US 20070211418A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2007/0211418 A1

Iwamoto et al. (43) Pub. Date: Sep. 13, 2007

(54) CASE, PORTABLE INFORMATION EQUIPMENT USING THE SAME AND MANUFACTURING METHOD OF THE CASE

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(21) Appl. No.: **11/508,439**

(22) Filed: **Aug. 23, 2006**

(30) **Foreign Application Priority Data**

Mar. 7, 2006 (JP) 2006-060836

Publication Classification

(51) **Int. Cl.**
G06F 1/16 (2006.01)

(52) **U.S. Cl.** **361/683**; 361/681

(57) **ABSTRACT**

The case disclosed has a raised portion stepped upward convexly and a rib molded inside of the raised portions integrally. The case is disposed at a rear surface of a display unit of a portable information equipment.

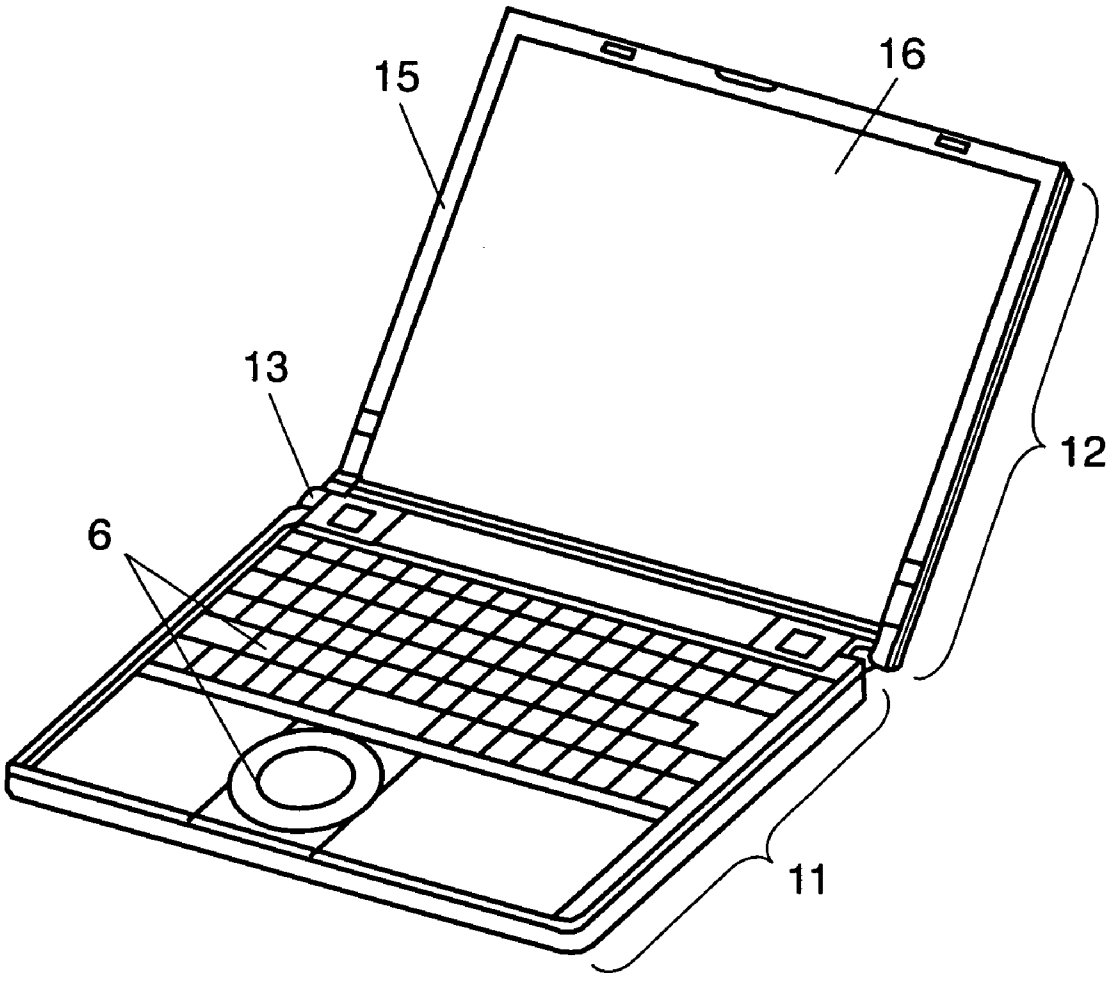


FIG. 1A

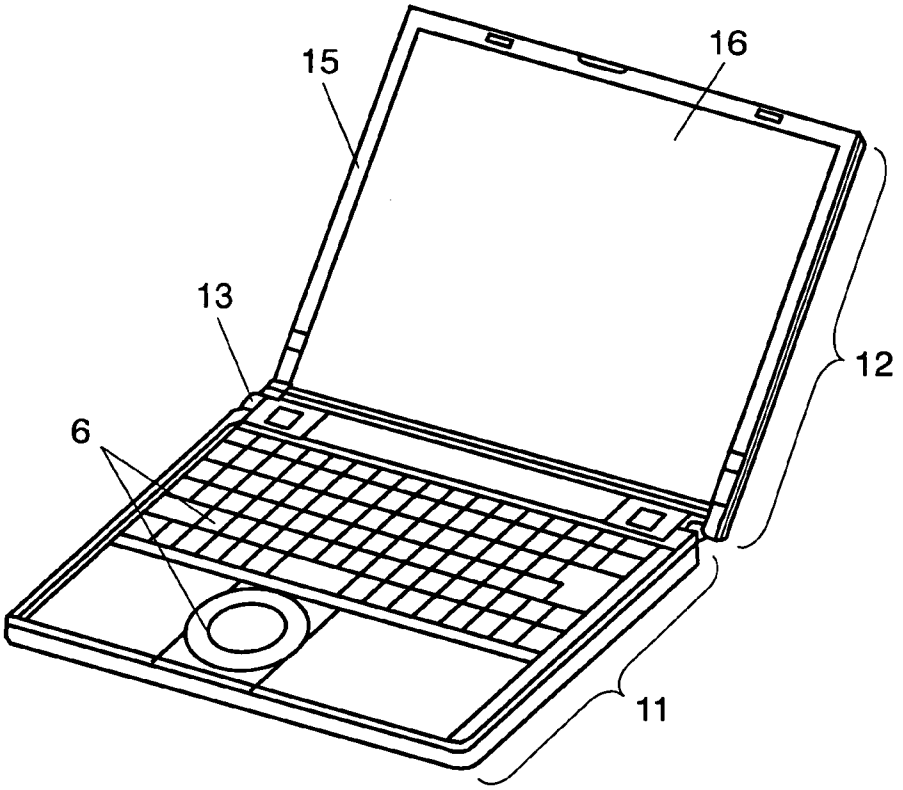


FIG. 1B

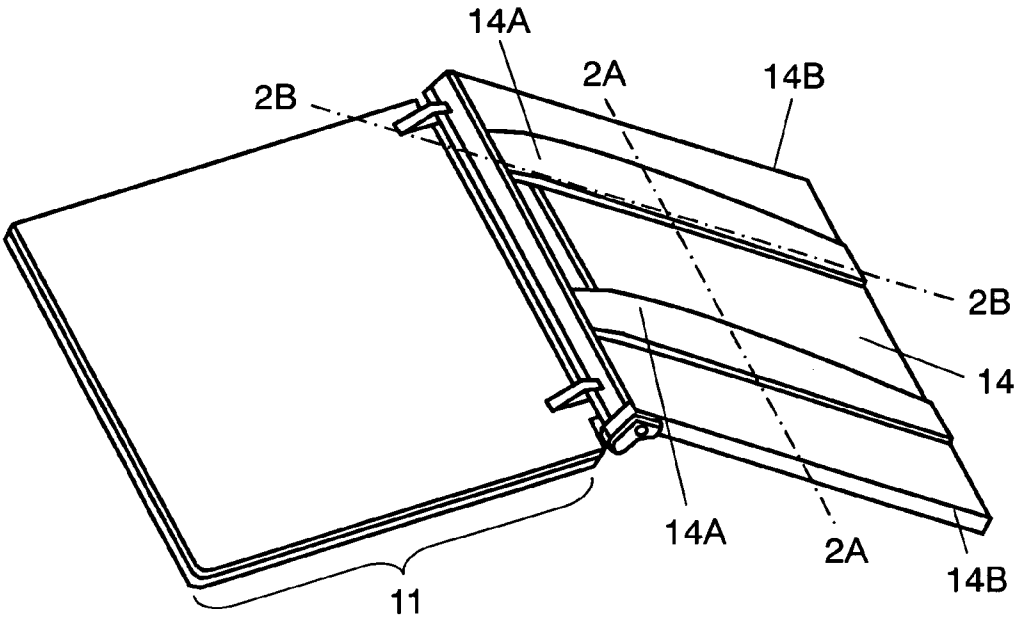


FIG. 1C

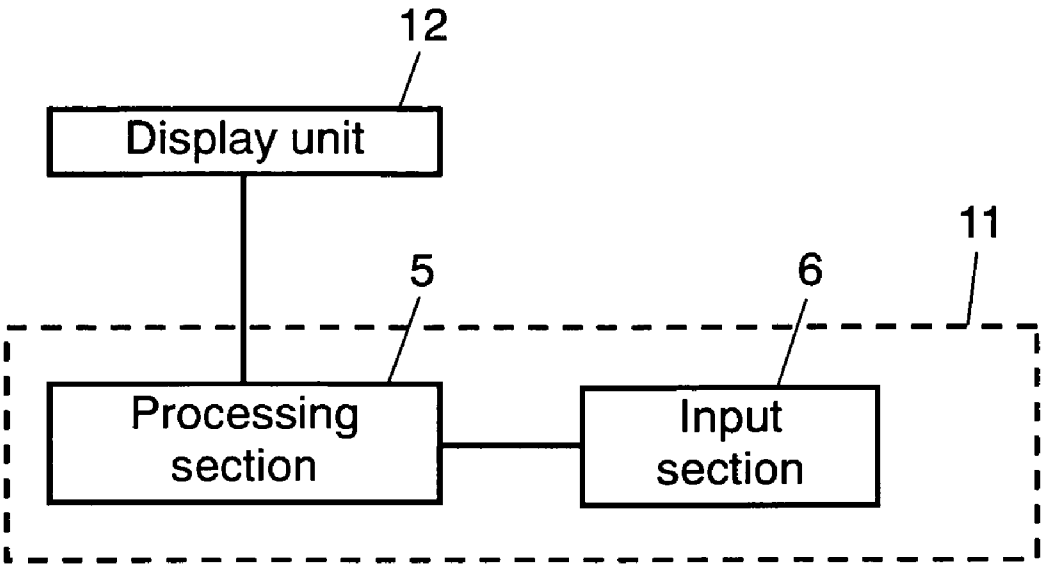


FIG. 2A

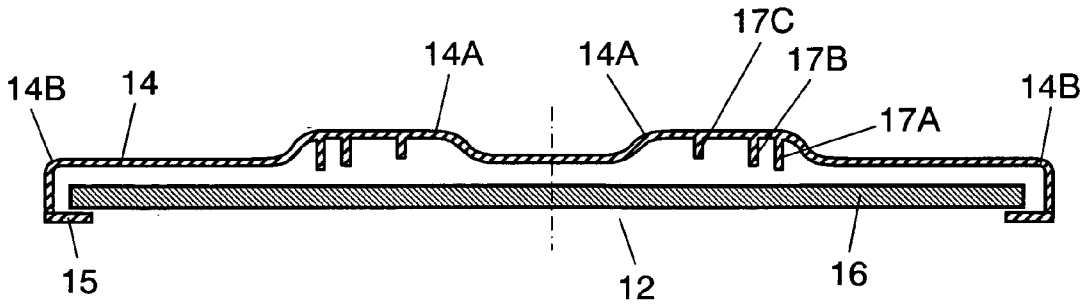


FIG. 2B

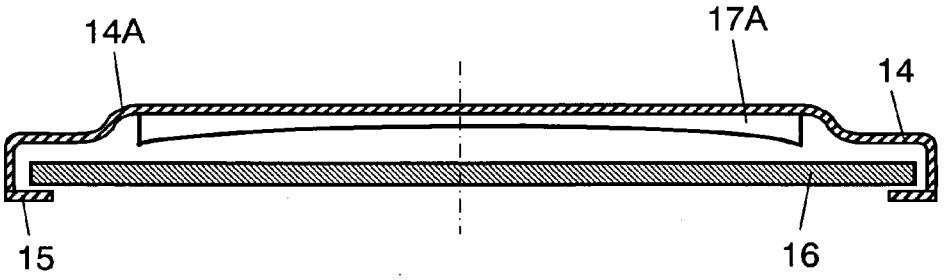


FIG. 3

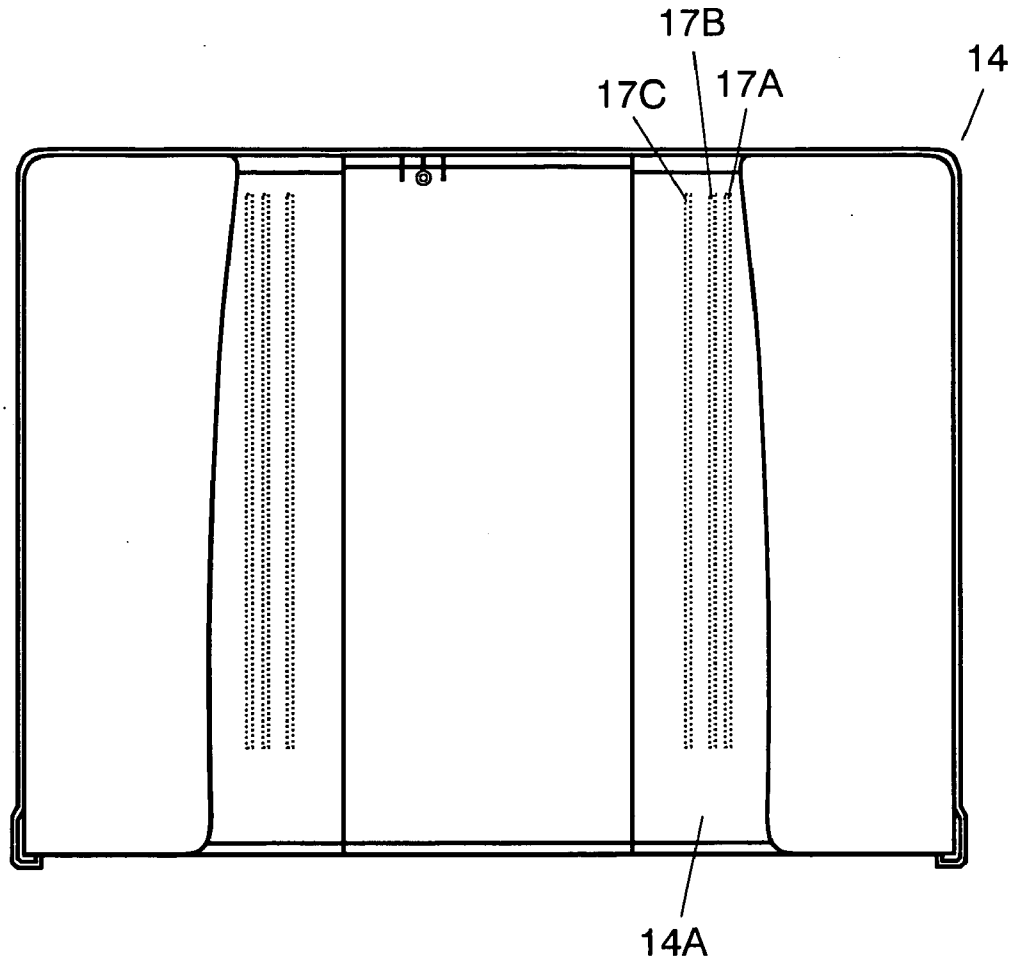


FIG. 4A

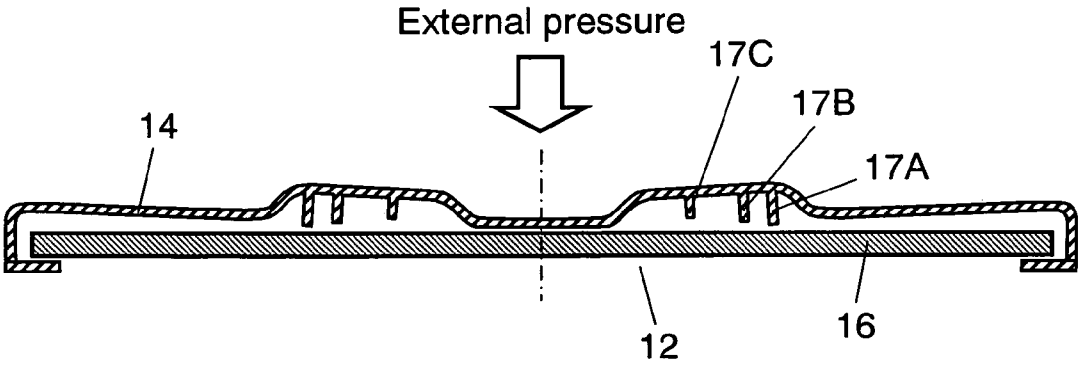

External pressure
17C
17B
14
17A
12
16

FIG. 4B

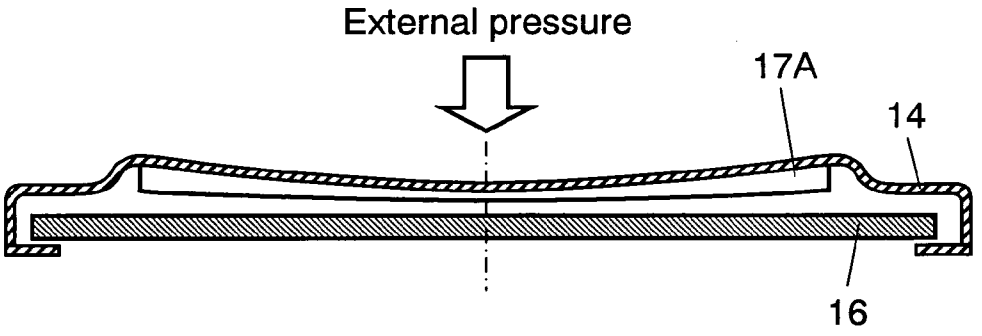

External pressure
17A
14
16

FIG. 5A

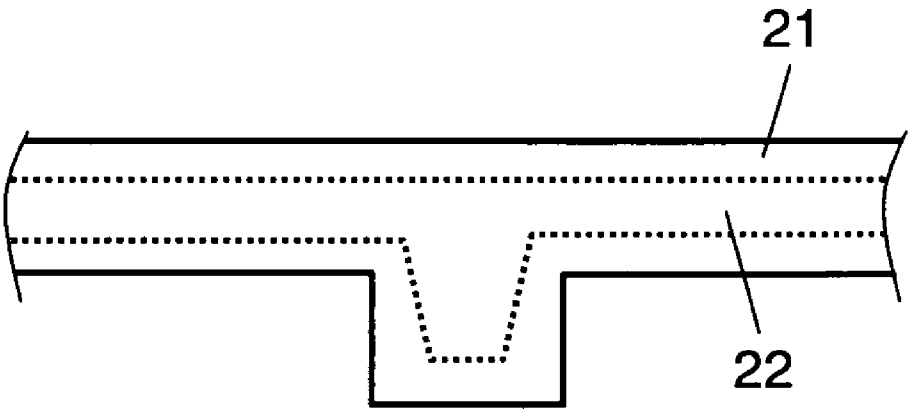


FIG. 5B

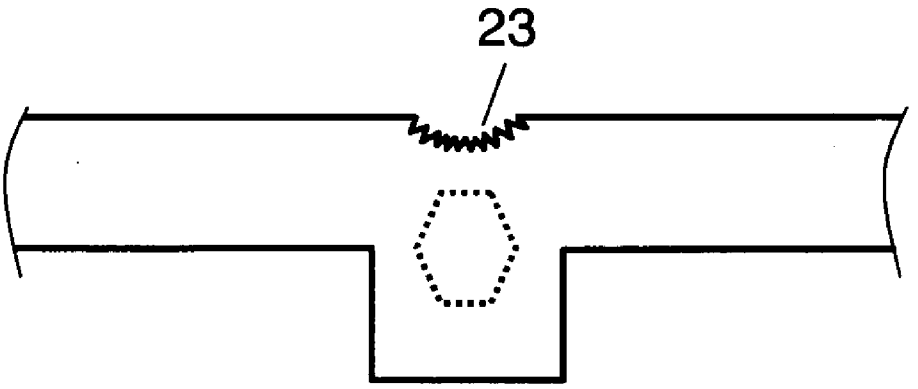


FIG. 6A

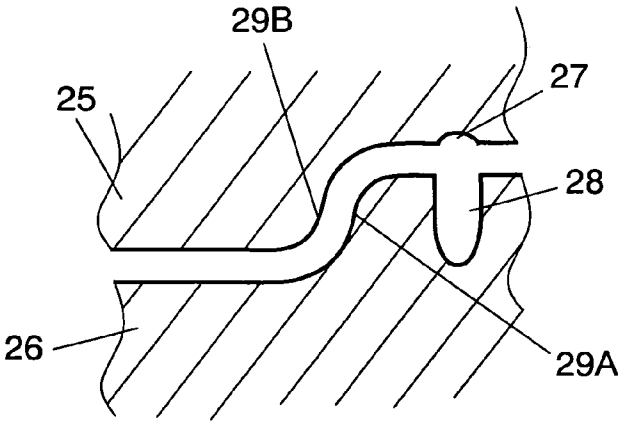


FIG. 6B

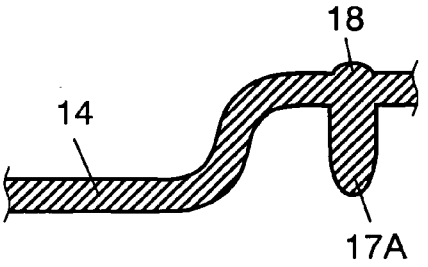


FIG. 6C

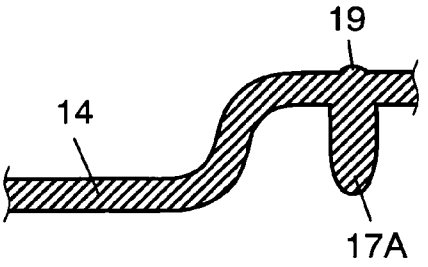


FIG. 6D

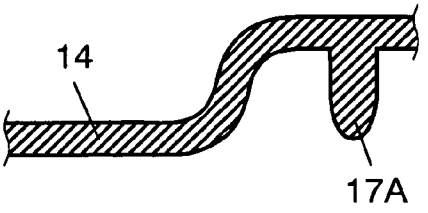


FIG. 7A
PRIOR ART

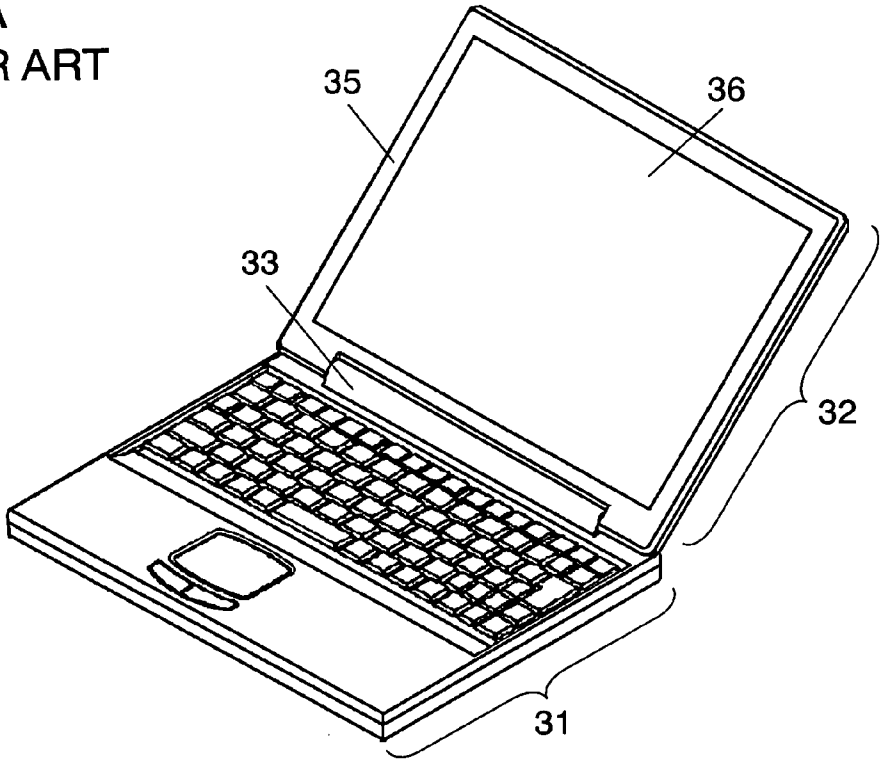


FIG. 7B
PRIOR ART

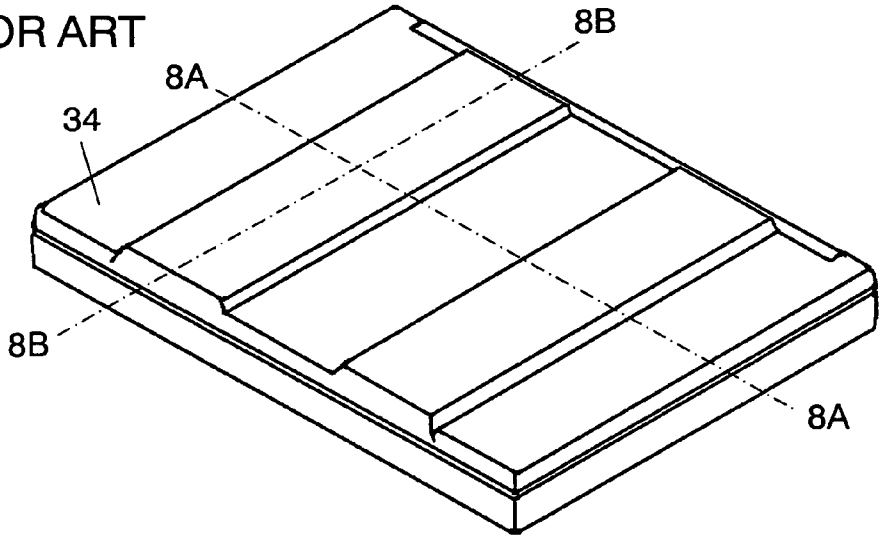


FIG. 8A PRIOR ART

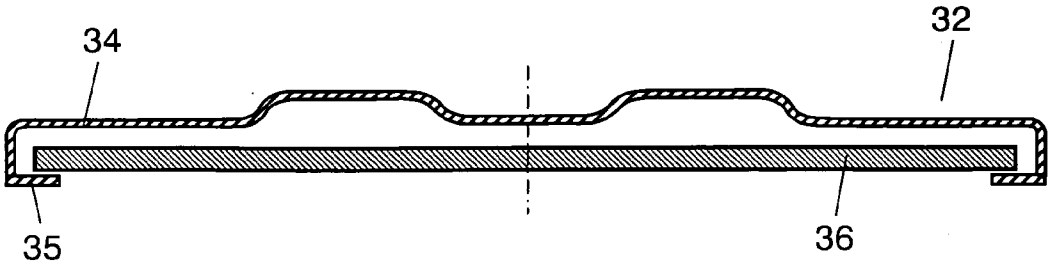
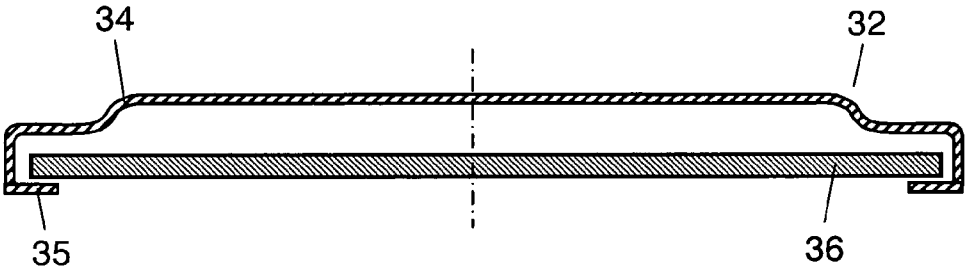


FIG. 8B PRIOR ART



CASE, PORTABLE INFORMATION EQUIPMENT USING THE SAME AND MANUFACTURING METHOD OF THE CASE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a portable information equipment such as a notebook computer or the like and particularly relates to a metallic case for use in the portable information equipment and a manufacturing method of the case.

[0003] 2. Background Art

[0004] In recent years, the portable information equipment such as a notebook computer or the like has been made thinner and lighter to enhance the portability, the case forming an outer shell has also been made in a thinner profile. Meanwhile, the case has been made of a metallic material to improve mechanical strength, in order to protect electromagnetic interference (EMI) and to dissipate heat generated inside the equipment efficiently.

[0005] A conventional portable information equipment is described below with reference to the drawings. FIG. **7**A shows an outward perspective view of a conventional portable information equipment in a state that a display unit is opened, and FIG. **7**B shows the same in a state that the display unit is closed. FIG. **8**A shows a cross-sectional view of the display unit taken along the line **8**A-**8**A in FIG. **7**B, and FIG. **8**B shows the same taken along the line **8**B-**8**B in FIG. **7**B.

[0006] Display unit **32** is joined with body **31** of the equipment via hinge **33** which makes the both can be opened and closed. In display unit **32**, a liquid crystal display drive (LCD drive; not shown) and LCD panel **36**, which are components to form an LCD display device, are disposed between rear case **34** and front frame **35**.

[0007] The portable information equipment has generally, as is called a note type or a book type, a thin box shape with a rectangular flat portion to put into a bag or the like suitably. Rear case **34** is made of a metallic material such as aluminum or the like to improve mechanical strength so as to protect EMI and to dissipate heat generated inside the equipment efficiently. To reduce weight of the equipment, especially in recent years, magnesium alloy having lower specific gravity and greater strength than aluminum is used to realize an utmost thin case thickness. The advance in thin-and-light design has increased further chances for the equipment to be carried around in a bag or the like. However, when a person carrying a bag gets on a crowded train, the bag receives a high pressure from outside. The pressure will be applied on display unit **32** of the equipment if packed in the bag. Measures have been studied variously to prevent thin-walled rear case **34** from being deformed by the pressure to break LCD panel **36** housed therein. That is, Unexamined Japanese Patent Publication No. 2003-204174 discloses a technology that is to form a non-flat rear case **34** like a car-hood as shown in FIGS. **7**B and **8**A while a thin thickness is maintained. Additionally, Unexamined Japanese Patent Publication No. H09-62400 discloses a technology to provide the entire case surface with ribs. These structures improve the mechanical strength of rear case **34**.

[0008] In some cases, however, even such structures cannot perfectly prevent LCD panel **36** from being broken. Therefore, rear case **34** is required to improve further its mechanical strength.

SUMMARY OF THE INVENTION

[0009] A case of the present invention has a raised portion stepped upward convexly and a rib disposed molded inside of the raised portion integrally. The case is used on a rear face of a display device of a portable information equipment. The configuration can contribute to improve a mechanical strength of the display unit including the display device and to prevent the display unit from being deformed by an external pressure. Since the mechanical strength against the external pressure is improved, the display device of the portable information equipment employing the case is hard to be damaged.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1**A shows an outward perspective view of a portable information equipment according to an exemplary embodiment of the present invention.

[0011] FIG. **1**B shows an outward perspective view from the rear side of the portable information equipment shown in FIG. **1**A.

[0012] FIG. **1**C is a block diagram showing the configuration of the portable information equipment according to the exemplary embodiment of the present invention.

[0013] FIG. **2**A shows a cross-sectional view of the display unit taken along the line **2**A-**2**A of the portable information equipment shown in FIG. **1**B.

[0014] FIG. **2**B shows a cross-sectional view of the display unit taken along the line **2**B-**2**B of the portable information equipment shown in FIG. **1**B.

[0015] FIG. **3** shows a perspective plan view of a rear case of the display unit of the portable information equipment shown in FIG. **1**B.

[0016] FIG.**4**A shows a cross-sectional view of the display unit shown in FIG. **2**A when applied a high pressure from outside.

[0017] FIG.**4**B shows a cross-sectional view of the display unit shown in FIG. **2**B when applied a high pressure from outside.

[0018] FIGS. **5**A and **5**B illustrate a reject phenomena called a "shrink mark" that occurs in mold-manufacturing.

[0019] FIG. **6**A shows a cross-sectional view of an essential part of a mold to form the rear case shown in FIG. **2**A.

[0020] FIGS. **6**B to **6**D illustrate cross-sectional views of an essential part of the mold shown in FIG. **2**A to explain the manufacturing of the rear case.

[0021] FIG. **7**A shows an outward perspective view of a conventional portable information equipment in a state that a display unit is opened.

[0022] FIG. **7**B shows an outward perspective view of the portable information equipment shown in FIG. **7**A in a state that the display unit is closed.

[0023] FIG. **8**A shows a cross-sectional view of the display unit taken along the line **8**A-**8**A in FIG. **7**B.

[0024] FIG. **8**B shows a cross-sectional view of the display unit taken along the line **8**B-**8**B in FIG. **7**B.

DETAILED DESCRIPTION OF THE INVENTION

[0025] FIG. **1**A is a perspective view showing an appearance on the operating faces of the portable information equipment according to the exemplary embodiment of the present invention in a state that the display unit is opened. FIG. **1**B is a perspective view showing an outward appearance from the rear side of the same. FIG. **1**C is a block diagram showing the configuration of the portable information equipment according to the exemplary embodiment of the present invention. FIG. **2**A shows a cross-sectional view of the display unit taken along the line **2**A-**2**A shown in FIG. **1**B, and FIG. **2**B shows a cross-sectional view of the display unit taken along the line **2**B-**2**B of the same. FIG. **3** shows a perspective plan view of the rear case of the display unit. FIGS. **4**A and **4**B show cross-sectional views of the display unit when applied with a high pressure from outside.

[0026] Display unit **12** is joined with body **11** of the equipment via hinge **13** which makes the both can be opened and closed as shown in FIGS. **1**A and **1**B. In display unit **12**, an LCD drive (not shown) and LCD panel **16**, which are components to form the display device, are disposed between rear case **14** and front frame **15** as shown in FIGS. **2**A and **2**B. A device other than an LCD panel such as a plasma display panel (PDP) or the like can be used for the display device.

[0027] Body **11** includes processing section **5** and input section **6** is mounted thereon as shown in FIG. **1**C. Display unit **12** and input section **6** are connected with processing section **5**. Processing section **5** includes a CPU, a memory, a hard disk or the like. Input section **6** is a keyboard, a touch-panel or a mouse-pad (or touch-pad) provided on body **11** as shown in FIG. **1**A, an interface or media-drive to an external device, or a mouse connected via a cable. A touch-panel can be disposed on LCD panel **16** in display unit **12**, for instance, to use as input section **6**.

[0028] Rear case **14** has raised portions **14**A stepped upward convexly. Each of raised portions **14**A is formed in parallel with edge **14**B of a short side of rear case **14** which is substantially rectangular solid-shaped. Namely, rear case **14** has a structure like a car-hood. Respective ribs **17**A, **17**B and **17**C are disposed on a rear surface of raised portion **14**A (inside raised portion **14**A).

[0029] Ribs **17**A, **17**B and **17**C are, molded to the raised portion **14**A integrally, disposed perpendicularly to the surface of raised portion **14**A and in parallel with edge **14**B. The configuration can improve the mechanical strength of the short side of rectangular solid-shaped display unit **12** to prevent the deformation by the external pressure. In this way, a plurality of ribs provided on rear case **14** are preferable from the view point of improving the mechanical strength. Ribs **17**A, **17**B and **17**C are preferably provided in a direction parallel with edge **14**B. This can improve the mechanical strength of display unit **12** effectively that is fixed to body **11** with the long side.

[0030] The clearance between ribs **17**A and **17**B is preferably smaller than the clearance between ribs **17**B and **17**C as shown in FIG. **2**A. That is, the three ribs are preferably disposed more densely as nearer to the outside from the centerline of rear case **14**, or as nearer to the outside step of rear case **14**. The protrusion heights of respective ribs **17**A, **17**B and **17**C are preferably getting lower in this order. That is, the protrusion height of each rib is preferably lower as nearer to the inner side. Additionally, the side width of rib **17**A is preferably narrower as nearer to the center as shown in FIG. **2**B. That is, the protrusion height of rib **17**A is preferably lower as nearer to the center of rear case **14**. FIG. **2**B illustrates rib **17**A only, but the same shape can be applied for ribs **17**B and **17**C.

[0031] When rear case **14** is deformed by the external pressure, the amount of deformation is larger as nearer to the center of rear case **14** as shown in FIGS. **4**A and **4**B. Therefore, the clearance between rear case **14** and LCD panel **16** or an LCD drive (not shown) to show images on LCD panel **16** becomes smaller as nearer to the center of rear case **14**. The clearance can be maintained in every configuration by the help of ribs **17**A, **17**B and **17**C thus formed as described above. That is, each of the configuration can prevent LCD panel **16** and the LCD drive from colliding with ribs **17**A, **17**B and **17**C to cause damaging or breaking due to the stress.

[0032] As described above, using empty spaces at the back of raised portions **14**A of rear case **14** having a car-hood like structure, ribs **17**A, **17**B and **17**C are disposed molded integrally to rear case **14**. Ribs **17**A, **17**B and **17**C are disposed perpendicularly to the surface of rear case **14** and in parallel with a short side of display unit **12**. The configuration can improve the mechanical strength in the direction of the short side of display unit **12** to prevent the deformation by the external pressure.

[0033] If the clearance between rear case **14** and LCD panel **16** can be maintained, ribs may be disposed in the direction of a long side of display unit **12**. The configuration can improve the mechanical strength in the direction of the long side of display unit **12**. Depending on the size of display unit **12**, ribs can be provided for instance in the direction of a diagonal line of a raised portion **14**A instead of in parallel with edge **14**B. There is no limitation in the number of rib though three ribs are described in the above example.

[0034] More than three raised portions **14**A may be acceptable though two raised portions **14**A are described in the example shown in FIG. **3**. Only one raised portion **14**A may also be acceptable. In any case, a plurality of ribs are preferably disposed more densely as nearer to the outer side from the center of rear case **14**. The protrusion height of ribs is preferably lower as nearer to the inner side. The protrusion height of each rib is preferably lower as nearer to the center of rear case **14**.

[0035] A manufacturing method of rear case **14** with ribs **17**A, **17**B and **17**C is described hereinafter. A reject phenomenon called a "shrink mark" is described first. FIGS. **5**A and **5**B illustrate the reject phenomenon called the shrink mark that occurs in manufacturing molded products.

[0036] The shrink mark means a dent like a dimple formed on a surface of a molded product. The molded product changes greatly in volume in a solidifying period being influenced by pressure and temperature. The cooling rate for molded product **21** to solidify differs in portions. Surfaces cool down rapidly. On the contrary hot portion **22** is left internally, especially in an internal thick portion as shown in FIG. **5**A. When heat tends to accumulate in this way, the material will solidify slowly under a low pressure and will shrink into a smaller volume. This affects greatly a dimen-

sional stability of molded product **21**. Dent **23** thus occurs as shown in FIG. **5**B. Followings are said to be the two main factors of the shrink mark.

(1) Product Design

[0037] The molded product is basically considered that the product tends to have an equalized thickness in forming a shape. The shrink mark is a phenomenon which occurs when a resin or a metal molten in a high temperature does not solidify in a same cooling rate partially as described before, proving that the above consideration is true. If there are a portion of 2 mm thick and a portion of 4 mm thick in thickness, for instance, the portion of 4 mm thick will tend to delay in solidifying. That is, the shrink mark tends to occur in an intersection of portions with different thickness.

(2) Molding Condition

[0038] In molding operation, a cavity (a mold void) is filled with a high-temperature molten resin or metal. Usually, the material that will contract while cooling down is pressed on into every cavity corner by applying a hold pressure. The shrink mark tends to occur when the hold pressure is low. Taking into account the outcome of molded products, the molding condition is determined in this process to balance the cooling time and the hold pressure. The shrink mark will tend to occur if the cooling time including the time to apply the hold pressure is tried to shorten, though every product is generally required to be manufactured in a short period of time.

[0039] A molding method of rear case **14** using magnesium alloy is described hereinafter with reference to FIGS. **6**A to **6**D. FIG. **6**A shows a cross-sectional view of an essential part of a mold to form rear case **14**, and FIGS. **6**B to **6**D illustrate cross-sectional views of essential parts in manufacturing steps to form rear case **14**. States of just after molding, after cooling, and after surface polishing are shown in FIGS. **6**B, **6**C and **6**D, respectively. Now, rib **17**A is described as a representative.

[0040] Rib **17**A is disposed molded integrally perpendicularly to the surface of rear case **14**. Rib **17**A, however, has a large width (thickness) with respect to the case thickness. Therefore, the shrink mark caused mainly by aforementioned factor (1) occurs in the solidifying process of high-temperature molten magnesium alloy in the mold. On the outer surface of raised portions **14**A of rear case **14**, a shrink mark of rib **17**A disposed on the inner surface appears as a groove-like trace. Although such a trace can be erased by a polishing, the polishing to erase the trace like a groove will inevitably decrease thickness of rear case **14**, causing a decrease in the mechanical strength. The production process will increase accordingly.

[0041] Therefore, the mold should be designed taking into account the portion where the shrink mark will occur beforehand as shown in FIG. **6**A. The amount (depth) of shrink mark can be determined experimentally by a ratio of the thickness of raised portion **14**A of rear case **14** to the width (thickness) of rib **17**A. Based on the experimental results, cavity **27** is provided in upper mold half **25** on the opposite side of rear case **14** where rib **17**A is provided so as to form mound **18**, taking into account the amount of thickness loss due to the shrink mark as shown in FIG. **6**B. At this time, a little bit larger amount than the thickness loss reduces amount variation of mounds **18**.

[0042] Sometimes, however, trace **19** of mound **18** remains as shown in FIG. **6**C.

[0043] Trace **19** can be erased easily by a surface polishing after the molding, which does not cause any decrease in the thickness of rear case **14** like in the case of polishing the groove-like trace due to the shrink mark.

[0044] As described above, the material of molten magnesium alloy is poured between upper mold half **25** and lower mold half **26** to mold rear case **14**. First step **29**A to form raised portion **14**A and groove **28** to form rib **17**A in an upper side (to the center) than first step **29**A are provided on lower mold half **26**. Second step **29**B to form raised portion **14**A and cavity **27** to form mound **18** at the back surface corresponding to the position of rib **17**A in an upper side (to the center) than second step **29**B are provided on upper mold half **25**. Poured molten alloy is cooled down to solidify before upper mold half **25** and lower mold half **26** are removed to obtain rear case **14** with no shrink mark.

[0045] As described in the above exemplary embodiment, the mechanical strength of rear case **14** is improved further by rib **17**A (rib **17**B and **17**C) utilizing the car-hood structure. Moreover, factors that hamper moldability such as shrink mark which occurs in manufacturing molded products are restrained, enabling rear case **14** to have a high resistance to external pressures.

[0046] Although molding a metallic material of magnesium alloy is mainly described in the above, resins can be the substitute for the material.

[0047] Additionally, although the case of a notebook computer which consists of two flat boxes, body **11** and display unit **12**, joined together by a hinge is described in the above, the case can also be used for a rear case of one flat box-shaped notebook computer which carries a touch-panel instead of display unit **12** to use as a keyboard and has an LCD display device on body **11**.

[0048] Additionally, although the case for a portable information equipment is described using a notebook computer as an example, the case is not limited to use for a notebook computer only. The structure mentioned above can be applied to other kinds of portable equipment such as a DVD player with a display device, a measuring equipment and a car navigation system.

[0049] As described above, the case for the portable information equipment of the present invention has ribs which is molded integrally to the rear case, and disposed perpendicularly to the surface of the rear case by using empty spaces at the back of raised portions of rear case having a car-hood like structure. The configuration can further improve the mechanical strength of the display unit to prevent the deformation by the external pressure, and is useful especially for metallic cases for the portable information equipment.

What is claimed is:

1. A case disposed at a rear surface of a display unit of a portable information equipment, the case comprising:

a raised portion stepped upward convexly; and

a rib molded inside of the raised portion integrally.

2. The case according to claim **1**, wherein the rib is one of a plurality of ribs and a plurality of the ribs are molded inside of the raised portion integrally.

3. The case according to claim **2**, wherein the case is formed substantially in an outward shape of a rectangular

solid and a plurality of the ribs are disposed substantially in a direction parallel with an edge of an outer surface of the case.

4. The case according to claim **3**, wherein a clearance between the ribs become smaller as apart farther from a center of the case.

5. The case according to claim **3**, wherein a protrusion height of each of a plurality of the ribs becomes lower as nearer to a center of the case.

6. The case according to claim **1**, wherein a protrusion height of the rib becomes lower as nearer to a center of the case.

7. A portable information equipment comprising:

A) a processing section;

B) an input section connected to the processing section; and

C) a display unit connected to the processing section having;

C-1) a display panel; and

C-2) a case disposed on a rear surface of the display panel including;

C-2-1) a raised portion stepped upward convexly; and

C-2-2) a rib molded inside of the raised portion integrally.

8. A manufacturing method of a case comprising:

melting a material;

pouring the molten material between an upper mold half and a lower mold half, and

removing the upper mold half and the lower mold half after the molten material is cooled down to solidify,

wherein the lower mold half is provided with a first step to form a raised portion on the molded case and a groove to form a rib nearer to a center side from the first step, and the upper mold half is provided with a second step to form the raised portion.

9. The manufacturing method according to claim **8**, wherein the upper mold half is provided with a cavity to form a mound containing beforehand an amount of molding material equal to a volume loss due to a shrink mark, the cavity is provided at a position on the rear surface of corresponding the groove on the lower mold half to form a rib.

* * * * *