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Radiation imaging device

Abstract

A radiation imaging device according to one embodiment comprises a radiation detection panel, a base substrate having a support surface configured to support the radiation detection panel, and a housing, wherein: the housing has a top wall and a bottom wall, the base substrate has a protruding portion which protrudes further outward than the radiation detection panel when seen in a direction orthogonal to the support surface, a first extending portion is provided to the support surface of the protruding portion, a second extending portion is provided to a back surface of the protruding portion, the second extending portion being disposed at a position which it faces the first extending portion with the protruding portion interposed therebetween, and the base substrate is supported on the top wall via the first extending portion and is supported on the bottom wall via the second extending portion.

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Background/Summary

TECHNICAL FIELD
(1) The disclosure relates to a radiation imaging device.
BACKGROUND ART
(2) Patent Document 1 describes an X-ray detection device. This X-ray detection device includes a support member fixed in a housing (an envelope) and an X-ray detection panel fixed on the support member.
CITATION LIST
Patent Document
(3) [Patent Document 1] Japanese Unexamined Patent Publication No. 2010-145349
SUMMARY OF INVENTION
Technical Problem
(4) In the configuration in which the X-ray detection panel is supported in the housing via the support member as described above, it is required to stably support the support member in the housing. On the other hand, Patent Document 1 does not describe a specific structure which fixes the support member in the housing.
(5) One aspect of the disclosure is to provide a radiation imaging device capable of stably supporting a base substrate on which a radiation detection panel is supported.
Solution to Problem
(6) A radiation imaging device according to an aspect of the disclosure includes a radiation detection panel having a first surface on which a detection region for detecting radiation is formed and a second surface on a side opposite to the first surface, a base substrate having a support surface configured to face the second surface of the radiation detection panel and configured to

support the radiation detection panel, and a housing configured to accommodate the radiation detection panel and the base substrate, wherein the housing has a first wall portion which faces the first surface and a second wall portion which faces the second surface, the base substrate has a protruding portion which protrudes further outward than the radiation detection panel when seen in a first direction orthogonal to the support surface, a first extending portion configured to extend in the first direction is provided on the support surface of the protruding portion, a second extending portion disposed at a position at which the second extending portion faces the first extending portion with the protruding portion interposed therebetween and configured to extend in the first direction is provided on a surface of the protruding portion on a side opposite to the support surface, and the base substrate is supported on the first wall portion via the first extending portion and is supported on the second wall portion via the second extending portion.

(7) According to the radiation imaging device, the base substrate (the protruding portion) is sandwiched by parts of the housing (the first wall portion and the second wall portion) which face each other via the first extending portion and the second extending portion. Thus, the base substrate can be stably supported with respect to the housing. Here, as a method of supporting the base substrate with respect to the housing, for example, there is a method of supporting a back surface of the base substrate (a surface opposite to the support surface) on the second wall portion via a columnar support member. According to the radiation imaging device, since the base substrate is supported on the housing via the first extending portion and the second extending portion, even when the above-described supporting method is used in combination, the number of support members provided on the back surface of the base substrate can be reduced. Thus, it is possible to make it difficult for an impact from the outside (particularly, the second wall portion) to be transmitted to the back surface of the base substrate. As a result, it is possible to reduce the impact on the radiation detection panel disposed on the base substrate.

(8) The first extending portion may be a positioning member which positions the radiation detection panel. With such a configuration, since the first extending portion makes it possible to easily position the radiation detection panel with respect to the support surface of the base substrate, assembly workability can be improved.

(9) The first extending portion and the second extending portion may be formed separately from the base substrate. With such a configuration, warpage of the base substrate can be reduced as compared with a case in which the base substrate is integrally formed with at least one of the first extending portion and the second extending portion.

(10) The first extending portion and the second extending portion may be mounted on the protruding portion by a common mounting member. With such a configuration, a relative positional relationship between the first extending portion and the second extending portion can be maintained with high accuracy, and the base substrate can be supported more stably.

(11) The second extending portion may be larger than the first extending portion when seen in the first direction, and the second extending portion may have a portion which does not overlap the first extending portion when seen in the first direction. The second wall portion of the housing located on the side opposite to the first surface on which the detection region of the radiation detection panel is formed (that is, facing the second surface) is usually a ground surface (a bottom wall). Therefore, with such a configuration, the base substrate can be supported more stably by making the second extending portion supported by the second wall portion larger than the first extending portion. Further, since an impact from the ground surface side (the second wall portion) can be appropriately absorbed by the second extending portion, it is possible to make it difficult for the impact to be transmitted to the radiation detection panel.

(12) A plurality of first extending portions disposed apart from each other may be provided, and a plurality of second extending portions disposed apart from each other to correspond to the plurality of first extending portions may be provided on the support surface of the protruding portion. With such a configuration, the base substrate can be supported with respect to the housing by the first

extending portions and the second extending portions scattered at a plurality of positions separated from each other. Thus, for example, as compared with a case in which the first extending portion and the second extending portion are formed in a wall shape along an edge portion of the base substrate, the base substrate can be stably supported with respect to the housing while a weight of the first extending portions and the second extending portions is reduced.
(13) The base substrate may have a plurality of protruding portions disposed apart from each other, and the first extending portion and the second extending portion may be provided on each of the plurality of protruding portions. With such a configuration, it is possible to easily realize a configuration which achieves the above-described effect by providing the first extending portion and the second extending portion for each protruding portion.
(14) The radiation detection panel may be formed in a rectangular shape when seen in the first direction, and the plurality of protruding portions may be provided at positions corresponding to four corners of the radiation detection panel. With such a configuration, since four corners of the base substrate can be sandwiched by the first wall portion and the second wall portion via the first extending portion and the second extending portion in a well-balanced manner, the base substrate can be supported more stably with respect to the housing.
(15) The housing may have a third wall portion which extends in the first direction and connects the first wall portion to the second wall portion, the third wall portion may be formed in a rectangular ring shape when seen in the first direction, a recess which avoids interference with the protruding portion, the first extending portion, and the second extending portion may be formed in each corner portion of the third wall portion, and a thickness of the third wall portion in the recess may be smaller than a thickness of the third wall portion on a side portion of the third wall portion which connects the adjacent corner portions of the third wall portion. When a thickness of the third wall portion is constant (that is, a thickness at the corner portion is the same as a thickness at the side portion), it is necessary to increase an exterior size of the housing when seen in the first direction by an amount that it is necessary to avoid interference with the protruding portion at the corner portion. In this case, a proportion of a dead region in the radiation imaging device when seen in the first direction (that is, a ratio of a region other than a detection region to a region of the entire radiation imaging device) becomes large. On the other hand, with such a configuration, it is possible to reduce the proportion of the dead region by forming the recess.
(16) The first wall portion may have a shield member which is disposed to be in surface contact with the third wall portion and shields electromagnetic waves, and the first wall portion may be screwed to the side portion of the third wall portion and the first extending portion. With such a configuration, excellent surface contact between the first wall portion and the third wall portion can be achieved on the entire surface of the third wall portion which faces the first wall portion by screwing the first wall portion to the side portion of the third wall portion and the first extending portion (that is, a portion close to the corner portion of the third wall portion). Thus, an electromagnetic shield effect can be effectively enhanced.
Advantageous Effects of Invention
(17) According to one aspect of the disclosure, it is possible to provide a radiation imaging device capable of stably supporting a base substrate on which a radiation detection panel is supported.

Description

BRIEF DESCRIPTION OF DRAWINGS
(1) FIG. **1** is a plan view of a radiation imaging device of one embodiment.
(2) FIG. **2** is a cross-sectional view taken along line II-II of FIG. **1**.
(3) FIG. **3** is an enlarged plan view of a part of a radiation detection panel.
(4) FIG. **4** is a cross-sectional view taken along line IV-IV of FIG. **3**.

(5) FIG. **5** is a diagram showing an internal configuration of a light receiving part and an IC chip.
(6) FIG. **6** is a diagram for explaining a positional relationship between a connection region and a base substrate.
(7) FIG. **7** is a diagram showing a relationship between a distance from a heater and a temperature in the radiation detection panel.
(8) FIG. **8** is a diagram showing an example of a manufacturing process of the radiation imaging device.
(9) FIG. **9** is a diagram showing the example of the manufacturing process of the radiation imaging device.
(10) FIG. **10** is a diagram showing the example of the manufacturing process of the radiation imaging device.
(11) FIG. **11** is a diagram showing the example of the manufacturing process of the radiation imaging device.
(12) FIG. **12** is a diagram showing an arrangement example of an electrode pad.
(13) FIG. **13** is a diagram showing a modified example of the base substrate.
(14) FIG. **14** is a diagram showing an arrangement example of a first extending portion.

DESCRIPTION OF EMBODIMENTS

(15) Hereinafter, embodiments of the disclosure will be described in detail with reference to the accompanying drawings. In the description of the drawings, the same reference numerals are used for the same or equivalent elements, and duplicate description thereof will be omitted. The disclosure is not limited to these examples, but is shown by the scope of claims and is intended to include all modifications within the meaning and scope equivalent to the scope of claims. For ease of understanding, XYZ orthogonal coordinate systems are shown in FIGS. **1** to **4**, **6** and **8** to **11**.
(16) FIG. **1** is a plan view of a radiation imaging device **1** according to an embodiment of the disclosure. FIG. **2** is a cross-sectional view taken along line II-II of FIG. **1**. However, in FIG. **1**, a top wall **11** and a screw member **14** are not shown. The radiation imaging device **1** is, for example, a large-area flat panel sensor used in a medical X-ray imaging system. As shown in FIGS. **1** and **2**, the radiation imaging device **1** includes a housing **10**, a base substrate **20**, a radiation detection panel **30**, a flexible circuit substrate **40**, a control substrate **50**, and a radiation shielding member **60**.
(17) The housing **10** is a hollow container having a substantially rectangular parallelepiped shape. The housing **10** has a top wall **11** (a first wall portion), a bottom wall **12** (a second wall portion), and a side wall **13** (a third wall portion). The top wall **11** and the bottom wall **12** are each formed in a rectangular plate shape which extends along an XY plane, and face each other. The side wall **13** extends along an XZ plane or an YZ plane, and connects an edge portion of the top wall **11** with an edge portion of the bottom wall **12**. That is, the side wall **13** is formed in a rectangular ring shape when seen in a Z direction. The housing **10** accommodates the base substrate **20**, the radiation detection panel **30**, the flexible circuit substrate **40**, the control substrate **50**, and the radiation shielding member **60**.
(18) The top wall **11** is configured of a member which allows radiation (for example, X-rays) to be detected by the radiation imaging device **1** to be transmitted to the inside of the housing **10**. The top wall **11** guides the radiation incident in the Z direction to the inside of the housing **10**. That is, the Z direction is an incident direction of the radiation to be detected. In the embodiment, the top wall **11** has a two-layer structure. Specifically, the top wall **11** includes a carbon fiber plate **111** provided on the side (the outer side) on which the radiation is incident, and a shield member **112** provided on an inner surface of the carbon fiber plate **111** to shield electromagnetic waves. The shield member **112** is, for example, an aluminum shield formed by adhering an aluminum foil to the inner surface of the carbon fiber plate **111**.
(19) The bottom wall **12** and the side wall **13** are formed of a metal material (for example, iron or the like) which blocks radiation. An upper surface **13*a*** of the side wall **13** is in surface contact with

the shield member **112** and is electrically connected to the shield member **112**. Thus, electromagnetic waves directed from the outside of the housing **10** to the inside of the housing **10** are shielded. Further, a plurality of screw holes **13***b* are provided in the upper surface **13***a* of the side wall **13**. The screw member **14** is inserted through a through hole **11***a* provided in the top wall **11** and screwed into the screw hole **13***b*. Accordingly, the top wall **11** is fixed to the side wall **13**.
(20) The base substrate **20** is a member which supports the radiation detection panel **30**, the control substrate **50**, and the radiation shielding member **60**. The base substrate **20** is made of, for example, a metal such as iron, aluminum, stainless steel, a tungsten alloy, copper tungsten or the like. As an example, in the embodiment, the base substrate **20** is made of relatively lightweight aluminum. The base substrate **20** has a support surface **20***a* and a back surface **20***b* on the side opposite to the support surface **20***a*. The support surface **20***a* is a surface which faces the top wall **11**, and the back surface **20***b* is a surface which faces the bottom wall **12**. The support surface **20***a* supports a substrate **31** of the radiation detection panel **30**. The control substrate **50** is fixed to the back surface **20***b* via, for example, one or more support members **55** formed in a columnar shape which extends in the Z direction.
(21) The radiation detection panel **30** has the substrate **31** formed in a rectangular plate shape. The substrate **31** has a first surface **31***a* on which a light receiving part **32** (a light receiving surface) is formed, and a second surface **31***b* on the side opposite to the first surface **31***a*. The first surface **31***a* is a surface which faces the top wall **11**, and the second surface **31***b* is a surface which faces the bottom wall **12**. A scintillator **34** (a conversion part) is disposed on the light receiving part **32**. The scintillator **34** is formed by, for example, depositing a scintillator material containing CsI as a main component on the light receiving part **32**. The scintillator **34** converts radiation incident through the top wall **11** into light. Specifically, the scintillator **34** outputs scintillation light having an intensity corresponding to an incident intensity of radiation to the light receiving part **32**. Thus, a region on the first surface **31***a* in which the light receiving part **32** is formed serves as a detection region R for detecting radiation. The detection region R has, for example, a light receiving area (for example, 40 cm×30 cm) having a side of about 30 cm to 40 cm.
(22) The substrate **31** is, for example, a transparent glass substrate. The substrate **31** is fixed to the base substrate **20** by the second surface **31***b* of the substrate **31** being fixed to the support surface **20***a* of the base substrate **20**. For example, the second surface **31***b* of the substrate **31** is fixed to the support surface **20***a* of the base substrate **20** via an adhesive member G (refer to FIG. **6**) such as double-sided tape. When seen in the Z direction, at least the region in which the light receiving part **32** and the scintillator **34** are disposed is included in the support surface **20***a*. Further, the adhesive member G (refer to FIG. **6**) is provided at least in a region overlapping the light receiving part **32** when seen in the Z direction. Further, an outer end portion of the adhesive member G is located further inward than an end portion (an end portion **21***a* described later) of the base substrate **20** when seen in the Z direction. On the first surface **31***a* of the substrate **31**, a plurality of electrode pads **33** are formed on the outside of the detection region R. The plurality of electrode pads **33** are electrically connected to pixels P.sub.m,n (refer to FIG. **3**) formed in the light receiving part **32** via a wire (a reading wire and a row selection wire) described later. In the embodiment, as an example, **22** (11×2 sides) electrode pads **33** are formed on a peripheral edge portion of the substrate **31** in an X direction. Further, **14** (7×2 sides) electrode pads **33** are formed on the peripheral edge portion of the substrate **31** in a Y direction.
(23) The flexible circuit substrate **40** is a circuit member electrically connected to the electrode pads **33**. The flexible circuit substrate **40** includes a flexible substrate **41** which can be deformed by bending or the like, and an IC chip **42** mounted on the flexible substrate **41**. The flexible substrate **41** has, for example, a structure in which a circuit pattern made of a conductor foil (for example, copper or the like) is formed on a thin film insulator (for example, polyimide or the like). One end portion **41***a* of the flexible substrate **41** is connected to the electrode pads **33** via a connecting member **70**. The connecting member **70** is a member which generates an adhesive force by

thermocompression bonding, and is an anisotropic conductive material such as an anisotropic conductive film (ACF) or anisotropic conductive paste (ACP). The other end portion **41***b* of the flexible substrate **41** is connected to the control substrate **50** (a connector **51**).

(24) The control substrate **50** includes a circuit which controls an operation of the IC chip **42** (for example, an operation of vertical shift registers **42***a* and **42***b* and signal connection parts **42***c* and **42***d* which will be described later) and supplies electric power to the IC chip **42**. Specifically, for example, electric power is supplied to the control substrate **50** from an external power source (not shown) disposed on the outside of the housing **10** (for example, the outside of the bottom wall **12**), and the electric power is supplied to the IC chip **42** via the control substrate **50**. The external power source may be disposed inside the housing **10** (for example, a space between the control substrate **50** and the bottom wall **12**). However, from the viewpoint of curbing generation of measurement noise caused by the external power source, it is preferable that the external power source is disposed outside the housing **10**. The control substrate **50** is fixed to the back surface **20***b* of the base substrate **20** via one or more of the above-described support members **55**. Further, the control substrate **50** is also fixed to the bottom wall **12** via a support member **56** similar to the support member **55**. The support member **55** and the support member **56** may be integrally formed as a columnar member which supports the control substrate **50** while passing through the control substrate **50** in the Z direction. Such a columnar member serves as a member which supports the base substrate **20** with respect to the bottom wall **12** and supports the control substrate **50** with respect to the bottom wall **12** and the base substrate **20**.

(25) Here, the IC chip **42** mounted on the flexible circuit substrate **40** and an AD converter **52** mounted on the control substrate **50** are parts (heat generating members) which are particularly likely to generate heat. Further, when heat from the IC chip **42** or the AD converter **52** is transferred to the radiation detection panel **30**, noise may be generated in an image acquired by the light receiving part **32**. Therefore, in the embodiment, a heat sink member **57** is disposed between each of the IC chip **42** and the AD converter **52** and the bottom wall **12** to efficiently release the heat generated from the IC chip **42** and the AD converter **52** to the bottom wall **12** of the housing **10**. The heat sink member **57** is, for example, a gel sheet or the like of which a main material is silicone or the like. As shown in FIG. **2**, when a distance between the IC chip **42** or the AD converter **52** and the bottom wall **12** is large, a projection **12***a* which protrudes toward the top wall **11** side may be provided on a portion of the inner surface of the bottom wall **12** which overlaps the IC chip **42** or the AD converter **52** when seen in the Z direction. According to such a projection **12***a*, the heat generated from the IC chip **42** or the AD converter **52** can be appropriately released to the bottom wall **12** via the heat sink member **57** and the projection **12***a*. Further, it is possible to utilize a portion in which the projection **12***a* is not provided as a space for accommodating various parts and the like by partially raising the inner surface of the bottom wall **12**.

(26) The control substrate **50** overlaps the scintillator **34** and the base substrate **20** when seen in the Z direction. That is, most of the radiation incident from the top wall **11** and directed to the control substrate **50** is shielded by the scintillator **34** and the base substrate **20**. On the other hand, as in the embodiment, the IC chip **42** mounted on the flexible circuit substrate **40** may be disposed at a position at which it does not overlap the scintillator **34** and the base substrate **20** when seen in the Z direction. That is, the radiation incident from the top wall **11** and directed to the IC chip **42** may not be shielded by the scintillator **34** and the base substrate **20**. In this case, when no measures are taken, the IC chip **42** may be damaged by the radiation, and a malfunction of the IC chip **42** or the like may be caused. Therefore, in the embodiment, the radiation shielding member **60** is provided to shield the radiation incident from the top wall **11** and directed to the IC chip **42**.

(27) The radiation shielding member **60** is made of a material having high X-ray shielding ability such as lead and tungsten. In the embodiment, as an example, the radiation shielding member **60** is formed in a strip shape and is provided at an edge portion of the back surface **20***b* of the base substrate **20**. A part of the radiation shielding member **60** protrudes to the outside of the base

substrate **20** to overlap the IC chip **42** when seen in the Z direction. The radiation shielding member **60** may be provided for each of the IC chips **42**, or one radiation shielding member **60** (that is, a member formed in a size which overlaps the plurality of IC chips when seen in the Z direction) may be provided for a plurality of IC chips **42** adjacent to each other. In the embodiment, a weight of the radiation imaging device **1** is reduced by the base substrate **20** being made of relatively lightweight aluminum and the radiation shielding member **60** made of a relatively heavy material as described above being provided in part of a place in which radiation needs to be shielded.

(28) The base substrate **20** includes a main body **21** which is formed in a rectangular shape when seen in the Z direction (a first direction) orthogonal to the support surface **20***a*, and a protruding portion **22** which is formed at each of corner portions (four corners) of the main body **21** and protrudes to the outside of the main body **21**. In the embodiment, as an example, the protruding portion **22** is formed in a substantially rectangular shape of which corners are chamfered when seen in the Z direction. Further, the main body **21** and the protruding portion **22** are integrally formed, and a thickness (a plate thickness) of the protruding portion **22** is the same as a thickness of the main body **21**. That is, the base substrate **20** is configured as a single plate having a substantially uniform thickness.

(29) When seen in the Z direction, an end portion of the base substrate **20** corresponding to a portion in which the flexible circuit substrate **40** is connected to the electrode pad **33** is located further inward (on the detection region R side) than an end portion of the radiation detection panel **30** (that is, an end portion **31***c* of the substrate **31**). Specifically, the main body **21** is formed in a rectangular shape smaller than the substrate **31** when seen in the Z direction, and the end portion **21***a* of the main body **21** is located further inward than the end portion **31***c* of the substrate **31**. That is, the end portion of the base substrate **20** (that is, the end portion **21***a* of the main body **21**) corresponding to each of side portions (portions in which the electrode pad **33** is formed) of the radiation detection panel **30** is located further inward than the end portion **31***c* of the substrate **31**. Furthermore, in the embodiment, the base substrate **20** is formed not to overlap a connection region A in which the electrode pad **33**, the connecting member **70**, and the flexible circuit substrate **40** (the one end portion **41***a* of the flexible substrate **41**) overlap each other when seen in the Z direction. That is, the end portion **21***a* of the main body **21** is located further inward than an inner end portion A**1** of the connection region A. Thus, a configuration in which the base substrate **20** does not overlap the connection region A (**36** connection regions A in the embodiment) when seen in the Z direction is realized.

(30) The protruding portion **22** protrudes further outward than the radiation detection panel **30** at a position (as an example in the embodiment, the corner portion of the main body **21**) at which it does not overlap the flexible circuit substrate **40** when seen in the Z direction. That is, when seen in the Z direction, the protruding portion **22** protrudes further outward than the substrate **31**. In the embodiment, the protruding portion **22** protrudes further outward than an end portion (a bent portion which is a portion farthest from the end portion **31***c* of the substrate **31** in a direction parallel to the XY plane) of the flexible substrate **41** when seen in the Z direction.

(31) A first extending portion **81** which extends in the Z direction is provided in the support surface **20***a* of the protruding portion **22**. As an example in the embodiment, the first extending portion **81** is made of aluminum. However, the first extending portion **81** may be formed of other materials. For example, the material of the first extending portion **81** may be a metal other than aluminum such as iron, engineering plastics such as polyacetal (POM) and polyetheretherketone (PEEK), and the like. The first extending portion **81** is fixed to the protruding portion **22** via, for example, a fixing member (for example, a screw or the like) which is not shown. In the embodiment, the first extending portion **81** is a columnar member which extends in the Z direction and serves as a positioning member for positioning the radiation detection panel **30** (that is, the substrate **31**). Specifically, the first extending portion **81** has a guide groove **81***a* which extends in the Z direction to accommodate a corner portion **31***d* of the substrate **31**. The guide groove **81***a* is formed in an L

shape to match a shape of the corner portion **31***d* of the substrate **31** when seen in the Z direction. That is, the first extending portion **81** has a shape in which a part (a square columnar portion corresponding to a space formed by the guide groove **81***a*) of a square columnar member (a member having the same shape as a second extending portion **82** which will be described later) is cut out. In the embodiment, such a first extending portion **81** is provided corresponding to each of the four corners of the substrate **31**. That is, the substrate **31** can be positioned by disposing each of the corner portions **31***d* of the substrate **31** inside the guide groove **81***a* of each of the first extending portions **81**.

(32) The first extending portion **81** is supported by the top wall **11**. In the embodiment, a screw hole **81***b* is formed in the surface of the first extending portion **81** on the top wall **11** side. Then, the screw member **14** is inserted through the through hole **11***a* provided in the top wall **11** and screwed into the screw hole **81***b*. In this way, the first extending portion **81** is supported by the top wall **11** and is also supported by the protruding portion **22**. That is, the base substrate **20** is supported by the top wall **11** via the first extending portion **81**. In the embodiment, the base substrate **20** (the protruding portion **22**) is firmly fixed to the top wall **11** via the first extending portion **81** by screwing.

(33) The second extending portion **82** which is disposed at a position at which it faces the first extending portion **81** with the protruding portion **22** interposed therebetween and extends in the Z direction is provided in the back surface **20***b* of the protruding portion **22**. As an example in the embodiment, the second extending portion **82** is made of aluminum. However, the same material as the above-described material of the first extending portion **81** can be used as the material of the second extending portion **82**. The second extending portion **82** is supported by the protruding portion **22** via, for example, a fixing member (for example, a screw or the like) which is not shown. The first extending portion **81** and the second extending portion **82** may be fixed to the protruding portion **22** by being screwed from the first extending portion **81** side or the second extending portion **82** side using a common screw, or may be fixed to the protruding portion **22** by being individually screwed using different screws. Further, the second extending portion **82** is supported by the bottom wall **12** by the same fixing means as that of the first extending portion **81**. For example, a screw hole (not shown) is formed in a surface of the second extending portion **82** on the bottom wall **12** side, and a screw member (not shown) is inserted through a through hole (not shown) provided in the bottom wall **12** and screwed into the screw hole. In this way, the second extending portion **82** is supported by the protruding portion **22** and the bottom wall **12**. That is, the base substrate **20** is supported by the bottom wall **12** via the second extending portion **82**. In the embodiment, the base substrate **20** (the protruding portion **22**) is firmly fixed to the bottom wall **12** via the second extending portion **82** by screwing.

(34) It is not necessary to form a groove portion corresponding to the guide groove **81***a* of the first extending portion **81** in the second extending portion **82**. Therefore, in the embodiment, the second extending portion **82** is formed in a square columnar shape. That is, the second extending portion **82** has a portion which overlaps the first extending portion **81** when seen in the Z direction, and also has a portion which overlaps a space having a square columnar shape formed by the guide groove **81***a* when seen in the Z direction. However, for example, in order to commonize the members, the second extending portion **82** may be formed into an L-shaped columnar member having the same dimension as that of the first extending portion **81** and may be disposed to completely overlap the first extending portion **81** when seen in the Z direction.

(35) As described above, in the embodiment, the first extending portion **81** and the second extending portion **82** are provided on the protruding portions **22** provided at the corner portions (the four corners) of the main body **21**. That is, the first extending portion **81** and the second extending portion **82** are provided at positions corresponding to the corner portions **31***d* of the radiation detection panel **30** (the substrate **31**). Additionally, the side wall **13** is formed in a rectangular ring shape when seen in the Z direction, and a recess **13***c* is formed at a corner portion

of the side wall **13** to avoid interference with the protruding portion **22**, the first extending portion **81**, and the second extending portion **82**. A thickness t**1** of the side wall **13** in the recess **13***c* is smaller than a thickness t**2** of the side wall **13** in a side portion which connects the adjacent corner portions. In the embodiment, the recess **13***c* is formed at the corner portion of the side wall **13** to be spaced apart from an outer edge of the protruding portion **22** when seen in the Z direction by cutting out a part of an inner side surface of the side wall **13**. Stress concentration on the corner portion of the side wall **13** is curbed by forming the recess **13***c* having such a small thickness at the corner portion of the side wall **13**.

(36) Here, the above-described screw hole **13***b* is not provided in the recess **13***c* having a small thickness (a portion having the thickness t**1**), but is provided only in a side portion having a large thickness (a portion having the thickness t**2**). Therefore, the top wall **11** and the side wall **13** are not fixed (not screwed) to each other at the corner portions (the four corners) of the housing **10** when seen in the Z direction. However, instead, in the embodiment, as described above, the top wall **11** and the first extending portion **81** may be fixed to each other by the screw member **14**. That is, the top wall **11** and the side wall **13** are firmly fixed to each other even at the corner portions of the housing **10**. Thus, excellent surface contact between the shield member **112** of the top wall **11** and the side wall **13** can be achieved even at the corner portions of the housing **10** (the portions to which the top wall **11** and the side wall **13** are not directly screwed). As a result, leakage of electromagnetic waves from outside the housing **10** (invasion thereof into the housing **10**) can be effectively curbed.

(37) Further, an exterior of the housing **10** seen in the Z direction can be made as small as possible by forming such a recess **13***c*. That is, in order to screw the top wall **11** and the side wall **13** at the corner portions of the housing **10**, it is also necessary to increase the exterior size of the housing **10** when seen in the Z direction to secure a thickness of the side wall **13** required for providing the screw holes **13***b* at the corner portions of the housing **10**. In this case, a proportion of a dead region in the radiation imaging device **1** when seen in the Z direction (that is, a ratio of a region other than an effective light receiving area (the detection region R) to the entire region of the radiation imaging device **1**) becomes large. On the other hand, it is possible to reduce the proportion of the dead region while excellent surface contact between the top wall **11** and the side wall **13** is ensured by forming the recess **13***c* and fixing the first extending portion **81** and the top wall **11** to each other instead of fixing the top wall **11** and the side wall **13** at the corner portions of the housing **10** as described in the embodiment.

(38) Next, an operation (radiation detection) of the radiation imaging device **1** will be described. In the embodiment, a vertical shift register (a vertical scanning circuit) is formed on the IC chip **42** of the flexible circuit substrate **40** connected to the electrode pad **33** formed on the peripheral edge of the substrate **31** in the X direction. Specifically, the vertical shift register **42***a* is formed by the IC chip **42** of the flexible circuit substrate **40** provided on a left peripheral edge portion (a left side) of the substrate **31** in FIG. **1**, and the vertical shift register **42***b* is formed by the IC chip **42** of the flexible circuit substrate **40** provided on a right peripheral edge portion (a right side) of the substrate **31**. Further, an amplifier chip (a signal connection part) for reading a signal is formed on the IC chip **42** of the flexible circuit substrate **40** connected to the electrode pad **33** formed on the peripheral edge of the substrate **31** in the Y direction. Specifically, the signal connection part **42***c* is formed by the IC chip **42** of the flexible circuit substrate **40** provided on an upper peripheral edge portion (an upper side) of the substrate **31** in FIG. **1**, and the signal connection part **42***d* is formed by the IC chip **42** of the flexible circuit substrate **40** provided on a lower peripheral edge portion (lower side) of the substrate **31**. As described above, in the embodiment, a configuration in which a signal reading line (a data line) is divided into upper and lower parts is adopted to reduce noise in signal reading and to improve a speed thereof.

(39) A detailed configuration of the light receiving part **32** and the IC chip **42** (the operation of the radiation imaging device **1**) will be described with reference to FIGS. **3** to **5**. FIG. **3** is an enlarged

plan view of a part of the radiation detection panel **30**. FIG. **4** is a cross-sectional view taken along line IV-IV of FIG. **3**. FIG. **5** is a diagram showing an internal configuration of the light receiving part **32** and the IC chip **42**.
(40) The light receiving part **32** is configured by arranging M×N pixels in M rows and N columns in two dimensions. A pixel P.sub.m,n shown in FIG. **3** is a pixel located in the mth row and the nth column. Here, m is an integer of 1 or more and M or less, and n is an integer of 1 or more and N or less. In FIG. **3**, a column direction coincides with an X-axis direction, and a row direction coincides with a Y-axis direction. Each of a plurality of pixels P.sub.1,1 to P.sub.M,N included in the light receiving part **32** includes a photodiode PD and a reading switch SW**1**. A bias voltage is applied to an anode terminal of the photodiode PD, and one end (one current terminal) of the reading switch SW**1** is connected to a cathode terminal of the photodiode PD. Further, the other end (the other current terminal) of the reading switch SW**1** is connected to a corresponding reading wire (for example, in the case of the pixel P.sub.m,n, an nth column reading wire L.sub.o,n). A control terminal of the reading switch SW**1** is connected to a corresponding row selection wire (for example, in the case of the pixel P.sub.m,n, an mth row selection wire L.sub.v,m).
(41) As shown in FIG. **4**, a silicon film **35** is provided on the entire surface of the first surface **31***a* of the substrate **31**. Additionally, the photodiode PD, the reading switch SW**1**, and the nth column reading wire L.sub.o,n are formed on a surface of the silicon film **35**. The photodiode PD, the reading switch SW**1**, and the nth column reading wire L.sub.o,n are covered with an insulating layer **36**. A scintillator **34** is provided on the insulating layer **36** to cover the entire detection region R of the first surface **31***a* of the substrate **31**. The photodiode PD is configured to contain, for example, amorphous silicon.
(42) The photodiode PD of the embodiment includes an n-type semiconductor layer **91** made of n-type polycrystalline silicon, an i-type semiconductor layer **92** made of i-type amorphous silicon provided on the n-type semiconductor layer **91**, and a p-type semiconductor layer **93** made of p-type amorphous silicon provided on the i-type semiconductor layer **92**. Further, the reading switch SW**1** is a thin film transistor (TFT) made of polycrystalline silicon, and has a configuration as a field effect transistor (FET). That is, the reading switch SW**1** includes a channel region **94**, a source region **95** disposed along one side surface of the channel region **94**, a drain region **96** disposed along the other side surface of the channel region **94**, and a gate insulating film **97** and a gate electrode **98** formed on the channel region **94**. The nth column reading wire L.sub.o,n is made of a metal. The scintillator **34** generates scintillation light according to incident radiation, converts a radiation image into an optical image, and outputs the optical image to the light receiving part **32**.
(43) In FIG. **5**, **4**×4 pixels **100** are shown on behalf of M×N pixels P.sub.m,n (m=1, . . . , M, n=1, . . . , N). Each of the pixels **100** includes the photodiode PD and the reading switch SW**1**. The photodiode PD generates an electric charge in an amount corresponding to an intensity of incident light, and accumulates the generated electric charge in a junction capacitance part. As described above, the reading switch SW**1** is connected to the row selection wire L.sub.V corresponding to the row to which the pixel **100** belongs. Here, the row selection wire LV corresponding to the pixel P.sub.m,n in the mth row is the above-described mth row selection wire L.sub.v,m. The M row selection wires L.sub.v are connected to the vertical shift registers **42***a* and **42***b*. Each of the vertical shift registers **42***a* and **42***b* generates a row selection signal for controlling a conduction state and a non-conduction state of the reading switch SW**1** for each row and sequentially provides the row selection signal to the row selection wire L.sub.V in each of the rows.
(44) The reading switch SW**1** opens when the row selection signal output from the vertical shift register **42***a* or **42***b* to the row selection wire L.sub.v is a non-significant value (for example, a low level). At this time, the electric charge generated by the photodiode PD is accumulated in the junction capacitance part without being output to a corresponding column reading wire L.sub.o. Here, the column reading wire L.sub.o corresponding to the pixels P.sub.m,n in the nth column is the above-described nth column reading wire L.sub.o,n. On the other hand, when the row selection

signal is a significant value (for example, a high level), the reading switch SW**1** closes. At this time, the electric charge generated in the photodiode PD and accumulated in the junction capacitance part is output to the corresponding reading wire L.sub.o via the reading switch SW**1**. The output charge is sent to an integrating circuit **101** via the reading wire L.sub.o. In the embodiment, among the pixels **100** formed in the light receiving part **32**, the reading switch SW**1** of the pixel **100** located in the row on the side of an upper side of the substrate **31** is connected to the integrating circuit **101** of the signal connection part **42***c* via the corresponding reading wire L.sub.o. On the other hand, among the pixels **100** formed in the light receiving part **32**, the reading switch SW**1** of the pixel **100** located in the row on the side of a lower side of the substrate **31** is connected to the integrating circuit **101** of the signal connection part **42***d* via the corresponding reading wire L.sub.o. A method of dividing the row on the side of the upper side and the row on the side of the lower side of the substrate **31** is arbitrary. For example, when the number of rows on the side of the upper side of the substrate **31** is N1, and the number of rows on the side of the lower side of the substrate **31** is N2, any of relationships “N1=N2”, “N1>N2”, and “N1<N2” may be established.

(45) The integrating circuit **101** has a so-called charge integration type configuration including an amplifier **101***a*, a capacitance element **101***b*, and a discharge switch **101***c*. The capacitance element **101***b* and the discharge switch **101***c* are connected in parallel with each other and are connected between an input terminal and an output terminal of the amplifier **101***a*. The input terminal of the amplifier **101***a* is connected to the column reading wire L.sub.o. A reset control signal RE is provided to the discharge switch **101***c* via a reset wire L.sub.R.

(46) The reset control signal RE instructs an opening and closing operation of the discharge switch **101***c* of each of N integrating circuits **101**. For example, when the reset control signal RE is a non-significant value (for example, a high level), the discharge switch **101***c* is closed, the electric charge in the capacitance element **101***b* is discharged, and an output voltage value of the integrating circuit **101** is initialized. Further, when the reset control signal RE is a significant value (for example, a low level), the discharge switch **101***c* is opened, the electric charge input to the integrating circuit **101** is accumulated in the capacitance element **101***b*, and a voltage value corresponding to the accumulated electric charge is output from the integrating circuit **101**.

(47) Each of the signal connection parts **42***c* and **42***d* further includes N holding circuits **102** and a horizontal shift register **103**. Each of the holding circuits **102** includes an input switch **102***a*, an output switch **102***b*, and a voltage holding part **102***c*. One end of the voltage holding part **102***c* is connected to an output end of the integrating circuit **101** via the input switch **102***a*, and the other end of the voltage holding part **102***c* is connected to a voltage output wire L.sub.OUT via the output switch **102***b*. A holding control signal Hd is provided to the input switch **102***a* via a holding wire L.sub.H. The holding control signal Hd instructs an opening and closing operation of the input switches **102***a* of each of the N holding circuits **102**. A column selection signal is provided to the output switch **102***b* of the holding circuit **102** from the horizontal shift register **103**. The column selection signal instructs an opening and closing operation of the output switch **102***b* of the holding circuit **102** in the corresponding column.

(48) When the holding control signal Hd changes from a high level to a low level, the input switch **102***a* changes from a closed state to an open state, and the voltage value input to the holding circuit **102** at that time is held by the voltage holding part **102***c*. After that, when the column selection signal from the horizontal shift register **103** sequentially changes from the low level to the high level for each of the columns, the output switch **102***b* is sequentially closed, and the voltage value held in the voltage holding part **102***c* is sequentially output to the voltage output wire L.sub.OUT for each of the columns.

(49) Next, with reference to FIG. **6**, a positional relationship between the connection region A and the end portion **21***a* of the base substrate **20** (the main body **21**) will be described. As shown in FIG. **6**, the one end portion **41***a* of the flexible circuit substrate **40** is connected to the electrode pad

33 via the connecting member **70** by sandwiching the connecting member **70** between heaters H**1** and H**2** from above and below and heating (thermocompression bonding) it in a state in which the connecting member **70** is sandwiched between the one end portion **41***a* and the electrode pad **33**. The heater H**1** (a first heater) is a crimping jig disposed on the side opposite to the connecting member **70** with the flexible circuit substrate **40** interposed therebetween. The heater H**1** is a cemented carbide made of, for example, tungsten carbide and cobalt. The heater H**2** (a second heater) is a crimping jig disposed on the side opposite to the connecting member **70** with the heater H**1** and the radiation detection panel **30** (that is, the substrate **31**) interposed therebetween. The heater H**2** is, for example, quartz glass.
(50) When the flexible circuit substrate **40** is connected to the electrode pad **33**, a surface H**1***a* (a surface which faces the one end portion **41***a*) of the heater H**1** is brought into contact with the one end portion **41***a* of the flexible substrate **41** to overlap at least the connection region A when seen in the Z direction. Further, a surface H**2***a* (a surface of the substrate **31** which faces the second surface **31***b*) of the heater H**2** is brought into contact with the second surface **31***b* of the substrate **31** to overlap at least the connection region A when seen in the Z direction. In this state, for example, heating is performed for several seconds by the heater H**1** heated to 190° C. and the heater H**2** fixed at 40° C. In order to perform such thermocompression bonding (particularly, contact of the heater H**2** with the second surface **31***b* of the substrate **31**), a distance d from the inner end portion A**1** of the connection region A to the end portion of the base substrate **20** (the end portion **21***a* of the main body **21**) is preferably 10 jam or more to curb interference between the heater H**2** and the base substrate **20** during a work.
(51) On the other hand, any of the heat generated from the heaters H**1** and H**2** during the thermocompression bonding can be transferred to the light receiving part **32**, the scintillator **34**, and the adhesive member G via the substrate **31**. The heat transferred in this way may adversely affect these members. Here, as described above, the light receiving part **32**, the scintillator **34**, and the adhesive member G are all located further inward than the end portion **21***a* of the base substrate **20** when seen in the Z direction. That is, a distance (a distance along the XY plane) from the inner end portion A**1** of the connection region A to each of the light receiving part **32**, the scintillator **34**, and the adhesive member G is guaranteed to be longer than the distance d. Therefore, it is possible to secure a distance (a separation distance longer than the distance d) from the connection region A to each of the members (the light receiving part **32**, the scintillator **34**, and the adhesive member G) by adjusting the distance d. From the viewpoint of curbing the adverse effect of the heat generated from the heaters H**1** and H**2** on each of the members as described above, the distance d is preferably 1 mm or more.
(52) Further, when a material having a deliquescent property is used as the scintillator **34**, a moisture-proof film (a protective film) formed by parylene or the like may be provided to cover the entire scintillator **34**. It is known that a moisture-proof property of such a moisture-proof film decreases at about 50° C. In such a case, the distance d may be set so that a temperature of the scintillator **34** (the moisture-proof film) can be curbed to a temperature required for maintaining the moisture-proof property (here, 50° C. or less).
(53) FIG. **7** shows a simulation result when the thermocompression bonding is performed for 8 seconds with the heater H**1** at 200° C. and the heater H**2** at 40° C. (A) of FIG. **7** shows a relationship between a distance from the heater H**1** (a distance along the Y axis in FIG. **6**) and a temperature of the substrate **31** at a portion corresponding to the distance when the substrate **31** is a glass substrate (here, non-alkali glass having a thermal conductivity of 1.2 W/mK). (B) of FIG. **7** shows a relationship between the distance from the heater H**1** and the temperature of the substrate **31** at the portion corresponding to the distance when the substrate **31** is a flexible substrate (here, a film material having a thermal conductivity of 0.3 W/mK). When the substrate **31** is a glass substrate, the simulations have been performed for each of cases in which the thickness t of the substrate **31** is 0.3 mm, 0.5 mm, 0.7 mm, and 0.9 mm. On the other hand, when the substrate **31** is a

flexible substrate, the simulations have been performed for each of cases in which the thickness t of the substrate **31** is 0.1 mm and 0.2 mm.

(54) As shown in (A) of FIG. **7**, in the case in which the substrate **31** is the above-described glass substrate, it is confirmed that when the distance from the heater H**1** is about 3.5 mm or more, it can be curbed to 50° C. or less in any one of the thicknesses (0.3 mm, 0.5 mm, 0.7 mm, 0.9 mm) Also, as shown in (B) of FIG. **7**, in the case in which the substrate **31** is the above-described flexible substrate, it is confirmed that when the distance from the heater H**1** is about 1.5 mm or more, it can be curbed to 50° C. or less in any one of the thicknesses (0.1 mm, 0.2 mm) Here, a distance (a length in the Y direction) from a reference position of the distance from the heater H**1** to the inner end portion A**1** of the connection region A is 0.27 mm. Further, as described above, an edge portion of the scintillator **34** is located further inward than the end portion **21***a* of the base substrate **20** when seen in the Z direction. Therefore, from the viewpoint of curbing the temperature of the scintillator **34** (the moisture-proof film) to 50° C. or less, when the substrate **31** is the above-described glass substrate, the distance d is preferably 3.23 mm or more, and when the substrate **31** is the above-described flexible substrate, the distance d is preferably 1.23 mm or more.

(55) Next, an example of a method for manufacturing the radiation imaging device **1** will be described with reference to FIGS. **8** to **11**.

(56) First, as shown in (A) of FIG. **8**, the radiation detection panel **30** on which the scintillator **34** is formed is prepared. For example, the quality of the radiation detection panel **30** is determined by performing an image inspection such as probing on the radiation detection panel **30**. Subsequently, the scintillator **34** is formed by depositing a scintillator material such as CsI on a pixel area (the light receiving part **32**) of the radiation detection panel **30** determined as a non-defective product. Thus, the radiation detection panel **30** shown in (A) of FIG. **8** is prepared.

(57) Further, as shown in (B) of FIG. **8**, the base substrate **20** on which the first extending portion **81** and the second extending portion **82** are mounted is prepared. For example, the base substrate **20** including the above-described main body **21** and protruding portion **22** is produced by performing planar shape processing on a single metal plate. Subsequently, the first extending portion **81** is mounted on the support surface **20***a* of the protruding portion **22** (each of the four protruding portions **22** provided at the four corners of the main body **21** in the embodiment) by screwing or the like. Further, the second extending portion **82** is mounted on the back surface **20***b* of the protruding portion **22** by screwing or the like. Further, the support member **55** for fixing the control substrate **50** is mounted on the back surface **20***b* of the main body **21**. When the first extending portion **81** and the second extending portion **82** are individually screwed using different screws, the second extending portion **82** may not be necessarily mounted on the protruding portion **22** at this stage. In this case, the second extending portion **82** may be mounted on the protruding portion **22** at an arbitrary time point prior to a step of accommodating the second extending portion **82** in a box portion of the housing which will be described later (refer to FIG. **11**). Further, the support member **55** may not be necessarily mounted on the main body **21** at this stage and may also be mounted on the main body **21** at an arbitrary time point prior to a mounting step of the control substrate **50** (refer to (A) of FIG. **9**) which will be described later.

(58) Subsequently, as shown in (C) of FIG. **8**, the radiation detection panel **30** (refer to (A) of FIG. **8**) on which the scintillator **34** is formed is fixed to the support surface **20***a* of the base substrate **20** (refer to (B) of FIG. **8**) on which the first extending portion **81** and the second extending portion **82** are mounted. Here, the radiation detection panel **30** (the substrate **31**) is positioned using the guide grooves **81***a* of the first extending portion **81** provided at the four corners (the protruding portions **22**) of the base substrate **20** when seen in the Z direction. Subsequently, for example, the substrate **31** is fixed to the support surface **20***a* of the base substrate **20** by an adhesive member G (refer to FIG. **6**) such as a double-sided tape provided in advance on the second surface **31***b* of the substrate **31**. Here, the base substrate **20** is disposed with respect to the radiation detection panel **30** not to overlap the connection region A (refer to FIGS. **2** and **6**) in which the electrode pad **33**, the

connecting member **70**, and the flexible circuit substrate **40** will overlap each other. In the embodiment, as a result of positioning the substrate **31** by the guide groove **81***a* of the first extending portion **81**, the end portion **21***a* of the main body **21** of the base substrate **20** is disposed further inward than the end portion **31***c* of the substrate **31**. Thus, the base substrate **20** is disposed not to overlap the connection region A. In a state shown in (C) of FIG. **8**, the radiation detection panel **30** and the base substrate **20** can be easily carried by gripping the portion (in the embodiment, at least one of the protruding portion **22**, the first extending portion **81**, and the second extending portion **82**) at which the protruding portion **22** is provided. That is, handleability of the radiation detection panel **30** and the base substrate **20** is improved by the portion in which the protruding portion **22** is provided.
(59) Subsequently, as shown in (A) of FIG. **9**, the control substrate **50** is fixed to the back surface **20***b* of the base substrate **20** via the support member **55**.
(60) Subsequently, as shown in (B) of FIG. **9**, the one end portion **41***a* of the flexible circuit substrate **40** is connected to the electrode pad **33** via the connecting member **70**. For example, each of the IC chips **42** is inspected in advance, and the IC chip **42** determined as a non-defective product in the inspection is mounted on the flexible substrate **41**. Subsequently, in the state in which the IC chip **42** is mounted on the flexible substrate **41**, other inspections (for example, confirmation of conduction between the IC chip **42** and the flexible substrate **41**) are further performed. Through such inspections, the flexible circuit substrate **40** which will be mounted on the electrode pads **33** of the substrate **31** (**36** electrode pads **33** in the embodiment) is prepared. A mounting order of the control substrate **50** and the flexible circuit substrate **40** may be reversed from the above. That is, the control substrate **50** may be mounted on the base substrate **20** after the flexible circuit substrate **40** is mounted on the radiation detection panel **30**.
(61) Subsequently, the connecting member **70** is heated (thermocompression bonded) by the heater H**1** disposed on the side opposite to the connecting member **70** with the flexible circuit substrate **40** (the one end portion **41***a*) interposed therebetween and the heater H**2** disposed on the side opposite to the connecting member **70** with the radiation detection panel **30** (the substrate **31**) interposed therebetween. As described above, interference between the heater H**2** and the base substrate **20** is prevented by disposing the base substrate **20** not to overlap the connection region A. Further, in the embodiment, since the substrate **31** is a transparent glass substrate, a position of the electrode pad **33** can be confirmed from the back surface (the second surface **31***b*) side of the substrate **31**. Thus, positioning of the heater H**2** can be easily performed. Each of the electrode pads **33** and each of the flexible circuit substrates **40** are electrically connected by the above-described processing. Although it is difficult to grip each of the side portions of the substrate **31** after the flexible circuit substrate **40** is mounted on the electrode pads **33** disposed on each of the side portions of the substrate **31**, the radiation detection panel **30** and the base substrate **20** can be easily carried by gripping the portion at which the protruding portion **22** is provided as described above.
(62) Subsequently, as shown in (A) of FIG. **10**, a radiation shielding member **60** for shielding radiation directed to the IC chip **42** mounted on each of the flexible circuit substrates **40** is provided at an edge portion of the back surface **20***b* of the base substrate **20**.
(63) Subsequently, as shown in (B) of FIG. **10**, the other end portion **41***b* of each of the flexible circuit substrates **40** is connected to the control substrate **50** (the connector **51**). Thus, each of the flexible circuit substrates **40** and the control substrates **50** are electrically connected. As a result, as shown in (B) of FIG. **10**, a detection unit **1***a* before it is mounted in the housing **10** is completed.
(64) Subsequently, an operation check is performed in the state shown in (B) of FIG. **10**. Here, when a defect in the flexible circuit substrate **40** (for example, a malfunction of the IC chip **42** mounted on the flexible circuit substrate **40**) is found, a repair work (a repair method of one embodiment) is carried out according to the following procedure.
(65) First, the other end portion **41***b* of the flexible circuit substrate **40** (hereinafter, “first flexible circuit substrate”) in which a defect is found is removed from the connector **51**, and the radiation

shielding member **60** provided corresponding to the first flexible circuit substrate is removed from the back surface **20***b* of the base substrate **20**. Here, since the radiation shielding member **60** is partially provided for one or each of the plurality of IC chips **42**, it is only necessary to remove a part of the radiation shielding member **60**, and workability is improved. Subsequently, the first flexible circuit substrate (the one end portion **41***a*) is removed from the electrode pad **33** in a state in which the radiation detection panel **30** is supported by the base substrate **20**. Specifically, the connecting member **70** is removed from the electrode pad **33** by heating the connecting member **70**. The first flexible circuit substrate (the one end portion **41***a*) can be removed from the electrode pad **33** by removing the connecting member **70** from the electrode pad **33** in this way. As a result, a state shown in (A) of FIG. **9** is obtained. The heating of the connecting member **70** when the first flexible circuit substrate is removed may be performed by the heaters H**1** and H**2** as in the case of mounting, or may be performed by another method. For example, the connecting member **70** may be heated by blowing hot air onto one side of the connecting member **70** (for example, the side of the first flexible circuit substrate (the one end portion **41***a*)) using an air gun or the like, instead of using the heaters H**1** and H**2**.
(66) Subsequently, the flexible circuit substrate **40** (a second flexible circuit substrate) which will be mounted on the radiation detection panel **30** is prepared. For example, when the above-described first flexible circuit substrate can be repaired (for example, when the IC chip **42** mounted on the first flexible circuit substrate can be repaired by replacing it with another IC chip), a repair work of the first flexible circuit substrate may be performed. In this case, the repaired first flexible circuit substrate is used as the second flexible circuit substrate. On the other hand, when the first flexible circuit substrate cannot be repaired, a spare of the flexible circuit substrate prepared in advance may be used as the second flexible circuit substrate.
(67) Subsequently, the second flexible circuit substrate is mounted on the electrode pad **33** in a state in which the radiation detection panel **30** is supported by the base substrate **20**. That is, as shown in (B) of FIG. **9**, the second flexible circuit substrate is connected to the electrode pad **33** via the connecting member **70** by heating (thermocompression bonding) the connecting member **70** with the heater H**1** disposed on the side opposite to the connecting member **70** with the second flexible circuit substrate (the one end portion **41***a*) interposed therebetween and the heater H**2** disposed on the side opposite to the connecting member **70** with the radiation detection panel **30** (the substrate **31**) interposed therebetween. The repair of the flexible circuit substrate **40** (that is, the removal of the failed first flexible circuit substrate and the reinstallation of the second flexible circuit substrate (for example, the first flexible circuit substrate after repair or the spare part)) is completed by the above-described procedure. Then, a state shown in (B) of FIG. **10** is obtained by mounting again the radiation shielding member **60** which was once removed for repairing the flexible circuit substrate **40** on the edge portion of the back surface **20***b* of the base substrate **20** and mounting the other end portion **41***b* of the second flexible circuit substrate on the connector **51**. In this way, the flexible circuit substrate **40** can be repaired without removing the radiation detection panel **30** from the base substrate **20** by the base substrate **20** being disposed not to overlap the connection region A.
(68) Subsequently, as shown in FIG. **11**, the detection unit **1***a* shown in (B) of FIG. **10** is accommodated (fixed) in the box portion (the bottom wall **12** and the side wall **13**) of the housing. Specifically, the second extending portion **82** is fixed to the bottom wall **12**. Further, the control substrate **50** is fixed to the bottom wall **12** via the support member **56**. Further, the heat sink member **57** is disposed between the IC chip **42** or the AD converter **52** and the projection **12***a* of the bottom wall **12**. Subsequently, as shown in FIG. **2**, a lid portion (the top wall **11**) of the housing is screwed to the side wall **13** and the first extending portion **81**. In this way, the radiation imaging device **1** is manufactured. The above-described repair work of the flexible circuit substrate **40** may be performed after the radiation imaging device **1** is completed. In this case, the above-described repair work may be performed after the top wall **11** is removed from the side wall **13** and the first

extending portion **81** and the detection unit **1***a* is removed from the bottom wall **12** to bring the state shown in (B) of FIG. **10**.
(69) Next, operational effects of the radiation imaging device **1** will be described.
(70) According to the radiation imaging device **1**, the base substrate **20** (the protruding portion **22**) is sandwiched by parts of the housing **10** (the top wall **11** and the bottom wall **12**) facing each other via the first extending portion **81** and the second extending portion **82**. Thus, the base substrate **20** can be stably supported with respect to the housing **10**. Here, as a method of supporting the base substrate **20** with respect to the housing **10**, as shown in the above-described embodiment, there is, for example, a method of supporting the back surface **20***b* of the base substrate **20** on the bottom wall **12** via the columnar support members **55** and **56** (or a support member in which the support members **55** and **56** are integrated to support the control substrate **50** while passing through the control substrate **50** in the Z direction). In the embodiment, the above-described support method is used in combination, but since the base substrate **20** is supported by the housing **10** via the first extending portion **81** and the second extending portion **82**, it is possible to reduce the number of support members provided on the back surface **20***b* of the base substrate **20** as compared with a case in which the first extending portion **81** and the second extending portion **82** are not provided. Thus, it is possible to make it difficult for an impact from the outside (particularly the bottom wall **12**) to be transmitted to the back surface **20***b* of the base substrate **20**. As a result, it is possible to reduce the impact on the radiation detection panel **30** supported by the base substrate **20**. Further, since the number of the support members **56** for supporting the control substrate **50** with respect to the bottom wall **12** can be reduced, it is possible to make it difficult for the impact from the outside (particularly the bottom wall **12**) to be transmitted to the control substrate **50**. Further, since it is possible to reduce the number of support members passing through the control substrate **50**, it is possible to improve a degree of freedom in designing a layout of the control substrate **50** (a layout of circuits, wire, or the like mounted on the control substrate **50**).
(71) Further, the first extending portion **81** serves as a positioning member which positions the radiation detection panel **30** (the substrate **31**). With such a configuration, since the first extending portion **81** makes it possible to easily position the radiation detection panel **30** (the substrate **31**) with respect to the support surface **20***a* of the base substrate **20**, assembling workability can be improved.
(72) Further, the first extending portion **81** and the second extending portion **82** may be integrally formed with the base substrate **20**, but in the above-described embodiment, the first extending portion **81** and the second extending portion **82** are formed separately from the base substrate **20**. With such a configuration, warpage of the base substrate **20** can be reduced as compared with a case in which the base substrate **20** is integrally formed with at least one of the first extending portion **81** and the second extending portion **82**. Further, when the first extending portion **81** or the second extending portion **82** is integrally formed with the base substrate **20**, it is necessary to cut out a relatively thick metal plate, and thus a disadvantage in which material cost and man-hours are increased occurs. On the other hand, such a disadvantage can be avoided by forming the first extending portion **81** and the second extending portion **82** separately from the base substrate **20**.
(73) Further, as described above, the first extending portion **81** and the second extending portion **82** may be mounted on the protruding portion **22** by a common mounting member (a screw or the like). With such a configuration, a relative positional relationship between the first extending portion **81** and the second extending portion **82** can be maintained with high accuracy, and the base substrate **20** can be supported more stably.
(74) Further, the second extending portion **82** is larger than the first extending portion **81** when seen in the Z direction, and the second extending portion **82** has a portion which does not overlap the first extending portion **81** when seen in the Z direction. In the embodiment, the second extending portion **82** is larger than the first extending portion **81** by an amount that a groove portion corresponding to the guide groove **81***a* of the first extending portion **81** is not provided. The

bottom wall **12** of the housing **10** located on the side opposite to the first surface **31***a* on which the detection region R of the radiation detection panel **30** is formed (that is, facing the second surface **31***b*) is usually a ground surface. Therefore, with such a configuration, the base substrate **20** can be supported more stably by making the second extending portion **82** supported by the bottom wall **12** larger than the first extending portion **81**. Further, since the impact from the ground contact surface side (the bottom wall **12**) can be suitably absorbed by the second extending portion **82**, it is possible to make it difficult for the impact to be transmitted to the radiation detection panel **30**.
(75) Further, a plurality of first extending portions **81** disposed apart from each other are provided, and a plurality of second extending portions **82** disposed apart from each other to correspond to the plurality of first extending portions **81** are provided on the support surface **20***a* of the protruding portion **22**. In the embodiment, four first extending portions **81** disposed apart from each other and four second extending portions **82** corresponding to the four first extending portions **81** are provided. With such a configuration, the base substrate **20** can be supported with respect to the housing **10** by the first extending portions **81** and the second extending portions **82** scattered at a plurality of positions (in the embodiment, the four corners of the base substrate **20**) spaced apart from each other. Thus, for example, as compared with a case in which the first extending portion and the second extending portion are formed in a wall shape along the edge portion of the base substrate **20**, the base substrate **20** can be stably supported with respect to the housing **10** while a weight of the first extending portion **81** and the second extending portion **82** is reduced.
(76) Further, the base substrate **20** has a plurality of (four in the embodiment) protruding portions **22** disposed apart from each other, and the first extending portion **81** and the second extending portion **82** are provided on each of the plurality of protruding portions **22**. With such a configuration, a configuration in which the above-described effects are achieved can be easily realized by providing the first extending portion **81** and the second extending portion **82** for each of the protruding portions **22**. Unlike the above-described embodiment, the plurality of first extending portions **81** which are separated from each other and the plurality of second extending portions **82** which are separated from each other may be provided on one protruding portion **22**. Also in this case, the above-described effects can be obtained. However, it is possible to reduce an useless region (a region in which the first extending portion **81** and the second extending portion **82** are not provided) in the protruding portion **22** and it is possible to reduce a size and a weight of the protruding portion **22**, by providing one first extending portion **81** and one second extending portion **82** for each of the plurality of protruding portions **22** disposed in a dispersed manner as in the embodiment.
(77) Further, the radiation detection panel **30** is formed in a rectangular shape when seen in the Z direction. The plurality of protruding portions **22** are provided at positions corresponding to the four corners of the radiation detection panel **30**. With such a configuration, since the four corners of the base substrate **20** can be sandwiched by the top wall **11** and the bottom wall **12** via the first extending portion **81** and the second extending portion **82** in a well-balanced manner, the base substrate **20** can be supported more stably with respect to the housing **10**.
(78) Further, the side wall **13** is formed in a rectangular ring shape when seen in the Z direction. The recess **13***c* is formed at the corner portion of the side wall **13** to avoid interference with the protruding portion **22**, the first extending portion **81**, and the second extending portion **82**. The thickness t**1** of the side wall **13** in the recess **13***c* is smaller than the thickness t**2** of the side wall **13** in the side portion which connects the corner portions of the adjacent side walls **13**. When the thickness of the side wall **13** is made constant (that is, the thickness at the corner portion is the same as the thickness at the side portion), it is necessary to increase the exterior size of the housing **10** when seen in the Z direction by an amount that it is necessary to avoid interference with the protruding portion **22** at the corner portion. In this case, the proportion of the dead region in the radiation imaging device **1** when seen in the Z direction becomes large. On the other hand, with such a configuration, it is possible to reduce the proportion of the dead region by forming the recess

13*c*.

(79) Further, the top wall **11** has a shield member **112** disposed to be in surface contact with the side wall **13**, and the top wall **11** is screwed to the side portion of the side wall **13** (the screw hole **13***b* provided in the side portion of the side wall **13**) and the first extending portion **81** (the screw hole **81***b* provided in the first extending portion **81**). With such a configuration, excellent surface contact between the top wall **11** and the side wall **13** can be achieved on the entire upper surface **13***a* of the side wall **13** by screwing the top wall **11** to the side portion of the side wall **13** and the first extending portion **81** (that is, the portion close to the corner portion of the side wall **13**). Thus, an electromagnetic shield effect can be effectively enhanced.

(80) Further, the above-described method for manufacturing the radiation imaging device **1** includes a step of preparing the radiation detection panel **30** ((A) of FIG. **8**), a step of supporting the second surface **31***b* of the radiation detection panel **30** on the support surface **20***a* of the base substrate **20** ((C) of FIG. **8**), and a step of connecting the flexible circuit substrate **40** to the electrode pad **33** via the connecting member **70** ((B) of FIG. **9**). Additionally, In the supporting step, the base substrate **20** is disposed with respect to the radiation detection panel **30** so that the end portion **21***a* of the base substrate **20** is located further inward than the inner end portion A**1** of the connection region A (refer to FIG. **6**) in which the electrode pad **33**, the connecting member **70**, and the flexible circuit substrate **40** will overlap each other when seen in the Z direction. Also, in the connecting step, the connecting member **70** is heated by the heater H**1** disposed on the side opposite to the connecting member **70** with the flexible circuit substrate **40** interposed therebetween and the heater H**2** disposed on the side opposite to the connecting member **70** with the radiation detection panel **30** interposed therebetween. According to such a manufacturing method, in the supporting step, the flexible circuit substrate **40**, the connecting member **70**, and the radiation detection panel can be sandwiched between the heater H**1** and the heater H**2** and can be thermocompression bonded by disposing the base substrate **20** not to overlap the connection region A. That is, when the flexible circuit substrate **40** and the electrode pad **33** are connected, it is possible to prevent the interference between the heater H**2** and the base substrate **20**. Thus, the flexible circuit substrate **40** can be connected to the radiation detection panel **30** in a state in which the radiation detection panel **30** is stably supported by the base substrate **20**. Further, a sufficient connection strength can be ensured at a lower heating temperature (a heater temperature) by heating from both sides of the connecting member **70** (the flexible circuit substrate **40** side and the radiation detection panel **30** side) with the heaters H**1** and H**2** as described above, as compared with the case in which the heating is performed from one side of the connecting member **70**. Therefore, according to such a manufacturing method, it is also possible to secure the connection strength while the adverse effect of the heat during the heating on the radiation detection panel **30** and the like (for example, the scintillator **34** and the like) is curbed.

(81) However, the manufacturing procedure of the radiation imaging device **1** is not limited to the above-described procedure, and for example, the flexible circuit substrate **40** may be connected to the electrode pad **33** of the radiation detection panel **30** before the radiation detection panel **30** is supported by the base substrate **20**. That is, the flexible circuit substrate **40** may be connected to the radiation detection panel **30** in a state in which the radiation detection panel **30** is not supported by the base substrate **20**. In any case, since the shape and arrangement of the base substrate **20** are designed not to overlap the connection region A, a degree of freedom of the work procedure at the time of manufacturing the radiation imaging device **1** is improved. Specifically, a timing for carrying out the step of connecting the flexible circuit substrate **40** to the radiation detection panel **30** can be arbitrarily selected. That is, the flexible circuit substrate **40** can be connected to the radiation detection panel **30** before or after the radiation detection panel **30** is supported by the base substrate **20**.

(82) Moreover, the above-described repair method of the radiation imaging device **1** includes a step of removing the first flexible circuit substrate from the electrode pad **33** in a state in which the

radiation detection panel **30** is supported by the base substrate **20**, and a step of connecting the second flexible circuit substrate to the electrode pad **33** via the connecting member **70** by heating the connecting member **70** with the heater H**1** disposed on the side opposite to the connecting member **70** with the second flexible circuit substrate (the first flexible circuit substrate after repair or another flexible circuit substrate) interposed therebetween and the heater H**2** disposed on the side opposite to the connecting member **70** with the radiation detection panel **30** interposed therebetween in the state in which the radiation detection panel **30** is supported by the base substrate **20**. According to such a repair method, the repair (the removing step and the connecting step) of the flexible circuit substrate **40** can be performed without removing the radiation detection panel **30** from the base substrate **20** by disposing the base substrate **20** not to overlap the connection region A. Therefore, according to the above-described repair method, the repair work of the flexible circuit substrate **40** can be easily performed.

Appendix 1

(83) The radiation imaging device **1** includes the radiation detection panel **30** having the first surface **31***a* on which the detection region R for detecting radiation is formed and the electrode pad **33** is formed outside the detection region R and the second surface **31***b* on the side opposite to the first surface **31***a*, the base substrate **20** having the support surface **20***a* which faces the second surface **31***b* of the radiation detection panel **30** and supports the radiation detection panel **30**, and the flexible circuit substrate **40** connected to the electrode pad **33** via a connecting member **70**. The end portion **21***a* of the base substrate **20** is located further inward than the inner end portion A**1** of the connection region A in which the electrode pad **33**, the connecting member **70**, and the flexible circuit substrate **40** overlap each other when seen in the Z direction orthogonal to the support surface **20***a*. In the radiation imaging device **1**, when the flexible circuit substrate **40** is connected to the electrode pad **33**, it may be necessary to heat the flexible circuit substrate **40**, the connecting member **70**, and the radiation detection panel **30** with the heaters H**1** and H**2** from both sides in the Z direction. That is, for example, when a member which generates an adhesive force by thermocompression bonding, such as an anisotropic conductive material, is used as the connecting member **70**, thermocompression bonding by the above heaters H**1** and H**2** is required. On the other hand, in the radiation imaging device **1**, the end portion **21***a* of the base substrate **20** is located further inward than the inner end portion A**1** of the connection region A (all the connection regions A in the embodiment) when seen in the Z direction. Therefore, it is possible to avoid interference between the heater H**2** disposed on the second surface **31***b* side of the radiation detection panel **30** and the base substrate **20**. Thus, when the repair (repair, replacement, or the like) of the flexible circuit substrate **40** is required, the repair of the flexible circuit substrate **40** can be performed without removing the radiation detection panel **30** from the base substrate **20**. Therefore, according to the radiation imaging device **1**, the repair work of the flexible circuit substrate **40** can be easily performed.

(84) Further, when the end portion **21***a* of the base substrate **20** is located further outward than the end portion **31***c* of the radiation detection panel **30** when seen in the Z direction, it is necessary to route the flexible circuit substrate **40** further outward than the end portion **21***a* of the base substrate **20**. The flexible circuit substrate **40** becomes longer by an amount that such routing is required, and noise easily gets on the signal transmitted through the flexible circuit substrate **40**. On the other hand, in the radiation imaging device **1**, the end portion **21***a* of the base substrate **20** is located further inward than the inner end portion A**1** of the connection region A when seen in the Z direction (that is, it is located further inward than the end portion **31***c* of the radiation detection panel **30**). Therefore, it is not necessary to route the flexible circuit substrate **40** as described above, and the overall length of the flexible circuit substrate **40** can be shortened. As a result, it is possible to curb noise in the signal transmitted via the flexible circuit substrate **40**.

(85) Further, the radiation detection panel **30** is formed in a rectangular shape when seen in the Z direction, and one or more connection regions A are formed on at least one side portion of the

radiation detection panel **30**. In the embodiment, as an example, a plurality of connection regions A are formed on each of all (four) side portions. The end portion **21***a* of the base substrate **20** is located further inward than the inner end portions A**1** of all the connection regions A formed on at least one side portion (each of the side portions in the embodiment) when seen in the Z direction. With such a configuration, a position of the outer end portion **40***a* of the flexible circuit substrate **40** connected to the connection region A at the at least one side portion when seen in the Z direction can be brought closer to the end portion **31***c* of the radiation detection panel **30** without interfering with the end portion **21***a* of the base substrate **20**. That is, the outer end portion **40***a* of the flexible circuit substrate **40** at the at least one side portion can be located as inward as possible. Thus, the size of the housing **10** when seen in the Z direction can be reduced, and the radiation imaging device **1** can be miniaturized.

(86) Further, the radiation imaging device **1** includes the scintillator **34** which is disposed on the first surface **31***a* and converts radiation constituting the detection region R into light, the end portion **21***a* of the base substrate **20** is located further outward than the detection region R when seen in the Z direction, and the distance d (refer to FIG. **6**) between the inner end portion A**1** of the connection region A and the end portion **21***a* of the base substrate **20** in a direction along the XY plane (in a second direction) may be 1 mm or more. With such a configuration, it is possible to secure a certain distance (at least 1 mm or more) between the heater H**1** which heats the connecting member **70** and the scintillator **34** when the flexible circuit substrate **40** is connected to the electrode pad **33**. As a result, the adverse effect of the heat from the heater H**1** on the scintillator **34** can be curbed. Further, as described above, a moisture-proof film having a moisture-proof property may be provided at the scintillator **34**. Such a moisture-proof film has a property that it is particularly sensitive to heat. With such a configuration, it is possible to curb an adverse effect of the heat from the heater H**1** on the scintillator **34** (including the moisture-proof film) having such a particularly heat-sensitive property.

(87) Further, the base substrate **20** has the protruding portion **22** which protrudes further outward than the radiation detection panel **30** (the substrate **31**) at a position at which it does not overlap the flexible circuit substrate **40** when seen in the Z direction. With such a configuration, since the protruding portion **22** can be used as a gripping portion in a state in which the radiation detection panel **30** is supported by the base substrate **20**, it is possible to improve handleability at the time of manufacturing or repairing the radiation imaging device **1**.

Appendix 2

(88) The radiation imaging device **1** includes the radiation detection panel **30** having the first surface **31***a* on which the detection region R for detecting radiation is formed and the second surface **31***b* on the side opposite to the first surface **31***a*, the base substrate **20** having the support surface **20***a* which faces the second surface **31***b* of the radiation detection panel **30** and supports the radiation detection panel **30**, and the flexible circuit substrate **40** connected to the radiation detection panel **30**. The end portion **21***a* of the base substrate **20** corresponding to the portion to which the flexible circuit substrate **40** is connected is located further inward than the end portion **31***c* of the radiation detection panel **30** when seen in the Z direction orthogonal to the support surface **20***a*, and the base substrate **20** has the protruding portion **22** which protrudes further outward than the radiation detection panel **30** at a position at which it does not overlap the flexible circuit substrate **40** when seen in the Z direction. In the radiation imaging device **1**, the end portion **21***a* of the base substrate **20** corresponding to the portion to which the flexible circuit substrate **40** is connected is located further inward than the end portion **31***c* of the radiation detection panel **30** (the substrate **31**). Thus, when it is necessary to connect the other end portion **41***b* of the flexible circuit substrate **40** to the control substrate **50** disposed on the back surface **20***b* of the base substrate **20** as in the embodiment, interference between the flexible circuit substrate **40** and the base substrate **20** can be appropriately prevented.

(89) Further, from the viewpoint of reducing the proportion of the above-described dead region

(that is, the ratio of the region other than the effective light receiving area (the detection region R) to the entire region of the radiation imaging device **1**), preferably, a protruding length of the flexible circuit substrate **40** from the end portion **31***c* of the substrate **31** when seen in the Z direction is as small as possible. Here, the protruding length is a separation distance between the outer end portion **40***a* (a bent portion which is farthest from the end portion **31***c* of the substrate **31** in a direction parallel to the XY plane) of the flexible circuit substrate **40** and the end portion **31***c* of the substrate **31** when seen in the Z direction. Since the end portion **21***a* of the base substrate **20** is located further inward than the end portion **31***c* of the radiation detection panel **30** (the substrate **31**), the protrusion length can be made as small as possible. Specifically, when the end portion **21***a* of the base substrate **20** is located further outward than the end portion **31***c*, there is a restriction that the protruding length should be larger than the distance between the end portion **31***c* and the end portion **21***a* of the base substrate **20**. On the other hand, since the end portion **21***a* of the base substrate **20** is located further inward than the end portion **31***c* of the radiation detection panel **30** (the substrate **31**), the above restriction does not occur.
(90) Further, the base substrate **20** has the protruding portion **22** which protrudes further outward than the radiation detection panel **30** (the substrate **31**) at a position at which it does not overlap the flexible circuit substrate **40** when seen in the Z direction. Thus, since the protruding portion **22** can be used as a gripping portion in the state in which the radiation detection panel **30** is supported by the base substrate **20**, handleability of the base substrate **20** can be improved.
(91) Further, the protruding portions **22** are formed at at least two locations. In this case, the base substrate **20** can be stably gripped at two locations. Further, the protruding portions **22** may be formed at at least three locations or at least four locations. In the embodiment, the protruding portions **22** are formed at four locations. In this case, the base substrate **20** can be gripped more stably.
(92) Further, the substrate **31** (the radiation detection panel **30**) is formed in a rectangular shape when seen in the Z direction. The protruding portion **22** is provided at a position corresponding to the corner portion of the radiation detection panel **30**. The handleability of the base substrate **20** can be improved by providing the protruding portion **22** at the position corresponding to the corner portion of the substrate **31** while each of the side portions of the substrate **31** is used as a space connected to the flexible circuit substrate **40** (that is, a region in which the electrode pad **33** is formed). In the embodiment, the protruding portions **22** are formed at the four corners of the base substrate **20**, and the protruding portions **22** are fixed to the housing **10** via the first extending portion **81** and the second extending portion **82**. Thus, the base substrate **20** is supported in a well-balanced manner with respect to the housing **10** via the protruding portions **22** formed at the four corners thereof. Further, in this case, the base substrate **20** is supported on the housing **10** by the protruding portion **22** formed at a position as far as possible from the radiation detection panel **30** when seen in the Z direction. Accordingly, for example, even when the housing **10** is deformed by an external force applied to the housing **10**, it is possible to preferably curb spreading of an influence of the deformation of the housing **10** to the radiation detection panel **30** via the base substrate **20**.
(93) Further, the radiation detection panel **30** is formed in a rectangular shape when seen in the Z direction, and one or more flexible circuit substrates **40** are connected to at least one side portion of the radiation detection panel **30**. In the embodiment, as an example, a plurality of flexible circuit substrates **40** are connected to each of all (four) side portions. The end portion **21***a* of the base substrate **20** corresponding to the portion to which all the flexible circuit substrates **40** are connected at at least one side portion is located further inward than the end portion **31***c* of the radiation detection panel **30**. With such a configuration, positions of the outer end portions **40***a* of all the flexible circuit substrates **40** at at least one side portion when seen in the Z direction can be brought closer to the end portion **31***c* of the radiation detection panel **30** without interfering with the end portion **21***a* of the base substrate **20**. That is, the outer end portion **40***a* of the flexible

circuit substrate **40** at at least one side portion can be located as inward as possible. Thus, the size of the housing **10** when seen in the Z direction can be reduced, and the radiation imaging device **1** can be miniaturized.

(94) Although the preferred embodiments of the disclosure have been described in detail, the disclosure is not limited to the above-described embodiment. For example, not only the above-described materials and shapes but also various materials and shapes can be adopted as the material and shape of each of the parts.

(95) In the above-described embodiment, the vertical shift registers **42***a* and **42***b* and the signal connection parts **42***c* and **42***d* are all externally mounted via the flexible circuit substrate **40**. Further, in consideration of reading performance (noise, reading speed, and the like), the electrode pads **33** for connecting the vertical shift registers **42***a* and **42***b* are disposed on both the left and right sides of the detection region R, and the electrode pads **33** for connecting the signal connection parts **42***c* and **42***d* are disposed on both the upper and lower sides of the detection region R. That is, in the above-described embodiment, as shown in (A) of FIG. **12**, a plurality of electrode pads **33** are disposed on the four sides surrounding the detection region R. However, the electrode pads **33** may not be necessarily disposed on all the four sides. Further, the number of electrode pads **33** disposed on each of the sides and an arrangement interval thereof are not particularly limited.

(96) For example, one of the vertical shift registers **42***a* and **42***b* or one of the signal connection parts **42***c* and **42***d* may be omitted. In this case, as shown in (B) of FIG. **12**, the electrode pads **33** are disposed along three sides of the substrate **31**. Further, one of the vertical shift registers **42***a* and **42***b* and one of the signal connection parts **42***c* and **42***d* may be omitted. In this case, as shown in (C) of FIG. **12**, the electrode pads **33** are disposed along two sides of the substrate **31**. Further, for example, the circuit corresponding to the vertical shift registers **42***a* and **42***b* may be disposed on the substrate **31** instead of the external IC chip **42**. Further, one of the signal connection parts **42***c* and **42***d* may be omitted. In this case, as shown in (D) of FIG. **12**, the electrode pads **33** are disposed along one side of the substrate **31**. For example, arrangement of such a circuit can be easily performed by configuring the substrate **31** as a TFT panel using low-temperature polysilicon.

(97) Further, as shown in (E) of FIG. **12**, a plurality of (here, two as an example) electrode pads **33** may be disposed at relatively wide intervals on the side portions of the substrate **31** (here, two sides on both the left and right sides) at which the electrode pads **33** are provided. In the example, a relatively wide space in which the electrode pads **33** are not disposed is formed at center portions of the two sides on both the left and right sides. Further, as shown in (F) of FIG. **12**, only one electrode pad **33** may be disposed on the side portion of the substrate **31** (here, two sides on both the left and right sides) on which the electrode pad **33** is provided, and a relatively wide space may be formed on both sides of the electrode pad **33**. Then, as shown in (B) to (F) of FIG. **12**, when the side portion in which the electrode pad **33** is not formed or the relatively wide space in which the electrode pad **33** is not provided is provided on the substrate **31**, the protruding portion **22** (refer to, for example, (E) to (I) of FIG. **13**) may be disposed on the portion corresponding to the side portion or the space.

(98) In the above-described embodiment, the protruding portions **22** are provided at the four corners of the main body **21**, but the arrangement and the number of the protruding portions **22** are not limited to the above example. For example, the protruding portions **22** may be provided at one corner portion as shown in (A) of FIG. **13**, may be provided at two adjacent corner portions as shown in (B) of FIG. **13**, may be provided at two corner portions which are diagonal to each other as shown in (C) of FIG. **13**, or may be provided at three corner portions as shown in (D) of FIG. **13**.

(99) Further, the position at which the protruding portion **22** is provided is not limited to the corner portion of the main body **21**, and may be the side portion of the main body **21**. In this case, for example, the protruding portion **22** may be provided on one side as shown in (E) of FIG. **13**, may be provided on two sides adjacent to each other as shown in (F) of FIG. **13**, may be provided on two sides facing each other as shown in (G) of FIG. **13**, may be provided on three sides as shown in

(H) of FIG. **13**, or may be provided on four sides as shown in (I) of FIG. **13**. Further, in the examples of (F) to (I) of FIG. **13**, the protruding portion **22** is provided at the center portion of each of the sides, but the protruding portion **22** may be provided at a position deviated from the center portion of each of the sides, or two or more protruding portions **22** may be provided for one side (for example, refer to (D) of FIG. **14**). In addition, as shown in (A) to (E) of FIG. **13**, even when there is only one protruding portion **22**, the radiation detection panel **30** and the base substrate **20** can be easily carried by gripping the protruding portion **22**. That is, the handleability of the radiation detection panel **30** and the base substrate **20** is improved by the portion on which the protruding portion **22** is provided. On the other hand, when a plurality of protruding portions **22** are provided, the base substrate **20** can be stably gripped at a plurality of locations, and thus the handleability can be further improved.
(100) Further, the protruding portion **22** may be provided on both the corner portion and the side portion of the main body **21**. That is, the arrangement of the protruding portions **22** shown in the above-described embodiment and FIG. **13** and the like may be arbitrarily combined.
(101) In the above-described embodiment, although the first extending portion **81** (the first extending portion **81** in which the guide groove **81***a* is provided) as the positioning member is provided at a position corresponding to each of the four corners of the substrate **31**, at least one first extending portion **81** as the positioning member may be provided. Also in this case, since it is possible to position two sides adjacent to each other (two sides orthogonal to each other) with the corner portion of the substrate **31** interposed therebetween, the substrate **31** can be positioned. However, as shown in (A) to (C) of FIG. **14**, the first extending portion **81** as the positioning member is preferably provided at positions corresponding to two or more corner portions of the substrate **31**. Thus, workability when the substrate **31** is disposed on the support surface **20***a* of the base substrate **20** can be improved.
(102) Further, as shown in (D) to (F) of FIG. **14**, when the protruding portion **22** is provided on the side portion of the main body **21**, the first extending portion **81** may have a guide surface **81***c* (a surface parallel to the side portion of the corresponding substrate **31** when seen in the Z direction) for positioning the side portion of the substrate **31**. Further, in this case, at least one (two in total) first extending portion **81** may be provided on each of two sides orthogonal to each other. However, as shown in (D) to (F) of FIG. **14**, preferably, the first extending portion **81** as the positioning member is provided at three or more locations. Thus, workability when the substrate **31** is disposed on the support surface **20***a* of the base substrate **20** can be improved.
(103) Further, the first extending portion **81** as the positioning member may be provided on both the corner portion and the side portion of the main body **21**.
(104) The first extending portion **81** used as the positioning member may be removed after the substrate **31** is fixed to the support surface **20***a*. However, it is possible to prevent occurrence of a handling mistake when the first extending portion **81** is removed, and thus it is possible to prevent damage to members such as the base substrate **20** due to the handling mistake (that is, a decrease in a yield of the radiation imaging device **1**) by leaving the first extending portion **81** even after the substrate **31** is fixed to the support surface **20***a*. Further, the first extending portion **81** can serve as a protective member for protecting the end portion of the substrate **31** (in the above-described embodiment, the corner portion **31***d* of the substrate **31**) by leaving the first extending portion **81**. Furthermore, as in the above-described embodiment, the first extending portion **81** can be utilized as a support member for connecting the protruding portion **22** to the top wall **11**.
(105) In the above-described embodiment, although the first extending portion **81** serves as the positioning member for positioning the substrate **31** and also serves as the supporting member for supporting the protruding portion **22** with respect to the top wall **11**, the first extending portion **81** may have only one function of the positioning member and the supporting member. That is, the portion for positioning the substrate **31** (the guide groove **81***a* in the embodiment) may not be provided in the first extending portion **81**. Alternatively, the first extending portion **81** may not be

fixed to the top wall **11**. Alternatively, the first extending portion **81** may be omitted. Further, when the plurality of protruding portions **22** are provided, the first extending portion **81** may be provided only on any of the protruding portions **22**. Similarly, the second extending portion **82** may be omitted. Further, when the plurality of protruding portions **22** are provided, the second extending portion **82** may be provided only on any of the protruding portions **22**.
(106) The protruding portion **22** may be omitted. That is, the base substrate **20** may be a member consisting only of the above-described main body **21**. In this case, the first extending portion **81** and the second extending portion **82** fixed to the protruding portion **22** may also be omitted.
(107) In the above-described embodiment, although the base substrate **20** is formed not to overlap all the connection regions A when seen in the Z direction, the base substrate **20** may be formed not to overlap at least one connection region A, and may not necessarily be formed not to overlap all the connection regions A. For example, the base substrate **20** may be formed not to overlap the connection region A corresponding to the flexible circuit substrate **40** on which the IC chip **42** having a particularly high failure rate (that is, repair work is likely to occur) is mounted but to overlap other connection regions A. In this case, although the procedure shown in the above-described embodiment (that is, the procedure of connecting each of the flexible circuit substrates **40** to each of the electrode pads **33** after the radiation detection panel **30** is supported on the base substrate **20**) cannot be performed, the radiation imaging device **1** can be manufactured by connecting each of the flexible circuit substrates **40** to the radiation detection panel **30** and then supporting the radiation detection panel **30** on the base substrate **20**. Further, when the IC chip **42** breaks down due to the base substrate **20** being formed not to overlap the connection region A corresponding to the flexible circuit substrate **40** on which the IC chip **42** having a high failure rate is mounted, the repair work of the flexible circuit substrate **40** can be performed without removing the radiation detection panel **30** from the base substrate **20**. Therefore, even when the base substrate **20** is formed not to overlap only a part of the connection region A in this way, similar to the above-described embodiment, the repair work of the flexible circuit substrate **40** corresponding to the connection region A can be easily performed, and the effect of curbing noise in the signal transmitted via the flexible circuit substrate **40** is achieved.
(108) In the above-described embodiment, although only the flexible circuit substrate **40** is used as an electrical connection means with each of the electrode pad **33**, a connection means other than the flexible circuit substrate **40** (for example, wire bonding or the like) may be used in combination. For example, any of the electrode pads **33** may be connected to the control substrate **50** via the flexible circuit substrate **40**, and other electrode pads **33** may be connected to the control substrate **50** (or a control circuit provided separately) by wire bonding.
(109) Also, in the above-described embodiment, although the external IC chip **42** and the electrode pad **33** are electrically connected via the flexible circuit substrate **40**, for example, a substrate for mounting a chip may be accommodated in the housing **10**, and the IC chip may be mounted on the substrate. Further, the IC chip and the electrode pad **33** may be electrically connected only by a connecting means other than the flexible circuit substrate **40** (for example, the above-described wire bonding). Further, in such a case, since the connection region A as described in the above-described embodiment is not present, the end portion **21***a* of the base substrate **20** may not be disposed further inward than the end portion **31***c* of the radiation detection panel **30** (the substrate **31**) when seen in the Z direction. That is, the base substrate **20** having a size which completely includes the substrate **31** when seen in the Z direction (that is, the base substrate **20** of which the entire peripheral edge portion is located further outward than the substrate **31** when seen in the Z direction) may be used. In this case, the entire peripheral edge portion of the base substrate **20** corresponds to the protruding portion **22** in the above-described embodiment.
(110) Also, in the above-described embodiment, from the viewpoint of preventing interference between the base substrate **20** and the flexible circuit substrate **40** and reducing the proportion of the dead region, the end portion **21***a* of the base substrate **20** corresponding to the portion to which

the flexible circuit substrate **40** is connected may be located further inward than the end portion **31***c* of the radiation detection panel **30** (the substrate **31**), and the base substrate **20** may not be formed not to overlap the connection region A when seen in the Z direction.
(111) In the above-described embodiment, although the detection region R is a region to which an indirect conversion method in which a radiation image is converted into an optical image by the scintillator **34** and then the light image is imaged by the light receiving part **32** to obtain an image is applied, the detection region R may be a region to which a direct conversion method for directly capturing the radiation image to obtain an image is applied. For example, on the first surface **31***a* of the substrate **31**, a pixel circuit configured to accumulate and transfer electric charges may be provided instead of the light receiving part **32**, and a solid material (a converting part) (for example, CdTe, CdZnTe, GaAs, InP, TlBr, HgI2, PbI2, Si, Ge, a-Se, or the like) which directly converts radiation into electric charges may be provided instead of the scintillator **34**. Thus, the detection region R to which the direct conversion method is applied is obtained. In this case, the detection region R is a region on which radiation is incident and is a region to which a bias voltage is applied (that is, a region for which an image is acquired). Since such a solid material also has a property that it is sensitive to a high temperature like the scintillator **34**, preferably, a distance between the solid material and the connection region A (that is, the distance d between the end portion **21***a* of the base substrate **20** and the inner end portion A**1** of the connection region A) is as large as possible. Specifically, even when the solid material is provided (in the direct conversion method), the distance d is preferably set to 1 mm or more, as in the case in which the scintillator **34** is provided (in the indirect conversion method). Thus, a certain distance (at least 1 mm or more) can be secured between the heater H**1** which heats the connecting member **70** to connect the flexible circuit substrate **40** to the electrode pad **33** and the solid material. As a result, an adverse effect of the heat from the heater H**1** on the solid material can be curbed.
(112) In the above-described embodiment, although the radiation detection panel **30** in which polycrystalline silicon, amorphous silicon, or the like is formed on the substrate **31** which is a glass substrate has been described, the radiation detection panel **30** is not limited to the above-described configuration, and may have a configuration in which the light receiving part is formed on, for example, a single crystal silicon substrate. Further, the substrate **31** is not limited to the glass substrate, and may be, for example, a film-shaped substrate (a flexible substrate) or the like.
REFERENCE SIGNS LIST
(113) **1** Radiation imaging device **10** Housing **11** Top wall (first wall portion) **12** Bottom wall (second wall portion) **13** Side wall (third wall portion) **13***c* Recess **20** Base substrate **20***a* Support surface **20***b* Back surface **21***a* End portion **22** Protruding portion **30** Radiation detection panel **31***c* End portion **32** Light receiving part **33** Electrode pad **34** Scintillator (conversion part) **40** Flexible circuit substrate **70** Connecting member **81** First extending portion **82** Second extending portion **112** Shield member A Connection region A**1** Inner end portion H**1** Heater (first heater) H**2** Heater (second heater)

Claims

1. A radiation imaging device comprising: a radiation detection panel having a first surface on which a detection region for detecting radiation is formed and a second surface on a side opposite to the first surface; a base substrate having a support surface configured to face the second surface of the radiation detection panel and configured to support the radiation detection panel; and a housing configured to accommodate the radiation detection panel and the base substrate, wherein the housing has a first wall portion which faces the first surface and a second wall portion which faces the second surface, the base substrate has a protruding portion which protrudes from an edge of the base substrate further outward in a second direction parallel to the support surface than the radiation detection panel when seen in a first direction orthogonal to the support surface, the

protruding portion is provided only on a part of the edge of the base substrate, the part being less that the entire edge, and the base substrate is supported with respect to the housing via an extending portion connected to the protruding portion.
2. The radiation imaging device according to claim 1, wherein: the extending portion is provided on a surface of the protruding portion on a side opposite to the support surface and configured to extend in the first direction, and the base substrate is supported on the second wall portion via the extending portion.
3. The radiation imaging device according to claim 1, further comprising a flexible circuit substrate connected to the radiation detection panel, wherein an end portion of the base substrate corresponding to a portion to which the flexible circuit substrate is connected is located further inward in the second direction than an end portion of the radiation detection panel when seen in the first direction.
4. The radiation imaging device according to claim 1, wherein: the housing has a third wall portion which extends in the first direction and connects the first wall portion to the second wall portion, and the protruding portion is provided so as to be separated from the third wall portion.
5. The radiation imaging device according to claim 1, wherein the extending portion is formed separately from the base substrate.
6. The radiation imaging device according to claim 1, wherein a plurality of extending portions disposed apart from each other are provided on the surface of the protruding portion on a side opposite to the support surface.
7. The radiation imaging device according to claim 6, wherein: the base substrate has a plurality of protruding portions disposed apart from each other, and the extending portion is provided on each of the plurality of protruding portions.
8. The radiation imaging device according to claim 7, wherein: the radiation detection panel is formed in a rectangular shape when seen in the first direction, and the plurality of protruding portions are provided at positions corresponding to four corners of the radiation detection panel.
9. The radiation imaging device according to claim 8, wherein: the housing has a third wall portion which extends in the first direction and connects the first wall portion to the second wall portion, the third wall portion is formed in a rectangular ring shape when seen in the first direction, a recess which avoids interference with the protruding portion and the extending portion is formed in each corner portion of the third wall portion, and a thickness of the third wall portion in the recess is smaller than a thickness of the third wall portion on a side portion of the third wall portion which connects the adjacent corner portions of the third wall portion.