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(54) IC CARD AND IC CARD SYSTEM HAVING PROTECTIVE SEAL

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(57) ABSTRACT

An IC card having a simple construction whereby deterioration of the connector and internal circuits of an unused IC card is prevented at the seaside and in such inclement environmental conditions as outdoors in the rain, and penetration of water, dust, and foreign contaminants to the connector is prevented after the IC card is used. The IC card has a female connector with a plurality of pin insertion holes, and a seal that is waterproof, insulative and pierceable by a pin of the male connector, and covers the open front of all pin insertion holes of the female connector.

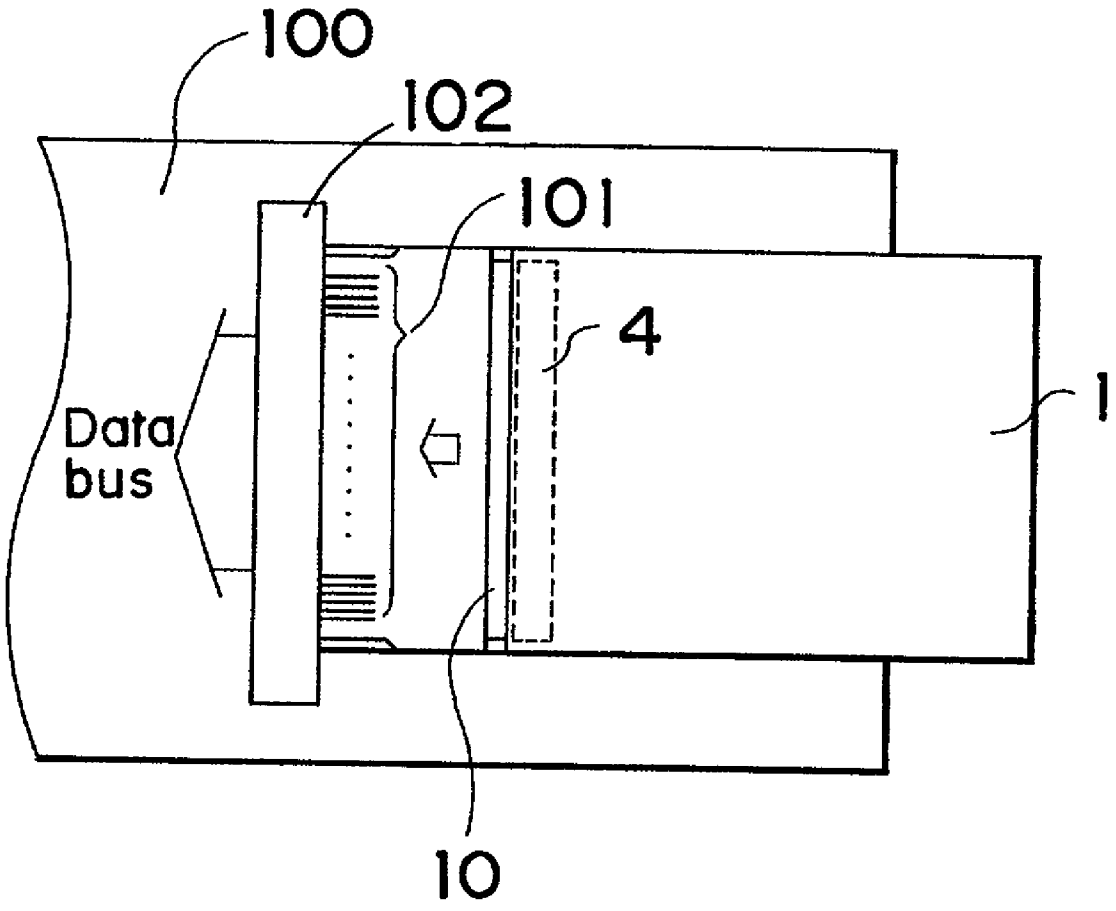


Fig. 1

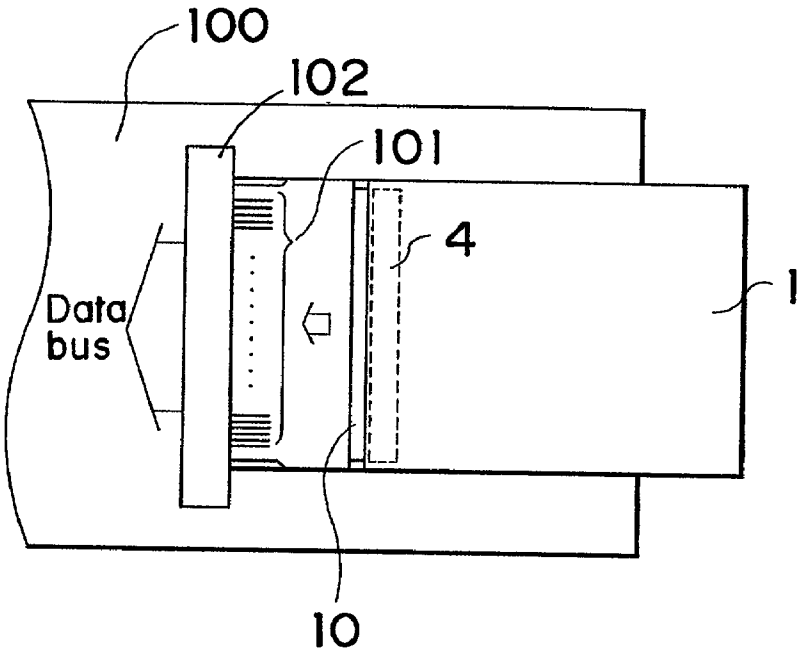



Fig. 2

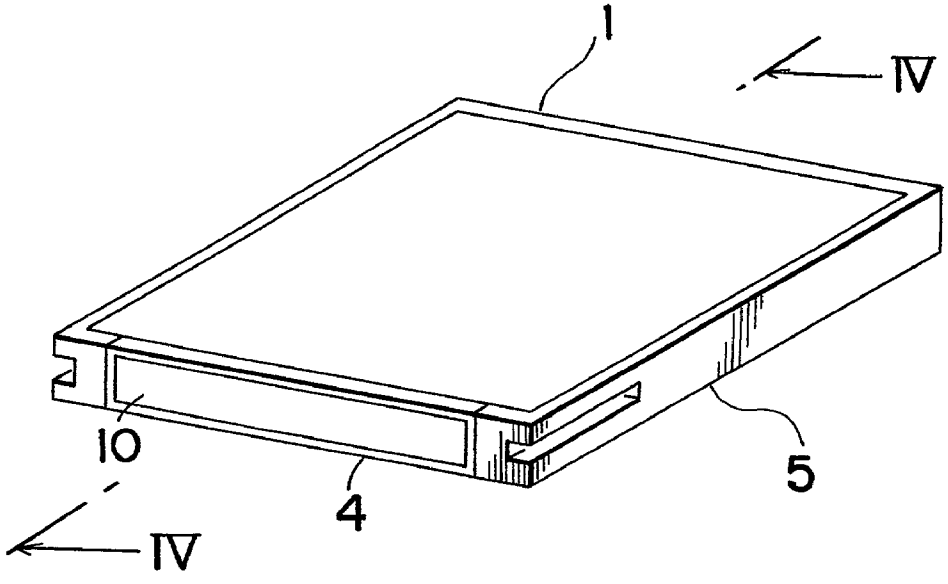


Fig. 3

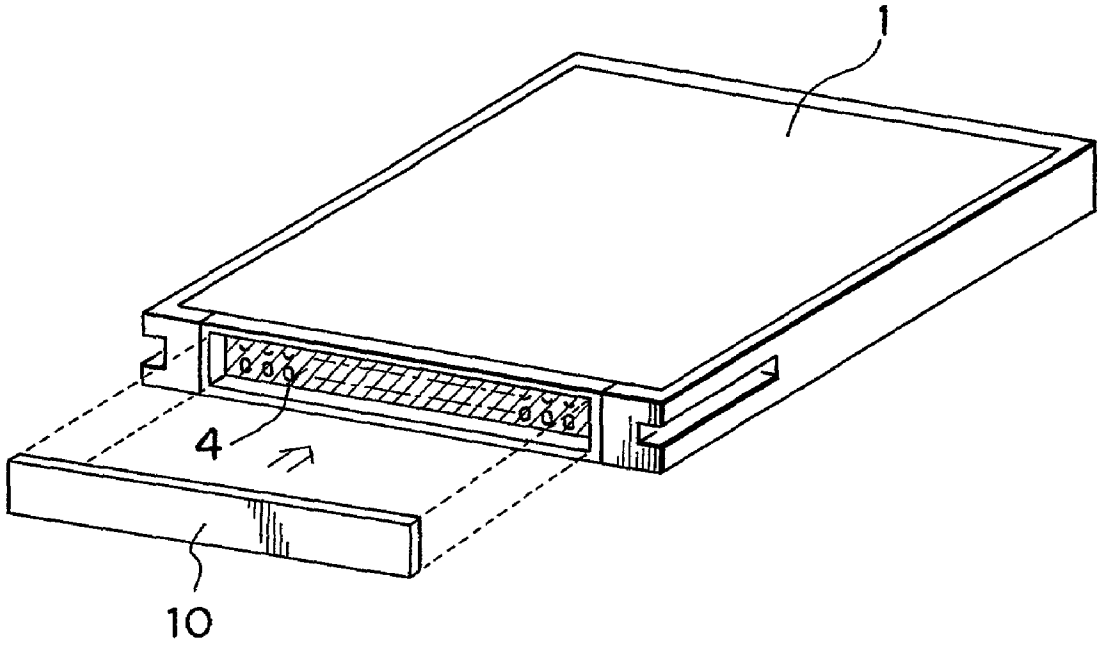



Fig. 4

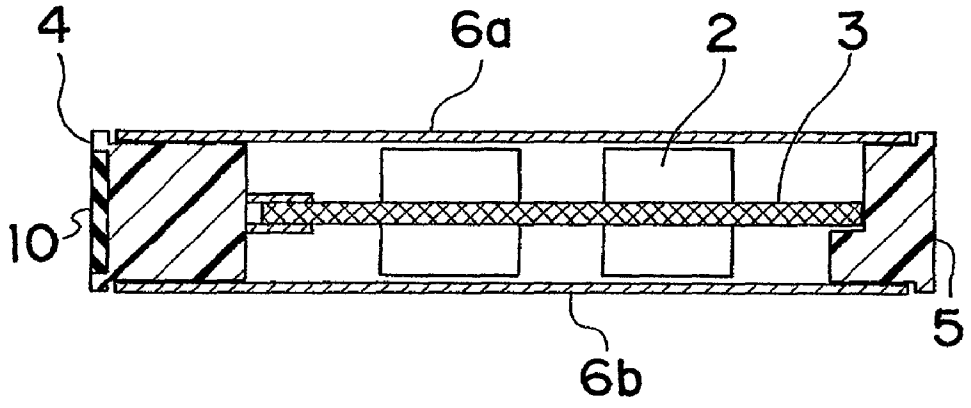


Fig. 5A

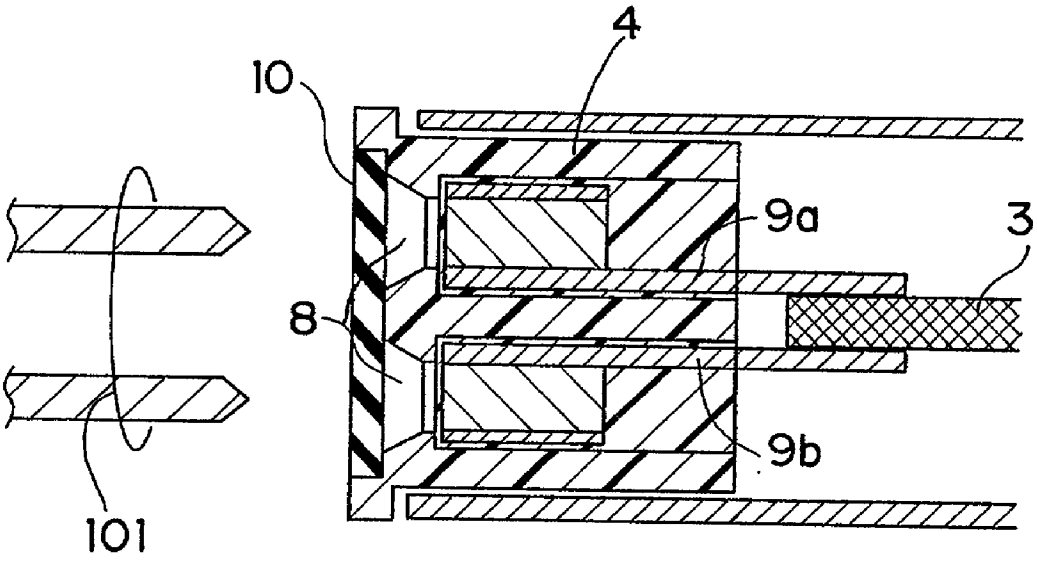



Fig. 5B

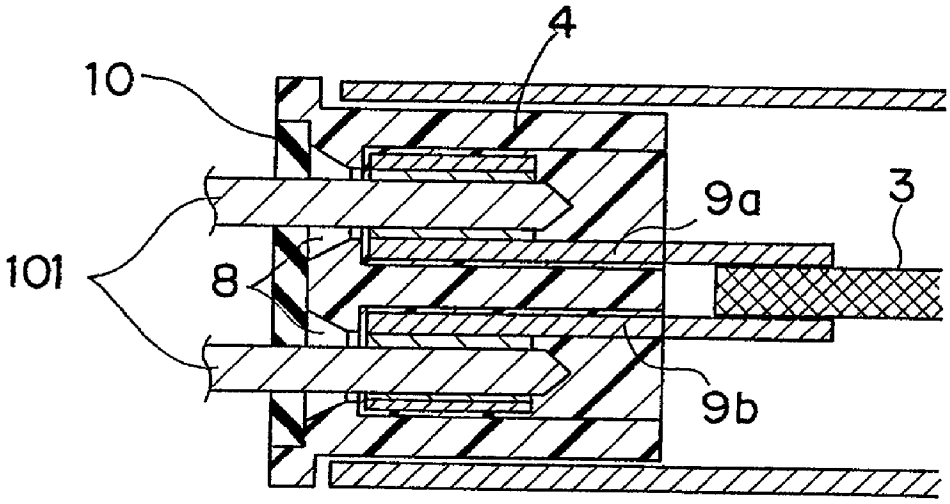


Fig. 6A

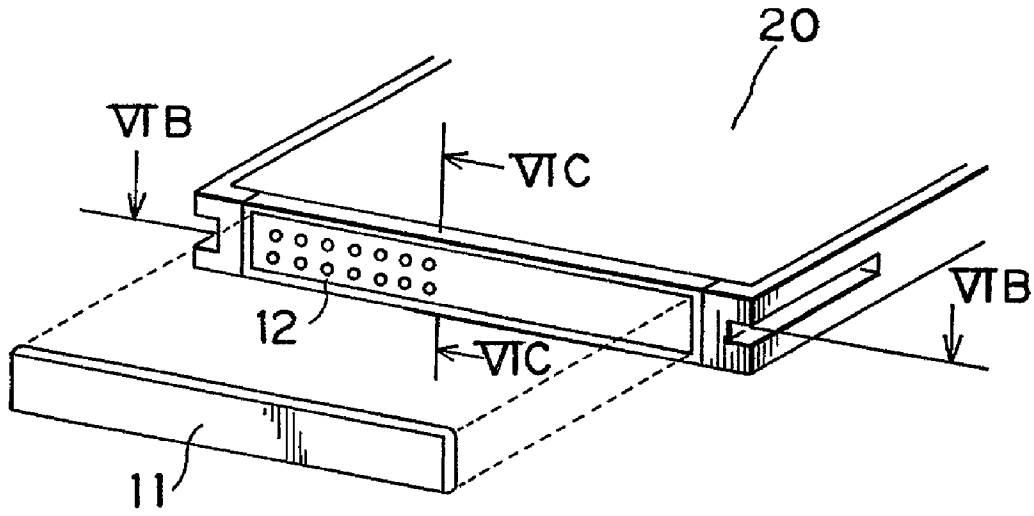



Fig. 6B

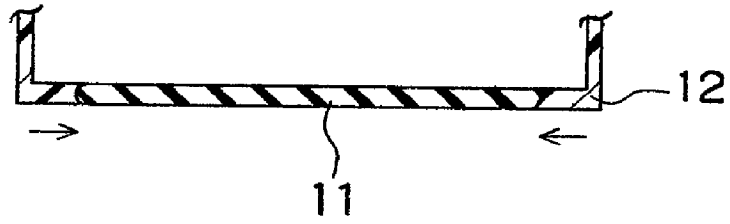



Fig. 6C

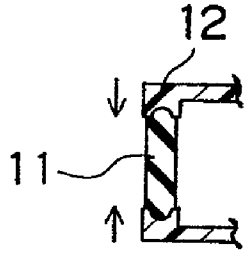


Fig. 7

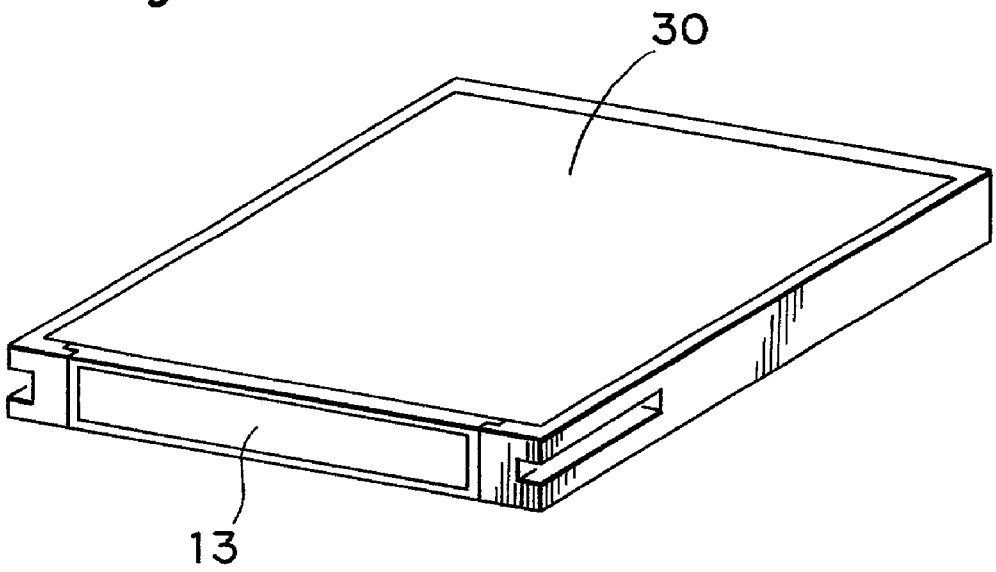



Fig. 8

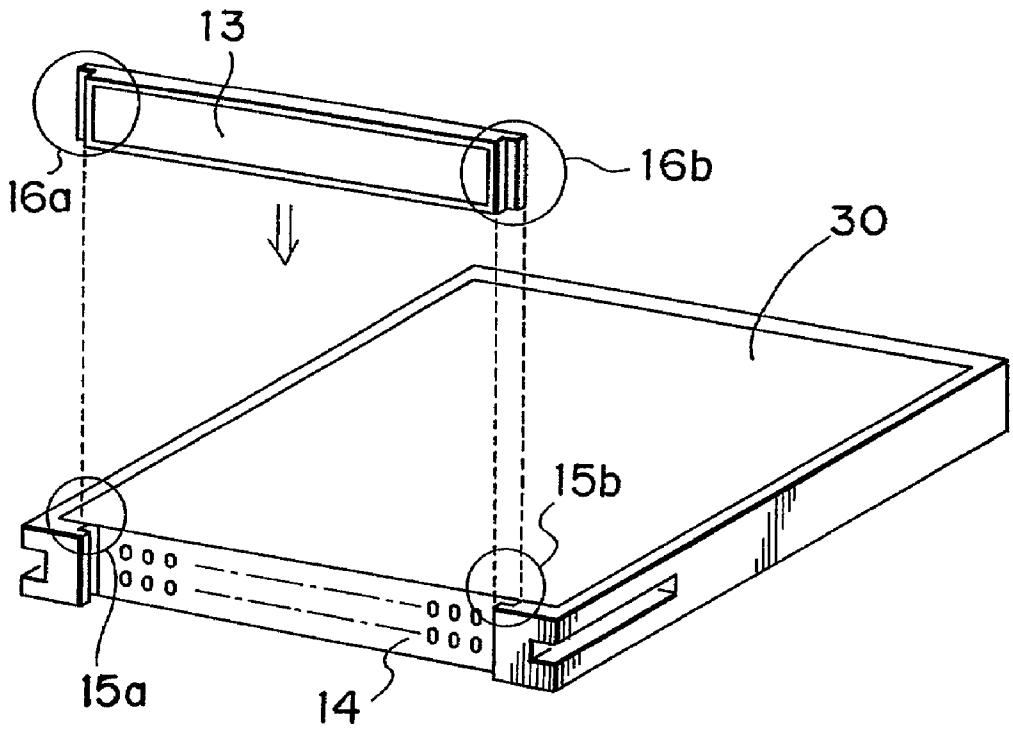


Fig. 9A

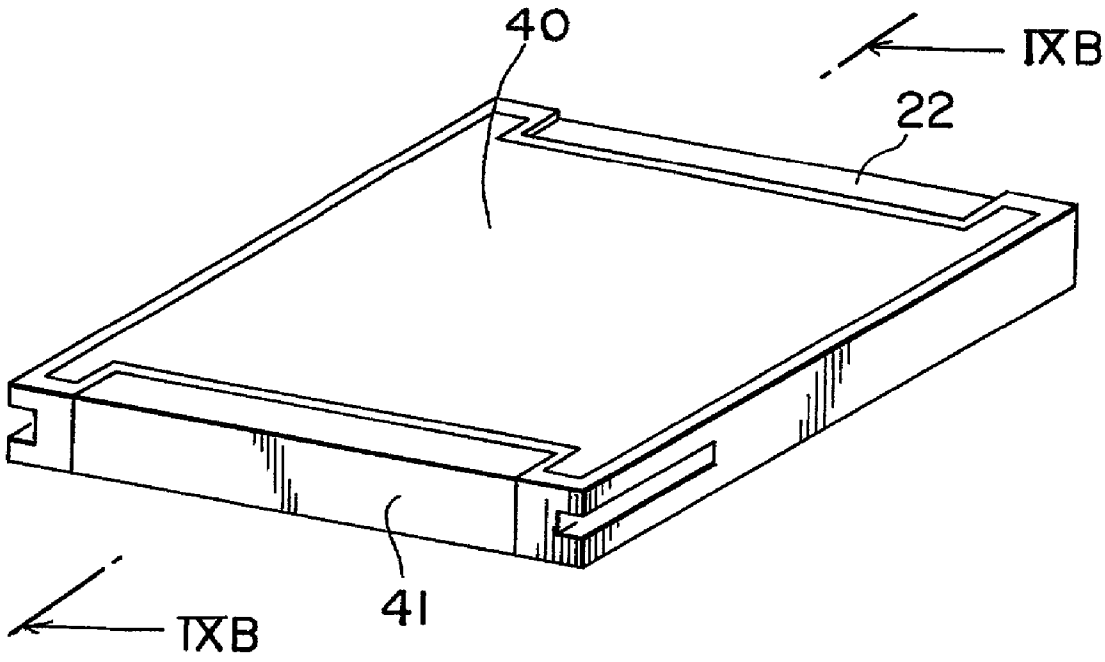



Fig. 9B

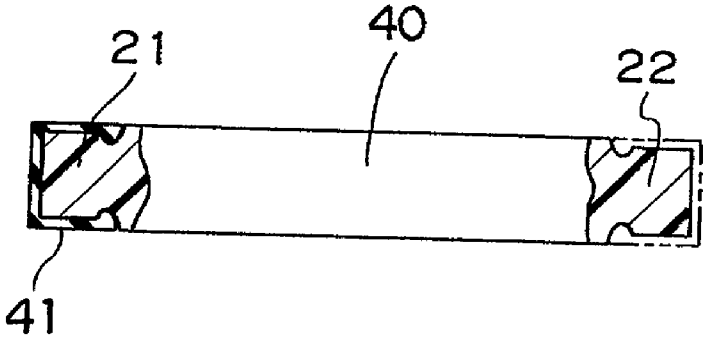


Fig. 10

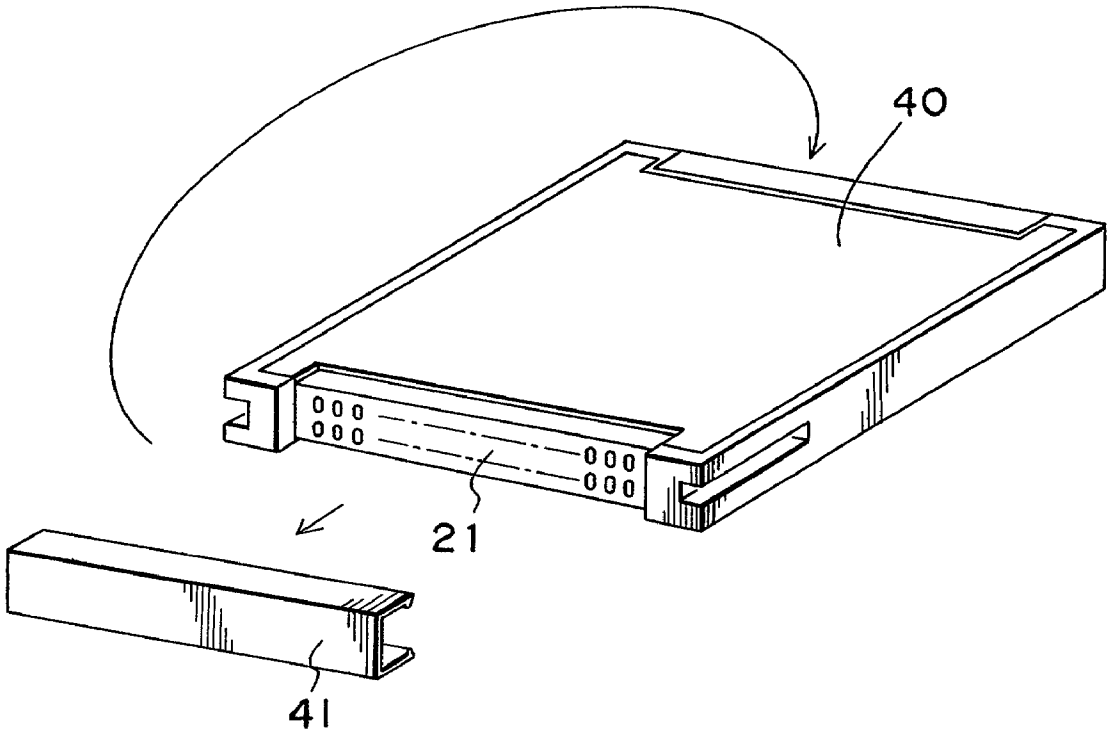



Fig. 11 PRIOR ART

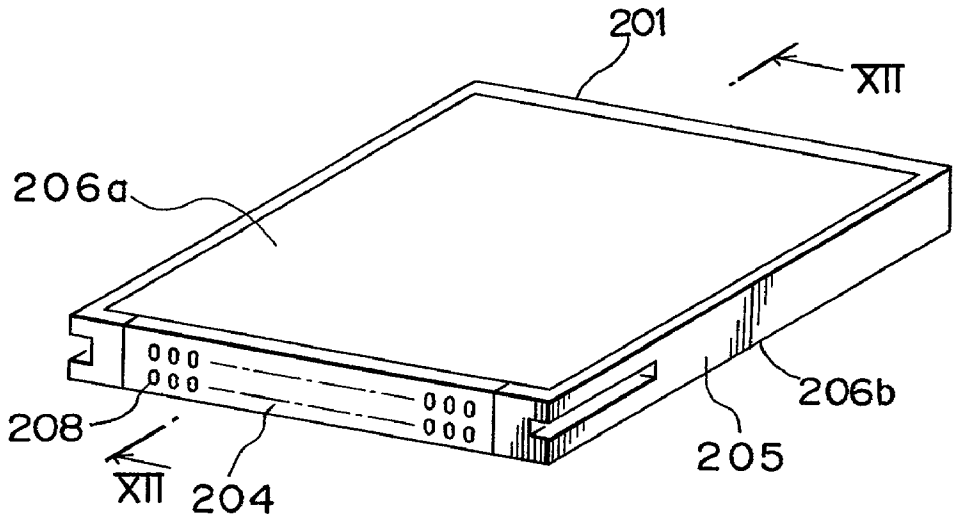


Fig. 12 PRIOR ART

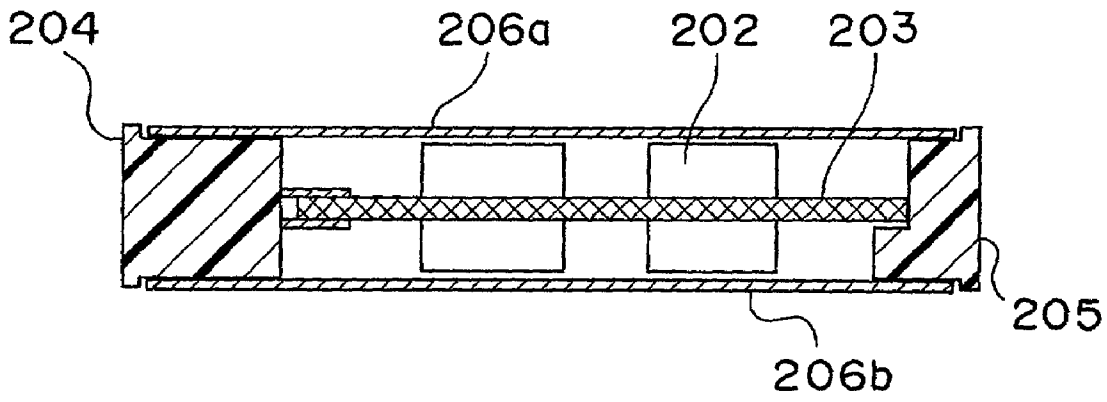
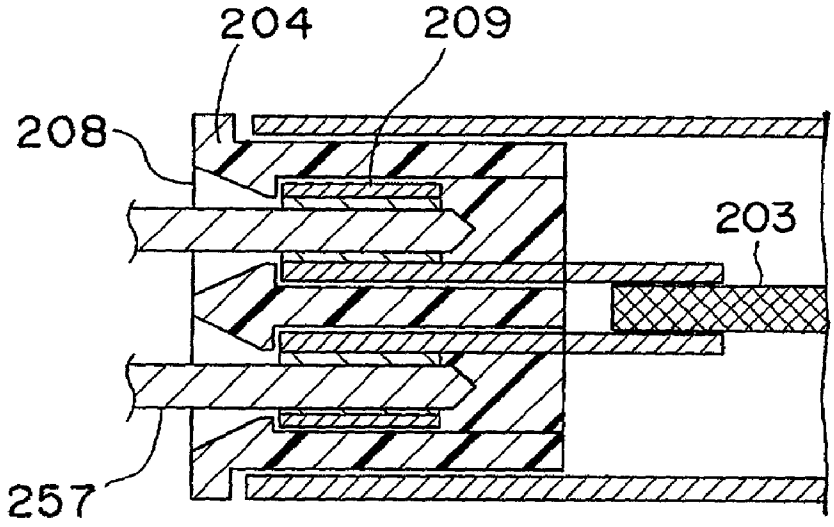



Fig. 13 PRIOR ART



# IC CARD AND IC CARD SYSTEM HAVING PROTECTIVE SEAL

## BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to an IC card having a female connector of a specific shape, and relates more specifically to a protective structure for the connector and internal circuits of the IC card.

[0003] 2. Description of the Related Art

[0004] **FIG. 11** is a perspective view of an IC card **201** according to the prior art. **FIG. 12** is a sectional view of the IC card **201** along line XII-XII in **FIG. 11**. As shown in the figures, this IC card **201** comprises a circuit board **203** on which is mounted a plurality of electronic parts **202**, and a female connector **204**. The circuit board **203** is connected to the female connector **204**, and then housed in a frame **205**. The frame **205** is a rectangular member to which a top panel **206***a* and a bottom panel **206***b* are bonded with an adhesive sheet, for example, to seal the inside of the frame **205**.

[0005] An IC card **201** thus configured can be connected to a card drive of an electronic device where the card drive has a male connector compatible with the female connector **204** of the IC card **201**. Examples of such electronic devices include digital cameras and portable information terminals such as personal digital assistant (PDA) devices and notebook computers. An enlarged view of this female connector **204** is shown in **FIG. 13**.

[0006] As shown in **FIG. 13**, the female connector **204** typically has a plurality of insertion holes **208**. When the IC card **201** is inserted to the card slot (drive) of an electronic device, each connector pin **257** of the card drive is inserted to the matching insertion hole **208** of the female connector **204**. A contact pin **209** is press fit inside each insertion hole **208**, and is connected to a circuit on the circuit board **203**. Inserting the connector pins **257** to the matching insertion holes **208** therefore results in an electrical connection with the corresponding contact pin **209** and internal circuits of the IC card, and connects the IC card **201** to the card drive for use.

[0007] The insertion holes **208** of the female connector **204** in an IC card **201** as shown in **FIG. 12** and **FIG. 13** are always open when the IC card **201** is not mounted in a card drive, and particularly when the connector pins **257** of the card drive are not inserted to the insertion holes **208**. As a result, dust and other foreign matter can easily penetrate into the insertion holes **208** and result in poor contact between the pins.

[0008] IC cards are also very likely to be used outdoors due to the rapid accpetance of digital cameras and other types of portable electronic devices that can use IC cards. Outdoor use also increases the potential for exposure to factors resulting in poor electrical contact between the connector pins. For example, when a digital camera with an IC card is used outside, and particularly when used at the beach, rainwater, sea spray, and even salt air can penetrate the IC card through the insertion holes **208**, causing the female connector **204** and the wiring of the internal circuit board **203** to corrode. The same problem occurs when the IC card is used in a high temperature, high humidity environment, or when the IC card is dropped in a puddle of water. Furthermore, if sea spray or rainwater gets into the female connector **204** through the insertion holes **208** when the IC card is not loaded in a card drive, the water or salt will also transfer to the mated connector pins **257** of the card drive when the IC card is then mounted for use. This will obviously also cause the connector pins **257** to corrode, contribute to circuit shorts, and even adversely affect the connectors of other IC cards that may subsequently be used in the damaged card drive.

[0009] In an attempt to resolve this problem, an IC card as taught by Japanese Patent Laid-Open Publication No. 7-52590 features a protective member made from a resilient material fastened to the front of the connectors of the IC card. This protective member has a plurality of cross-scored openings or slits designed to prevent the penetration of moisture and dust to the pin insertion holes of the IC card connector. The male connector pins of the card drive spread the cross-scored openings or slits open as the male pins are inserted to the female connector.

[0010] The problem with this design when applied to a Type II PCMCIA-standard IC card is that there are **34** pin insertion holes provided in two rows in a connector that is 54 mm wide. As a result, the spacing between adjacent pin insertion holes is extremely narrow. It is therefore difficult to form cross-scored slits in the resilient material conforming precisely to the arrangement of the pin holes, and even if the slits can be accurately formed, the narrow spacing creates problems with the strength of the resilient material and obstruction of the pin holes. It is also difficult to assure a high degree of airtightness inside this typical IC card. It is therefore not possible to completely prevent the penetration of water when the IC card is dropped in a puddle, for example, or when the IC card is exposed to salt air due to use at the seaside, for example.

[0011] For the same purpose, the above-cited Publication H7-52590 further teaches an IC card having a protective member made from a rubber or other resilient material that can be punctured by the male connector pins of the card drive connector. This protective member is held by the elasticity of the material in front of the female connector of the IC card. However, with the protective member held only by the elasticity of the resilient material, the force holding the protective member around the IC card connector is weak. This makes it difficult to maintain a high degree of airtightness inside the card. As a result, it is again not possible to completely prevent the penetration of water when the IC card is dropped in water, or when the IC card is exposed to salt air due to use at the seaside, for example.

[0012] Other attempts have also been made to prevent the penetration of dust and other foreign contaminants. Japanese Utility Model Laid-Open Publication No. 63-11866, for example teaches an IC card comprising a woven filter made from a stretchable insulating fiber on an end of the IC card. Japanese Utility Model Laid-Open Publication No. 63-47180 teaches an IC card comprising a protective cover on an end of the IC card that is only opened during use. Airtightness inside the card, and particularly airtightness when the card is not used, is not assured by either of these designs, however, and they cannot completely prevent the penetration of water when the IC card is dropped in water, or when the IC card is exposed to salt air due to use at the seaside, for example.

[0013] Japanese Patent Laid-Open Publication No. 7-239925 teaches an IC card in which a seal is disposed between the connector and internal circuits to create an airtight seal around the internal circuits. This card can therefore protect the internal circuits of the card from adverse environmental factors, including high humidity and large temperature changes, but cannot prevent penetration by water or salt air to the external connectors.

[0014] It should be noted that penetration of water, dust, and other foreign contaminants to the connector and the inside of the card can be prevented by combining various technologies according to the related art as described above. This, however, complicates the construction and thus leads to higher cost. Furthermore, an airtight seal around the connector cannot be assured even when these technologies are used in combination, and it is therefore obviously not possible to prevent penetration of salt air during use near the sea, or to prevent penetration of water to the connector when dropped in water.

[0015] There is therefore a need for an IC card of simple construction whereby deterioration of the IC card connectors and internal circuits can be completely prevented during use near the sea or outdoors during inclement weather, and penetration of water, dust, and other foreign matter to the connector after the IC card is used can be prevented.

## SUMMARY OF THE INVENTION

[0016] To address the above described need, an IC card according to the present invention comprises a female connector with a plurality of pin insertion holes corresponding to the pins of a male connector, and a seal that is waterproof, insulative and pierceable by the pins of the male connector. The seal covers the front of all pin insertion holes of the female connector, and forms an airtight seal protecting all of the pin insertion holes. By thus forming an airtight seal, the inside of the card is kept airtight when the IC card is not in use, and rainwater and other foreign matter is kept from penetrating the connector or card.

[0017] The seal of this IC card is preferably made from a resilient material with self-restoring force. This self-restoring force causes the holes formed by inserting the male connector pins to close, thereby maintaining a level of airtightness after the IC card is used and effectively preventing penetration of dust and other foreign matter to the card.

[0018] If the seal is further disposed in a manner enabling the seal to be removed and replaced to the front of all pin insertion holes of the female connector, the seal can be selectively used as required, and the original airtight state of the unused seal can be restored at any time. When the seal is thus removably disposed, a member for holding the seal when removed from in front of the connector is preferably provided opposite the connector or at another position not interfering with IC card use when the seal is held thereon.

[0019] The present invention also addresses an IC card system. An IC card system according to the present invention comprises a card drive having a male connector with a plurality of contact pins, and a female connector with pin insertion holes corresponding to the contact pins of the male connector where the front of the pin insertion holes of the female connector is covered and sealed by a seal that is waterproof, insulative, and pierceable by the pins of the male connector. With this IC card system, dust, foreign matter, saltwater, rainwater, and other contaminants cannot penetrate the pin insertion holes or inside of the unused IC card. When the IC card is then used in this IC card system, salt water or rainwater will not contact the male connector contact pins of the card drive. As a result, the pins will not corrode, and further adverse effects on a separate IC card subsequently used in the card drive can be prevented. Consistently reliable data and signal transfer operations can therefore be assured.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0020] These and other objects and features of the present invention will be readily understood from the following detailed description taken in conjunction with preferred embodiments thereof with reference to the accompanying drawings, in which like parts are designated by like reference numerals and in which:.

[0021] **FIG. 1** is a schematic plan view of an IC card according to a first embodiment of the present invention, and an IC card system comprising a card drive in which said IC card is used;

[0022] **FIG. 2** is a schematic perspective view of the IC card shown in **FIG. 1**;

[0023] **FIG. 3** is a schematic perspective view of the IC card shown in **FIG. 1** partially disassembled;

[0024] **FIG. 4** is a schematic side section of view of the IC card shown in **FIG. 1** along line IV-IV in **FIG. 2**;

[0025] **FIG. 5A** is a partially enlarged view of the connector of the IC card shown in **FIG. 1**;

[0026] **FIG. 5B** is a partially enlarged view of a connector pin inserted to a connector of the IC card in **FIG. 5A**;

[0027] **FIG. 6A** is a perspective view of an IC card **20** according to a second embodiment of the present invention;

[0028] **FIG. 6B** is a side section view of the connector **12** shown in **FIG. 6**A through line VIB-VIB in **FIG. 6A**;

[0029] **FIG. 6C** is a side section view of the connector **12** shown in **FIG. 6**A through line VIC-VIC in **FIG. 6A**;

[0030] **FIG. 7** is a shcematic perspective view of an IC card according to a third embodiment of the present invention;

[0031] **FIG. 8** is a schematic perspective view of the IC card shown in **FIG. 7** partially disassembled;

[0032] **FIG. 9A** is a schematic perspective view of an IC card according to a fourth embodiment of the present invention;

[0033] **FIG. 9B** is a partial sectional view of the IC card along line IXB-IXB of **FIG. 9A**;

[0034] **FIG. 10** is a schematic perspective view of the IC card shown in **FIG. 9A** partially disassembled;

[0035] **FIG. 11** is a schematic perspective view of an IC card according to the prior;

[0036] **FIG. 12** is a sectional view of the IC card along line XII-XII of in **FIG. 11**; and

[0037] **FIG. 13** is an enlarged view of the connector of the IC card shown in **FIG. 11**.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0038] The preferred embodiments of the present invention are described below with reference to the accompanying drawings.

[0039] Embodiment 1

[0040] **FIG. 1** is a typical plan view of an IC card **1** according to a first embodiment of the present invention, and part of a card drive **100** in which said IC card **1** is used. The card drive **100** comprises a male connector **102** of a specific shape and having a plurality of pins **101**. The ends of the pins **101** in the connector **102** are preferably pointed.

[0041] The IC card **1** has a female connector **4** that is compatible with the male connector **102**. A shield cover **10** is bonded to the front of the female connector **4**, that is, the side of the connector **4** at the leading edge of the IC card **1** when inserted to the card drive **100**. This shield cover **10** is made from a resilient material, such as rubber, that is both waterproof and insulative.

[0042] Resilient materials that can be used for the shield cover **10** include chloroprene rubber, nitrile rubber, propylene rubber, silicon rubber, and fluoroelastomers. The shield cover **10** shall not be so limited, however, and can essentially be manufactured from any material that is pierceable by the pins **101**, is waterproof and dielectric, and has sufficient self-restoring force to close holes opened by the pins **101**. In practice, the material used for the shield cover **10** is chosen with consideration also given to such properties as tensile strength, stretchability, tear resistance, and wear resistance, in addition to self-restoring force.

[0043] The card drive **100** can be integrated to a digital camera, notebook or desktop computer, personal digital assistant or other type of portable electronic device. The construction and operation thereof is known in the literature, and further description is therefore omitted below.

[0044] **FIG. 2** is a perspective view of the IC card **1** in **FIG. 1**. A shield cover **10** that is waterproof, dielectric, and can be pierced by the pins **101** of the card drive connector as described above is provided covering the front of all pin insertion holes (not shown in the figure) of the IC card connector **4**.

[0045] **FIG. 3** is a perspective view of the IC card **1** with the shield cover **10** removed. Note that the shield cover **10** is attached by adhesive to form a completely airtight seal around all pin insertion holes of the connector **4**.

[0046] **FIG. 4** is a side section view of the IC card **1** through line IV-IV in **FIG. 2**. As shown in the figure, the IC card **1** also comprises a circuit board **3** on which is mounted a plurality of electronic parts **2**. The circuit board **3** is connected to the female connector **4**, and then housed in a frame **5**. A top panel **6***a* and a bottom panel **6***b*, as seen in **FIG. 4**, are bonded to the frame **5** using an adhesive sheet, for example, to seal the inside of the frame **5**. The shield cover **10** is then applied with adhesive to the front of the connector **4**.

[0047] **FIGS. 5A and 5B** are enlarged side views of the connector **4**. **FIG. 5A** shows the connector **4** before the pins **101** of the male connector **102** of the card drive **100** are inserted to the connector **4**. Insertion holes **8** are provided in the connector **4** at positions corresponding to the pins **101**. A contact pin **9***a* and **9***b* is press fit into each insertion hole **8**, and is connected to the wiring pattern of the circuit board **3** as required.

[0048] Note that there are no holes open in the shield cover **10** before the pins **101** are inserted, and an airtight seal around the inside of the IC card **1** is thus assured. Penetration of saltwater, rainwater, humid air, dust, and other foreign contaminants to the inside of the IC card **1**, which includes the connector **4**, can therefore be completely prevented without housing the IC card **1** in a special case and without providing a special cover over the connector **4**.

[0049] Note that because penetration of saltwater, rainwater, humid air, dust, and other foreign contaminants to the inside of the connector **4** can be prevented when the IC card **1** is unused, the transfer of seawater, for example, to the pins **101** of the card drive **100** when the IC card is used can be prevented, and circuit shorting resulting therefrom can be prevented. As a result, consistently accurate data communications between the IC card **1** and the card drive **100** can be maintained.

[0050] **FIG. 5B** shows the IC card connector **4** when the pins **101** of the male connector **102** of the card drive **100** mate with the corresponding connector and contact pin. As shown in the figure, the pins **101** pierce the resilient shield cover **10** in order to penetrate an insertion hole **8** and contact the corresponding contact pin **9**. This electrically connects the card drive **100** and IC card **1**.

[0051] The holes opened in the shield cover **10** by the pins **101** are extremely small in comparison with holes that are prescored in a cross shape or are preopened to approximately the same size as the insertion hole **8**. After the pins **101** are removed, the holes are closed substantially completely by the self-restoring force of the shield cover **10** material. It is therefore possible to effectively prevent penetration of moisture and foreign materials to the insertion holes **8** even after the IC card has been used.

[0052] The connector **4** of the IC card **1** can be any female connector that is compatible with the mated male connector of the card drive **100** in which the IC card **1** is used. An IC card **1** according to the present invention is therefore specifically not limited to IC cards conforming to the PCMCIA standard or the Compact Flash Association (CFA) standard, and can therefore conform to any other desired standard. It should be noted that this is also true of IC cards according to the second through fourth embodiments described below.

[0053] Embodiment 2

[0054] An IC card **20** according to a second embodiment of the present invention is described next with reference to **FIGS. 6A, 6B**, and 6C. **FIG. 6A** is a perspective view of an IC card **20** according to a second embodiment of the present invention, **FIG. 6B** is a side section view of the connector **12** along line VIB-VIB in **FIG. 6**A, and **FIG. 6C** is a side section view of the connector **12** along line VIC-VIC in **FIG. 6A**.

[0055] As shown in **FIG. 6**B and **FIG. 6**C, the shield cover **11** of an IC card **20** according to this second embodiment has a protruding rib formed around the outside edge of the cover, and the connector **12** to which the shield cover **11** is fit and fixed has a frame member in which a channel matching the rib of the shield cover **11** is formed. The connector **12** and inside circuits of the IC card **20** can be completely sealed and made airtight by fitting the shield cover **11** to the connector **12**.

[0056] The shield cover **11** configuration according to this embodiment makes it possible to replace the shield cover **11** as required, and makes it possible to restore a used IC card **20** to the same airtight condition as an unused IC card **20**.

[0057] It should be noted that the effects of sealing the connector **12** and the inside of the IC card **20** airtight by means of the shield cover **11** are the same as those of an IC card **1** according to the first embodiment above.

[0058] The material from which the shield cover **11** is made can be the same as the material used for the shield cover **10** of the IC card **1** according to the first embodiment, that is, a rubber or other resilient, waterproof, insulative material that can be pierced by the pins of the matching male connector. In addition, however, the material of this shield cover **11** must have strength sufficient to hold the shield cover **11** fit to the front of the connector **12**. The shield cover **11** can therefore have a thick perimeter and a thin wall in the area opposite the insertion holes **8**. Alternatively, a plastic or other relatively hard material can be used in the perimeter, and a rubber or other resilient material can be used in the area opposite the insertion holes **8** of the connector **12**.

[0059] Embodiment 3

[0060] An IC card **30** according to a third embodiment of the present invention is described next with reference to **FIG. 7, a** perspective view, and **FIG. 8, a** perspective view of the IC card **30** with the shield cover **13** thereof removed.

[0061] As shown in the figures, the shield cover **13** of an IC card **30** according to the present embodiment has guides **16***a* and **16***b* of a specific configuration on opposite ends of the shield cover **13**. The matching connector **14** has guide channels **15***a* and **15***b* of a configuration matching the guides **16***a* and **16***b* of the shield cover **13**.

[0062] The shield cover **13** is fit to the connector **14** by sliding the guides **16***a* and **16***b* thereof into the guide channels **15***a* and **15***b* in the direction indicated by the arrow in **FIG. 8**. When thus fit, the connector **14** and inside of the IC card **30** are sealed completely airtight. It should be noted that to assure a reliable fit to the connector **14**, the shield cover **13** is made with a perimeter of plastic or other relatively hard material, and a rubber or other resilient material in the area opposite the insertion holes of the connector **14**. A resilient material of a specific hardness can also be used for the shield cover **13** itself while using a thin rubber or other resilient material with sufficient self-recovering force in the area opposite the insertion holes of the connector **14**.

[0063] An advantage of using this shield cover **13** compared with the shield cover **11** of the second embodiment is that the shield cover **13** can be removed and replaced more easily. The other effects and benefits of this embodiment are the same as those of the IC card **20** according to the second embodiment.

[0064] Embodiment 4

[0065] An IC card **40** according to a fourth embodiment of the present invention is described next with reference to **FIGS. 9A and 9B**. **FIG. 9A** is a perspective view of an IC card **40** according to this fourth embodiment of the invention, and **FIG. 9B** is a side section view thereof through line IXB-IXB in **FIG. 9A**.

[0066] As shown in **FIG. 9**B, the shield cover **41** of this embodiment is removably fit to the connector **21** of the IC card **40** such that the connector **21** is partially contained within shield cover **41**. The shield cover **41** is a waterproof, insulative material that can be pierced by the pins of the matching male connector, and forms a completely airtight seal over all pin insertion holes of the connector **21**. A shield cover holder **22** for holding the shield cover **41** when not in use on the connector **21** is provided on the side opposite the connector **21**. Note, however, that the shield cover holder **22** can be provided at any place other than in front of the connector **21** insofar as use of the IC card **40** is not inhibited when the shield cover **41** is mounted to the shield cover holder **22**.

[0067] **FIG. 10** shows the IC card **40** with the shield cover **41** removed. As indicated by the two arrows in **FIG. 10**, the shield cover **41** can be removed from the connector **21** and held on the shield cover holder **22** of the IC card **40**.

[0068] When the IC card **40** is used at the seaside or outdoors in inclement weather, the shield cover **41** can be fit over the connector **21** to form an airtight seal around the connector **21** and card interior, and thus prevent penetration of salt water, rain, dust, and other foreign materials. When the IC card **40** is used indoors, and particularly where there is no particular concern about dust or moisture penetrating the card or connector holes, the shield cover **41** can be removed from the connector **21** and stored on the shield cover holder **22**. Unnecessary piercing of the shield cover **41** by the pins can thus be reduced, and the service life of the shield cover **41** can thus be extended. The other effects and benefits of this embodiment are the same as those of the IC card **20** according to the second embodiment.

[0069] Although the present invention has been described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications will be apparent to those skilled in the art. Such changes and modifications are to be understood as included within the scope of the present invention as defined by the appended claims, unless they depart therefrom.

What is claimed is:

**1**. An IC card comprising a female connector with a pin insertion hole corresponding to a pin of a male connector, and

a seal that is waterproof, insulative and pierceable by a pin of the male connector,

wherein the seal seals airtight the front of all pin insertion holes of the female connector.

**2**. The IC card according to claim 1, wherein the seal is made from a resilient material with self-restoring force.

**3**. The IC card according to claim 1, wherein the seal is removably disposed in front of all pin insertion holes of the female connector.

**4**. The IC card according to claim 3, further comprising a holding member for holding the seal at a position other than in front of the connector.

**5**. An IC card system comprising a card drive having a male connector with a plurality of contact pins, and

an IC card comprising a female connector with a pin insertion hole corresponding to a contact pin of the male connector, and

a seal that is waterproof, insulative and pierceable by a pin of the male connector,

wherein the seal seals airtight the front of all pin insertion holes of the female connector.

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