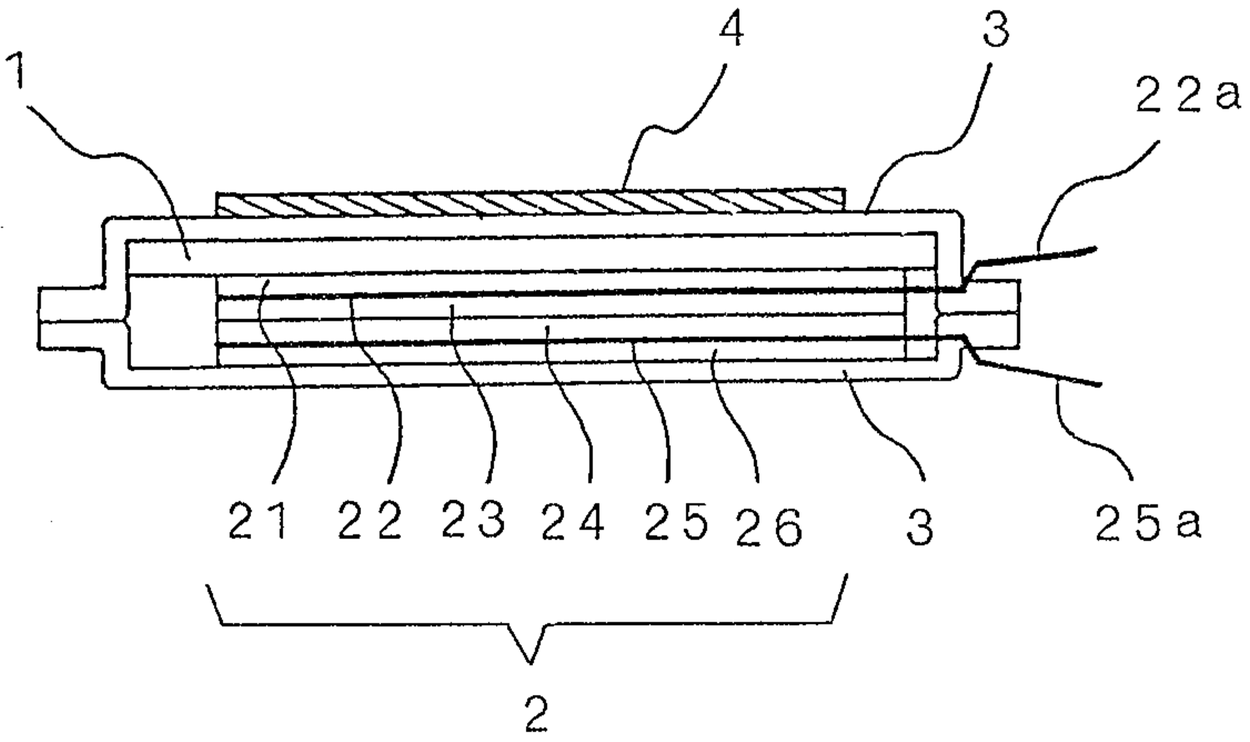

Fig. 4

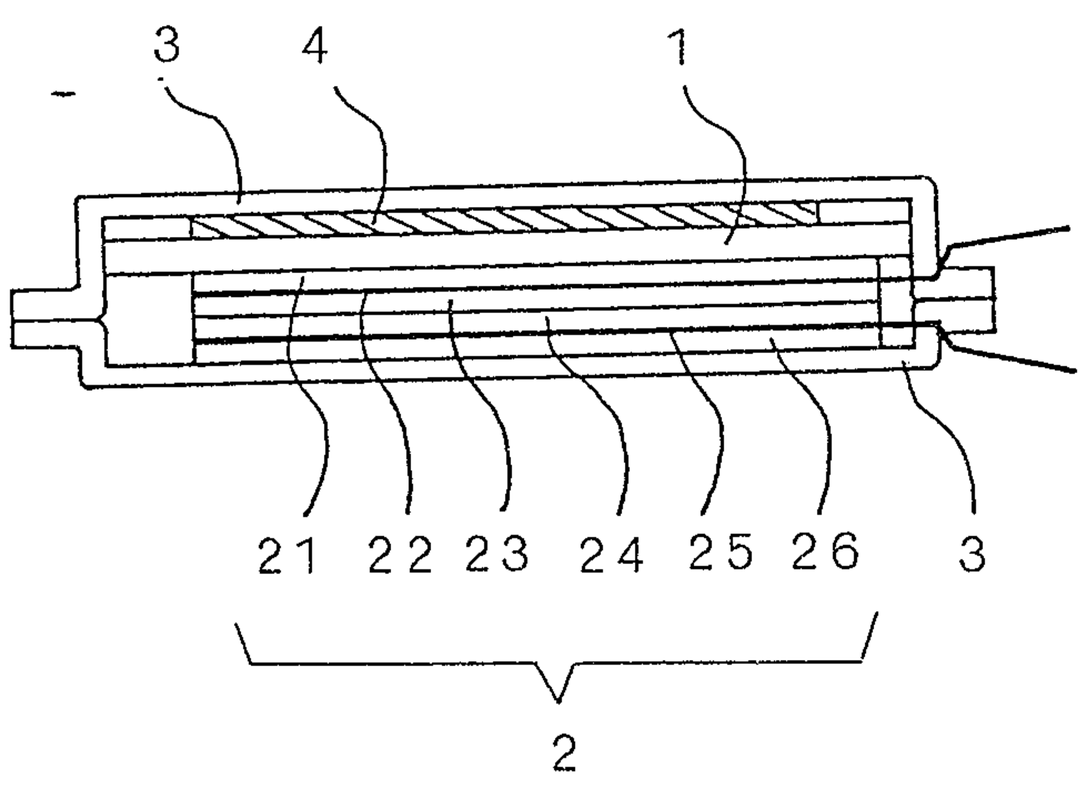

Fig. 5

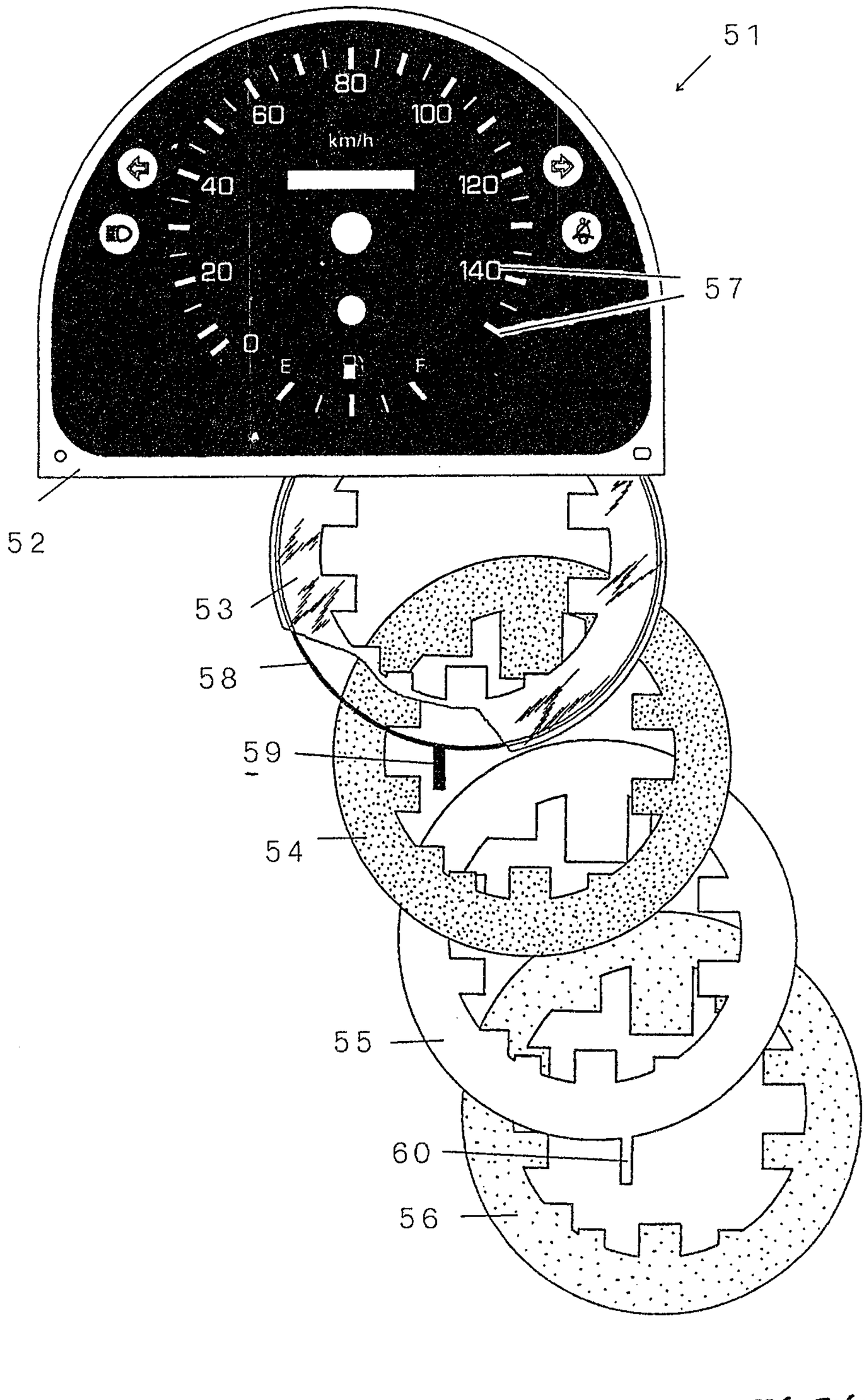

Fig. 6

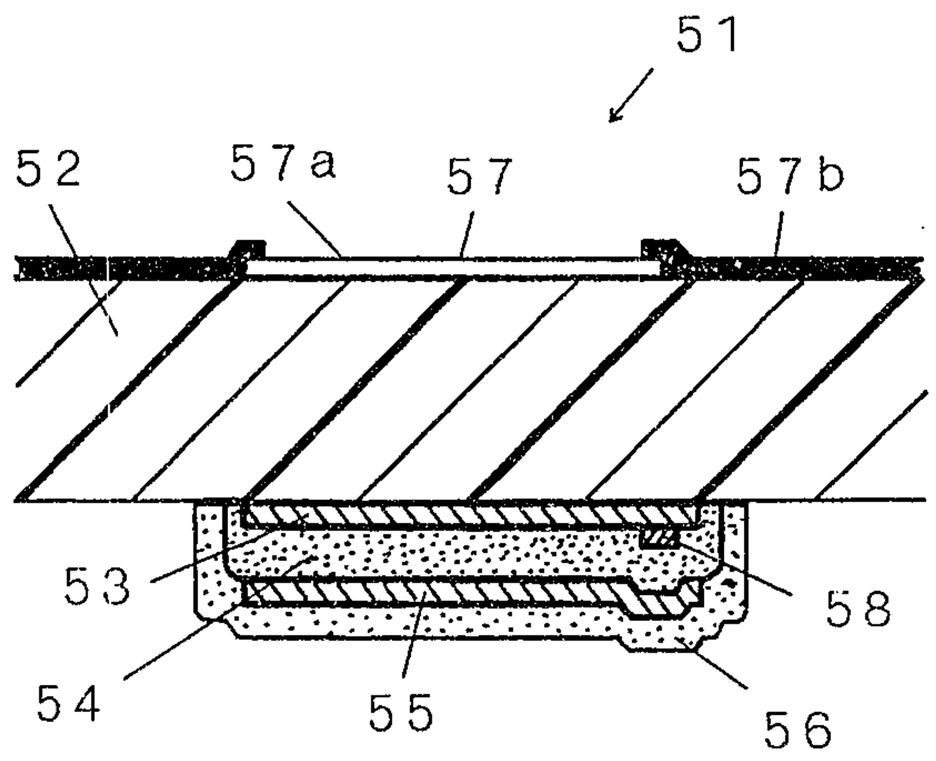

Fig. 7