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(54) **ELECTRICAL JUNCTION BOX**

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(58) **Field of Classification Search**
None
See application file for complete search history.

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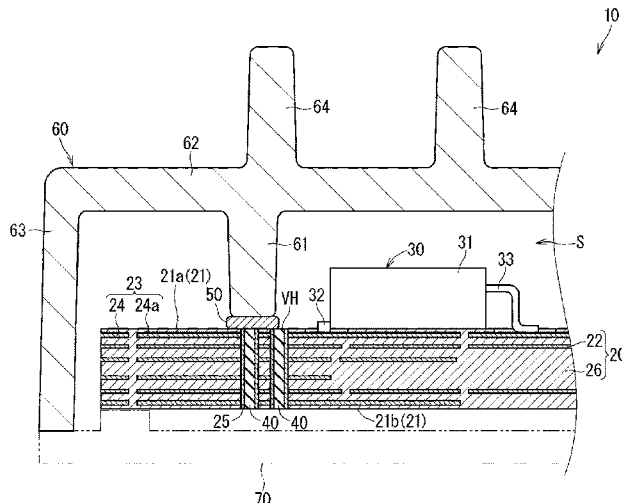
(57) **ABSTRACT**

An object is to provide a technique that can make it easy to achieve favorable heat dissipation performance. An electrical junction box includes: a circuit substrate in which a via hole is formed; a blocking member that blocks the via hole; a heat-transfer member provided in a region of a main surface of the circuit substrate in which the via hole is formed; and a heat dissipation member that comes into contact with the heat-transfer member from the opposite side to the circuit substrate, wherein the blocking member is a solid member, and fills at least the main surface side of the via hole.

10 Claims, 2 Drawing Sheets



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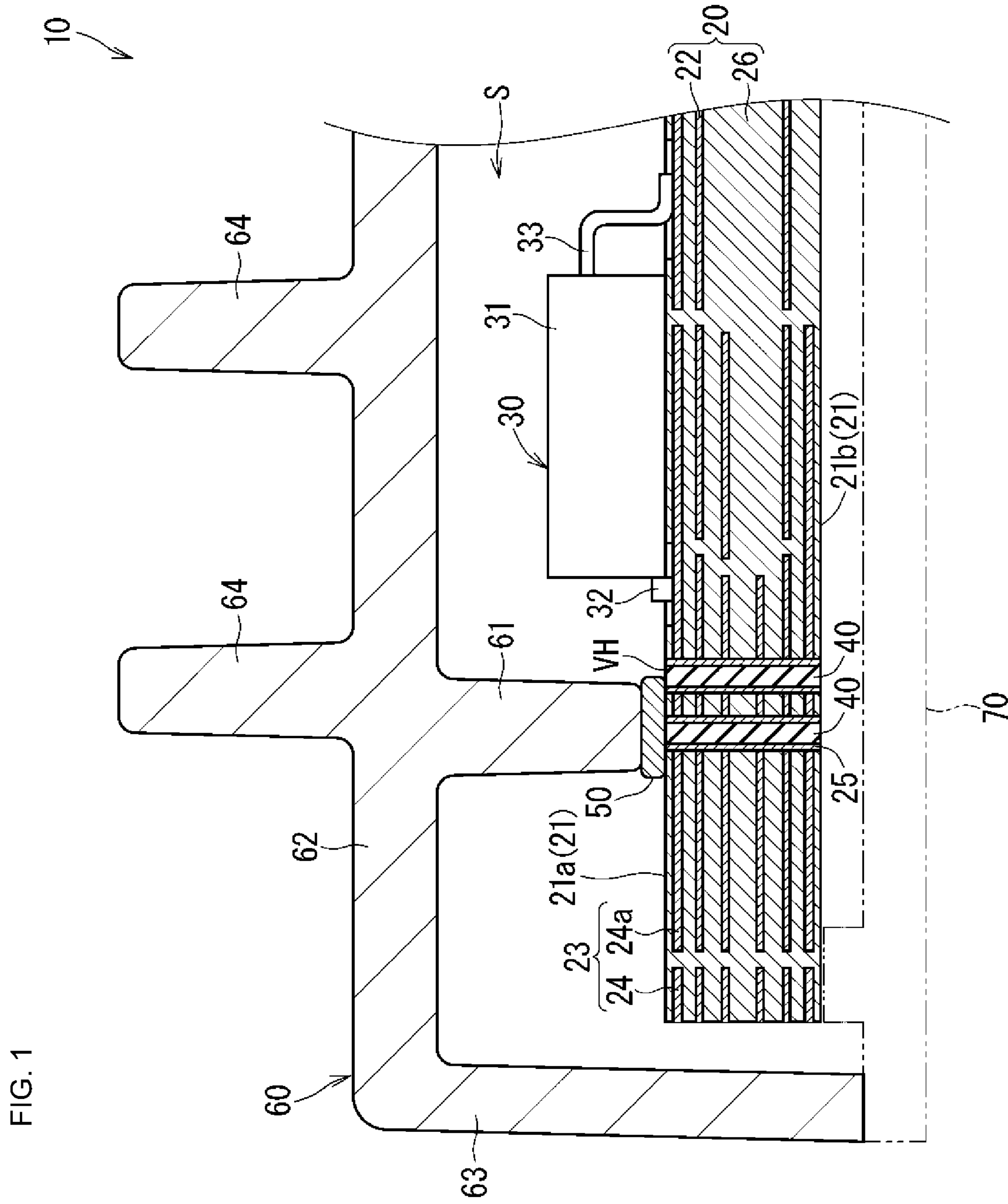
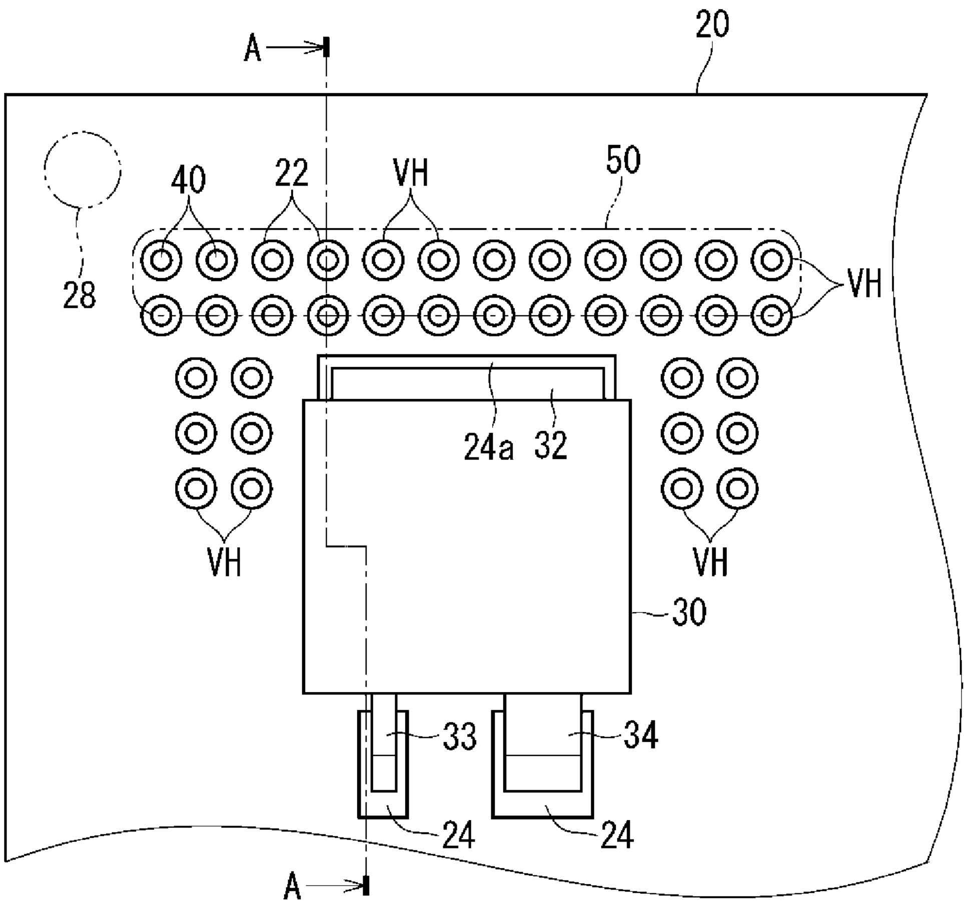


FIG. 1

FIG. 2



ELECTRICAL JUNCTION BOX

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is the U.S. national stage of PCT/JP2020/030570 filed on Aug. 11, 2020, which claims priority of Japanese Patent Application No. JP 2019-156771 filed on Aug. 29, 2019, the contents of which are incorporated herein.

TECHNICAL FIELD

The present disclosure relates to an electrical junction box.

BACKGROUND

Japanese Unexamined Utility Model Application Publication No. 5-20365 discloses a technique for dissipating heat generated by an integrated circuit implemented on a printed substrate. Specifically, heat-conductive grease is applied between a surface pattern and the integrated circuit on the printed substrate. In addition, a conductor hole that is formed in a surface pattern portion is filled with the heat-conductive grease. Accordingly, heat generated by the integrated circuit is transmitted to a back side pattern via the heat-conductive grease, and is dissipated.

In the technique described in Japanese Unexamined Utility Model Application Publication No. 5-20365, there is a risk that the heat-conductive grease will leak from the conductor hole. In this case, there is a risk that, due to variation in how the heat-conductive grease spreads, the heat dissipation performance will vary.

In view of this, an object of the present disclosure is to provide a technique that can make it easy to achieve favorable heat dissipation performance.

SUMMARY

An electrical junction box according to the present disclosure includes: a circuit substrate in which a via hole is formed; a blocking member that blocks the via hole; a heat-transfer member provided in a region of a main surface of the circuit substrate in which the via hole is formed; and a heat dissipation member that comes into contact with the heat-transfer member from the opposite side to the circuit substrate, and the blocking member is a solid member, and fills at least the main surface side of the via hole.

ADVANTAGEOUS EFFECTS OF INVENTION

According to the present disclosure, favorable heat dissipation performance can be easily achieved.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a cross-sectional view showing an electrical junction box according to an embodiment of the present disclosure.

FIG. **2** is a plan view showing the electrical junction box with a heat dissipation member removed therefrom.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

First, embodiments of the present disclosure will be listed and described.

An electrical junction box according to the present disclosure is as follows.

An electrical junction box including: a circuit substrate in which a via hole is formed; a blocking member that blocks the via hole; a heat-transfer member provided in a region of a main surface of the circuit substrate in which the via hole is formed; and a heat dissipation member that comes into contact with the heat-transfer member from the opposite side to the circuit substrate, wherein the blocking member is a solid member, and fills at least the main surface side of the via hole. The blocking member keeps the heat-transfer member from entering the via hole. Accordingly, the heat-transfer member is likely to spread over a predetermined range on the main surface, and favorable heat dissipation performance is easily achieved.

The heat dissipation member may include a protruding wall that protrudes toward the main surface, and the protruding wall may be provided at a position so as to avoid a region of the main surface in which an electrical component is implemented and a leading end surface of the protruding wall may be in contact with the heat-transfer member. By providing the protruding wall on the main surface side on which the electrical component is implemented, the heat of the electrical components is likely to be efficiently transmitted to the heat dissipation member, and an increase in the temperature of the electrical component can be easily suppressed.

The heat dissipation member may further include a covering portion that covers the main surface, the protruding wall may protrude from an inner surface of the covering portion toward the main surface, and a space enclosed by the covering portion and the protruding wall may be formed to allow an electrical component implemented on the main surface to be housed. Accordingly, the heat dissipation member can also function as a container that houses the circuit substrate. In addition, the protruding wall is provided so as to protrude from the covering portion, and thus the via hole, the heat-transfer member, and the protruding wall can be easily disposed at positions close to the electrical component.

A field-effect transistor may be implemented on the circuit substrate, the circuit substrate may have a terminal connection conductor pattern that is connected to a terminal of the field-effect transistor, and the via hole may be provided so as to pass through the terminal connection conductor pattern. Accordingly, the heat dissipation of the conductor pattern that is connected to the field-effect transistor increases, thus making it easier to suppress an increase in the temperature of the field-effect transistor.

A major component of the blocking member may be a resin. Accordingly, parts in the electrical junction box are kept from short-circuiting via the blocking member.

A major component of the blocking member may be metal. Accordingly, the heat conductivity of the blocking member increases, and the heat dissipation can be improved.

Specific examples of an electrical junction box of the present disclosure will be described below with reference to the drawings. Note that the present invention is not limited to illustrations of these, but is indicated by the claims, and all changes that come within the meaning and range of equivalency of the claims are intended to be embraced therein.

Embodiments

An electrical junction box according to an embodiment of the present disclosure will be described below. FIG. **1** is a

cross-sectional view showing an electrical junction box **10** according to the embodiment. FIG. **2** is a plan view showing the electrical junction box **10** with a heat dissipation member **60** removed therefrom. Note that FIG. **1** corresponds to a cross-sectional view taken along line A-A in FIG. **2**.

The electrical junction box **10** is disposed on a power supply path between a power source such as a battery and a load, that is, an in-vehicle electrical component such as a lamp or wipers, in a vehicle, for example. The electrical junction box **10** may be used for a large current semiconductor relay, a DC-DC converter or inverter, or the like. The electrical junction box **10** includes a circuit substrate **20**, a blocking member **40**, a heat-transfer member **50**, and a heat dissipation member **60**. The electrical junction box **10** also includes a cover member **70**.

The circuit substrate **20** includes a conductive portion **22** and an insulative portion **26**. The conductive portion **22** includes conductor layers **23** and an inner surface conductive portion **25**. Here, the circuit substrate **20** is described as a multi-layer substrate that has three or more conductor layers **23**. Note that, in the example shown in FIG. **1**, six conductor layers **23** are provided, but the number of conductor layers **23** in the multi-layer substrate is not limited to this. The number of conductor layers **23** in the multi-layer substrate may be three, four, or five, or may be seven or more. Each of the six conductor layers **23** includes a conductor pattern **24**. The conductor pattern **24** is formed such that conductive foil, conductive paste, or the like extends along a predetermined path on the conductor layer **23**.

Via holes VH are formed in the circuit substrate **20**. Each via hole VH is provided so as to pass through the conductor patterns **24** provided in the plurality of conductor layers **23**. The inner surface conductive portion **25** is provided on the inner surface of the via hole VH. The inner surface conductive portion **25** electrically connects the conductor patterns **24** provided on the plurality of conductor layers **23**. Accordingly, the inner surface conductive portion **25** is an interlayer connection portion. The inner surface conductive portion **25** is a plating material, conductive paste, solder, or the like. The same material as the material that forms the inner surface conductive portion **25** is provided on the opening peripheral edge of the via hole VH in a main surface **21**, and a land may be formed.

In the example shown in FIG. **1**, the via hole VH passes through the two main surfaces **21** of the circuit substrate **20**. Such a via hole VH is also called a "through hole via", etc. A configuration may also be adopted in which the via hole reaches an intermediate portion in the thickness direction of the circuit substrate **20** from one surface thereof, namely a main surface **21***a,* and does not pass through the circuit substrate **20** to reach the other surface thereof, namely a main surface **21***b.* Such a via hole is called a "blind via hole", etc.

The insulative portion **26** includes an insulation layer and cover layers. The insulation layer is a portion positioned between conductor layers **23**. The insulation layer is an insulative substrate main body such as a glass epoxy substrate. The cover layers are present on the main surfaces **21** of the circuit substrate **20**. The cover layers are resists such as solder masks.

An electrical component **30** that is a heat-generating component is implemented on the circuit substrate **20**. A description will be given below assuming that the electrical component **30** is implemented on the main surface **21***a.* In addition, the electrical component **30** is described below as a field-effect transistor (FET) **30**. The FET **30** includes a main body **31** and terminals **32**, **33**, and **34**. The terminals **32**, **33**, and **34** of the FET **30** are electrically connected to conductor patterns **24** on an outer layer. The conductor patterns **24** and the terminals **32**, **33**, and **34** may be may be connected to each other through soldering or the like. The three terminals **32**, **33**, and **34** of the FET **30** are electrically connected to different conductor patterns **24** on the outer layer. The three terminals **32**, **33**, and **34** of the FET **30** are a drain terminal **32**, a gate terminal **33**, and the source terminal **34**, respectively. The via hole VH is provided so as to pass through a terminal-connection conductor pattern **24***a* that is connected to the drain terminal **32**, from among the conductor patterns **24**.

The blocking member **40** is a solid member. The blocking member **40** blocks the via hole VH. The blocking member **40** fills the via hole VH along the axial direction of the via hole VH over the entire length thereof. The blocking member **40** may fill only a portion of the via hole VH along the axial direction of the via hole VH. The blocking member **40** may fill at least a main surface **21** side of the via hole VH.

Here, a description will be given assuming that a major component of the blocking member **40** is a resin. The blocking member **40** may or may not be directly joined to the inner surface of the via hole VH (here, the inner surface conductive portion **25**). If, for example, the material of the blocking member **40** can easily attach to the material of the inner surface of the via hole VH (here, the material of the inner surface conductive portion **25**), the blocking member **40** can easily be directly joined to the inner surface of the via hole VH. In addition, for example, when the blocking member **40** that has fluidity fills the via hole VH and is then solidified and formed, the blocking member **40** is likely to be directly joined to the inner surface of the via hole VH.

If there are a plurality of via holes VH, the blocking member **40** may be provided in all of the via holes VH, or the blocking member **40** may be provided only in some of the via holes VH. When there is a via hole VH that is in contact with the heat-transfer member **50** and a via hole VH that is not in contact with the heat-transfer member **50**, for example, the blocking member **40** may be provided only in the via hole VH that is in contact with the heat-transfer member **50** or the blocking member **40** may be provided in both the via hole VH that is in contact with the heat-transfer member **50** and the via hole VH that is not in contact with the heat-transfer member **50**. If the blocking member **40** is provided in all via holes VH, a process of providing blocking members **40** is kept from being complicated. Specifically, there is no need to select a via hole VH in which the blocking member **40** is to be provided, and it is unlikely that providing of the blocking member **40** will be forgotten. If the blocking member **40** is provided only in a portion of the via holes VH, it is possible to decrease the weight of the electrical junction box **10**. If the blocking member **40** is provided in only a portion of the via holes VH, a via hole VH filled with the blocking member **40** may be referred to as a first via hole, and a via hole VH that is not filled with the blocking member **40** may be referred to as a second via hole.

The outer surface of the blocking member **40** is in contact with the heat-transfer member **50**. Note that the outer surface of the blocking member **40** may be flush with the main surfaces **21** of the circuit substrate **20**. The outer surface of the blocking member **40** may protrude outward from a main surface **21** of the circuit substrate **20**. The outer surface of the blocking member **40** may be recessed from a main surface **21** of the circuit substrate **20** to the inside of the via hole VH. As described above, it is conceivable that the blocking member **40** is obtained by filling the via hole VH

with a material that has fluidity and solidifying the material. In this case, even if the via hole VH is filled with the material that has fluidity to be flush with the main surfaces **21** of the circuit substrate **20**, the outer surface of the blocking member **40** may not be flush with the main surfaces **21** of the circuit substrate **20** or may not be flat, depending on the behavior of the material with fluidity during solidification.

The heat-transfer member **50** is provided in a region of a main surface **21** of the circuit substrate **20** in which the via hole VH is formed. Here, the heat-transfer member **50** is provided on the main surface **21***a* on which the electrical component **30** is implemented. The heat-transfer member may also be provided on the main surface **21***b*. The heat-transfer member **50** allows heat generated by the circuit substrate **20** to be easily transmitted to the heat dissipation member **60**. The heat-transfer member **50** is called a "thermal Interface material (TIM)", etc. The heat-transfer member **50** is closely attached to the circuit substrate **20** and the heat dissipation member **60**, and fills the gap between the circuit substrate **20** and the heat dissipation member **60**. Accordingly, it is possible to reduce air included between the circuit substrate **20** and the heat dissipation member **60**, and the thermal resistance of this portion is reduced.

The heat-transfer member **50** can be closely attached to the circuit substrate **20** and the heat dissipation member **60**, for example, by the heat-transfer member **50**, which has fluidity, as a result of being pressed against the circuit substrate **20** and the heat dissipation member **60**. Preferably, the heat-transfer member **50** is a member that can be viscous at a lower temperature than the melting points of parts of the circuit substrate **20**. The heat-transfer member **50** may also be a member that is viscous in a normal state, such as heat-transfer grease, in other words a semisolid member (viscous member), for example. Also, the heat-transfer member **50** may be a member that can be viscous before being solidified, such as an adhesive, for example.

The heat dissipation member **60** comes into contact with the heat-transfer member **50** from the opposite side to the circuit substrate **20**. The heat dissipation member **60** is a member that receives heat generated by the circuit substrate **20**, and dissipates the heat. The heat dissipation member **60** may be a member that functions as a heatsink. The heat dissipation member **60** is formed of a material that has high heat conductivity, for example, metal such as an aluminum alloy. The heat dissipation member **60** also serves as at least a portion of a case that houses the circuit substrate **20**. The heat dissipation member **60** includes a protruding wall **61** and a covering portion **62**. The heat dissipation member **60** also includes a peripheral wall **63** and fins **64**. The heat dissipation member **60** is formed in a box shape that can house the circuit substrate **20**.

The protruding wall **61** protrudes toward the main surface **21***a* of the circuit substrate **20**. The protruding wall **61** is provided at a position so as to avoid a region of the main surface **21***a* in which the electrical component **30** is implemented. The leading end surface of the protruding wall **61** is in contact with the heat-transfer member **50**.

The covering portion **62** covers the main surface **21***a* of the circuit substrate **20**. The covering portion **62** is formed in a flat plate shape. The protruding wall **61** is provided so as to protrude from the inner surface of the covering portion **62** toward the main surface **21***a*. A space S enclosed by the protruding wall **61** and the covering portion **62** is formed to allow the electrical component **30** implemented on the main surface **21***a* to be housed.

The peripheral wall **63** is provided so as to protrude on the side on which the protruding wall **61** protrudes toward the covering portion **62**. The peripheral wall **63** encloses the circuit substrate **20**. The peripheral wall **63** is provided outside the outer edge of the circuit substrate **20**. The protruding wall **61** is provided on the inner side relative to the peripheral wall **63**. The peripheral wall **63** and the protruding wall **61** are provided spaced apart from each other.

The fins **64** are provided on the opposite side to the protruding wall **61** protruding from the covering portion **62**, in other words, on the outer surface side of the covering portion **62**. The fins **64** increase the surface area of the outer surface of the heat dissipation member **60**. A plurality of fins **64** may be provided. A portion of the plurality of fins **64** may be provided on the back side of a portion of the covering portion **62** in which the protruding wall **61** protrudes.

The cover member **70** covers the circuit substrate **20** from the opposite side to the heat dissipation member **60**. The circuit substrate **20** is housed on the inner sides of the cover member **70** and the heat dissipation member **60**. The cover member **70** is attached to the heat dissipation member **60**. The heat dissipation member **60** and the cover member **70** may be fixed to each other by a screw or the like. Here, the cover member **70** is formed in a plate shape. The material of the cover member **70** is not particularly limited, and may be a resin or metal, for example. Note that the peripheral wall **63** may be provided on the cover member **70** instead of being provided on the heat dissipation member **60**. Accordingly, the cover member **70** may be formed in a box shape. A screw hole **28** may be formed in the circuit substrate **20**. The circuit substrate **20** may be fixed to the heat dissipation member **60** or the cover member **70** by a screw or the like.

Exemplary Operation

A behavior example of the heat-transfer member **50** at the time of manufacturing the electrical junction box **10** will be described. A gap between the main surface **21***a* and the leading end surface of the protruding wall **61** when the heat dissipation member **60** is attached is defined as the length D**1**. The thickness of the heat-transfer member **50** before the heat dissipation member **60** is attached is defined as the length D**2**. The length D**2** is set larger than the length D**1**. Therefore, when the heat dissipation member **60** is attached to the circuit substrate **20** and is positioned at a predetermined position, the heat-transfer member **50** is pressed by the leading end surface of the protruding wall **61** and the main surface **21***a*. At this time, the via hole VH is blocked by the blocking member **40**, and thus the heat-transfer member **50** is kept from entering the via hole VH. Accordingly, the heat-transfer member **50** is likely to spread over a predetermined range of the main surface **21***a*. As a matter of course, the heat-transfer member **50** does not need to spread as a result of being pressed by the leading end surface of the protruding wall **61** and the main surface **21***a*.

Note that the lengths D1 and D**2** are not particularly limited, and can be set as appropriate. The length D1 may be set to any value of 0.5 to 1 millimeter, for example. The length D**2** may be set larger than the length D1 by any value of 0.1 to 1 millimeter, for example.

Effects, etc.

With the electrical junction box **10** configured as described above, the blocking member **40** keeps the heat-transfer member **50** from entering the via hole VH. Accordingly, the heat-transfer member **50** is likely to spread over a

predetermined range of the main surface **21***a*, and favorable heat dissipation performance is easily achieved.

In addition, by providing the protruding wall **61** on the main surface **21***a* side on which the electrical component **30** is implemented, the terminal-connection conductor pattern **24***a* can come in contact with the protruding wall **61** via the heat-transfer member **50**. Accordingly, the heat of the electrical component **30** is likely to be efficiently transmitted to the heat dissipation member **60**, and an increase in the temperature of the electrical component **30** can be easily suppressed.

In addition, the heat dissipation member **60** includes the covering portion **62**, and thus can also function as a container that houses the circuit substrate **20**. In addition, the protruding wall **61** is provided so as to protrude from the covering portion **62**, and thus the via hole VH, the heat-transfer member **50**, and the protruding wall **61** can be easily disposed at positions close to the electrical component **30**.

In addition, the via hole VH is provided so as to pass through the terminal-connection conductor pattern **24***a*, and thus the heat dissipation of the conductor pattern **24** that is connected to the field-effect transistor **30** increases, and an increase in the temperature of the field-effect transistor **30** can be easily suppressed.

In addition, a major component of the blocking member **40** is a resin, and thus parts in the electrical junction box **10** are kept from short-circuiting via the blocking member **40**.

MODIFIED EXAMPLES

In the embodiment, a description has been given assuming that the circuit substrate **20** is a multi-layer substrate, but this is not an essential configuration. The circuit substrate may be a single-sided substrate that has one conductor layer **23**, or may also be a double-sided substrate that has two conductor layers **23**.

Also, in the embodiment, a description has been given assuming that the electrical component **30** is the FET **30**, but this is not an essential configuration. The electrical component may be a heat-generating component other than the FET **30**. Such a heat-generating component may be a resistor such as a shunt resistor, a coil, a capacitor, or the like. In the example shown in FIG. **1**, one electrical component **30** is provided, but a plurality of electrical components **30** may be provided.

Also, in the embodiment, a description has been given assuming that, in the circuit substrate **20**, the main surface **21***a* that is in contact with the heat dissipation member **60** via the heat-transfer member **50** is the same main surface **21***a* on which the electrical component **30** is implemented, but this is not an essential configuration. In a circuit substrate, the main surface that comes into contact with the heat dissipation member via the heat-transfer member may also be a main surface on the opposite side to the main surface on which an electrical component is implemented. In this case, the covering portion in the heat dissipation member may be in contact with the main surface of the circuit substrate via the heat-transfer member. Also, the two main surfaces of the circuit substrate may be in contact with the heat dissipation member via the heat-transfer member. Similarly, electrical components may be implemented respectively on the two main surfaces of the circuit substrate.

Also, in the embodiment, a description has been given assuming that a major component of the blocking member **40** is a resin, but this is not an essential configuration. A major component of the blocking member may be a material other than a resin such as metal, for example. The blocking member may be formed through reflow soldering, for example. If a major component of the blocking member is metal, the heat conductivity of the blocking member increases, and the heat dissipation is increased. In addition, for example, if a major component of the blocking member **40** is a resin, a metal layer may be laid on the outer surface of the blocking member **40**. In this case, the heat-transfer member **50** is favorably provided on the metal layer.

Also, in the embodiment, a description has been given assuming that the heat-transfer member **50** is heat-transfer grease, but this is not an essential configuration. The heat-transfer member may be a member made of a material other than heat-transfer grease such as a heat-transfer sheet, for example.

Note that the configurations described in the above embodiment and the modified examples can be combined as appropriate provided that no contradiction arises.

The invention claimed is:

1. An electrical junction box comprising:

a circuit substrate in which a via hole is formed;

a blocking member that blocks the via hole;

a heat-transfer member provided in a region of a main surface of the circuit substrate in which the via hole is formed; and

a heat dissipation member that comes into contact with the heat-transfer member from the opposite side to the circuit substrate,

wherein the circuit substrate has a terminal connection conductor pattern that is connected to a terminal of an electrical component that is implemented on the main surface,

the terminal connection conductor pattern has a portion that spreads lateral to the electrical component,

the via hole is provided so as to pass through the portion of the terminal connection conductor pattern that spreads lateral to the electrical component,

the blocking member is a solid member, and fills at least the main surface side of the via hole,

the heat-transfer member is a viscous body or a viscous adhesive that has been solidified,

the heat dissipation member includes a protruding wall that protrudes toward the main surface, and

the protruding wall is provided so as to protrude from the main surface toward the portion of the terminal connection conductor pattern that spreads lateral to the electrical component and a leading end surface of the protruding wall is in contact with the heat-transfer member.

2. The electrical junction box according to claim **1**,

wherein the heat dissipation member further includes a covering portion that covers the main surface,

the protruding wall protrudes from an inner surface of the covering portion toward the main surface, and

a space enclosed by the covering portion and the protruding wall is formed to allow an electrical component implemented on the main surface to be housed.

3. The electrical junction box according to claim **2**, wherein a field-effect transistor is implemented on the circuit substrate, and

a terminal of the field-effect transistor is connected to the terminal connection conductor pattern of the circuit substrate.

4. The electrical junction box according to claim **2**, wherein a major component of the blocking member is a resin.

5. The electrical junction box according to claim **2**, wherein a major component of the blocking member is metal.

6. The electrical junction box according to claim **1**, wherein a field-effect transistor is implemented on the circuit substrate, and

a terminal of the field-effect transistor is connected to the terminal connection conductor pattern of the circuit substrate.

7. The electrical junction box according to claim **6**, wherein a major component of the blocking member is a resin.

8. The electrical junction box according to claim **6**, wherein a major component of the blocking member is metal.

9. The electrical junction box according to claim **2**, wherein a major component of the blocking member is a resin.

10. The electrical junction box according to claim **1**, wherein a major component of the blocking member is metal.

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