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Ada

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(54) **ELECTRICAL APPARATUS AND METHOD FOR PRODUCING ELECTRICAL APPARATUS**

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Dec. 28, 2010 (JP) 2010-293484

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H05K 1/02 (2006.01)
H05K 3/00 (2006.01)
(Continued)

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CPC ***H05K 1/0203*** (2013.01); ***H05K 3/00*** (2013.01); ***H05K 7/209*** (2013.01); ***H05K 7/20509*** (2013.01); *Y10T 29/49128* (2015.01)

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USPC 361/679.46, 679.54, 689–697, 361/700–712, 715, 719–724; 165/80.2, 165/80.3, 104.33, 185; 257/707, 713, 718, 257/719, 720; 174/15.1, 16.3, 252, 254, 174/260; 29/890.03
See application file for complete search history.

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Primary Examiner — Michail V Datskovskiy
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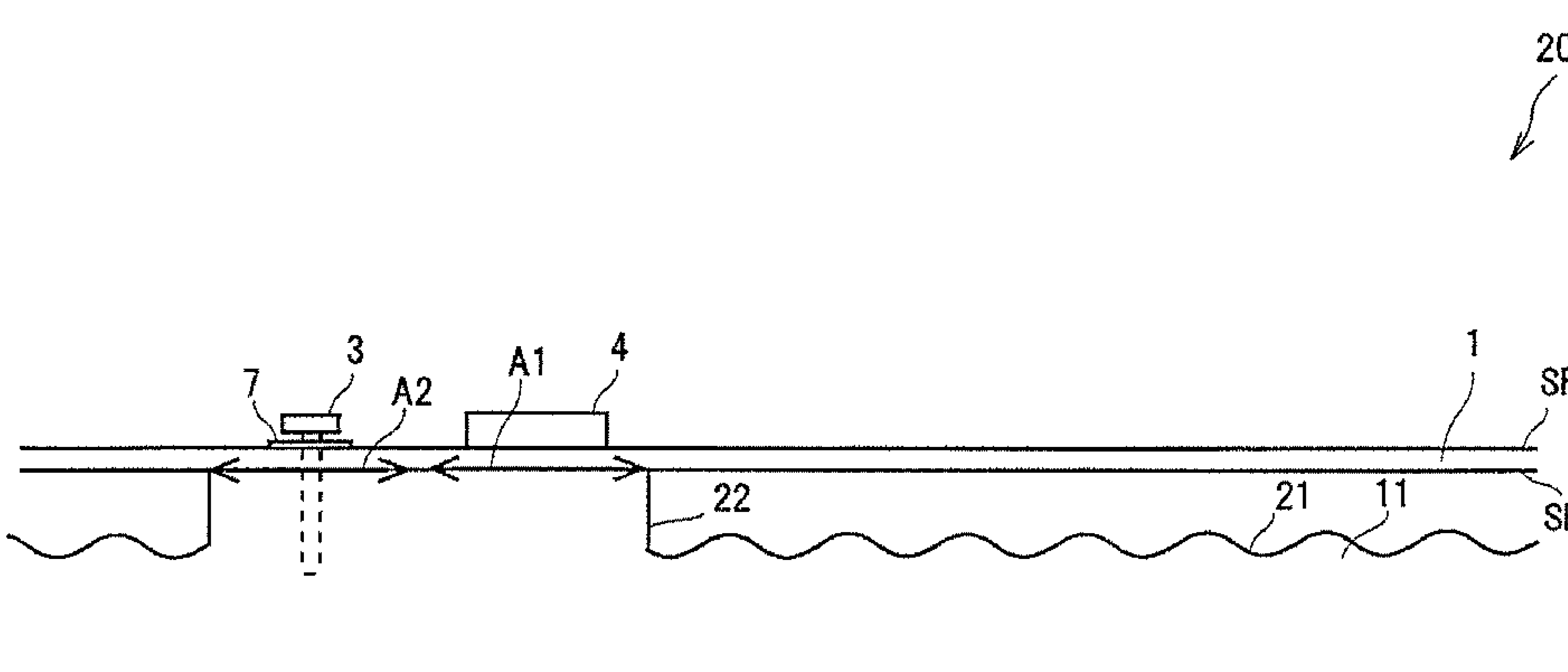
(57) **ABSTRACT**

Regarding an electrical apparatus, in an opposing part facing a board, the opposing part being on a surface of in a heat dissipator, a contact part which is brought into contact with a first region of a second main surface corresponding to an electrical component and a surrounding region of the electrical component and which is brought into contact with a second region of the second main surface corresponding to a fixing member and a surrounding region of the fixing member protrudes relative to a portion of the opposing part other than the contact part. The degree of flatness of a contact surface, in the contact part, that is brought into contact with the first region and the second region is higher than the degree of flatness of a surface of the opposing part other than the contact surface.

11 Claims, 17 Drawing Sheets



(51) **Int. Cl.**
H05K 7/20 (2006.01)
G06F 1/20 (2006.01)

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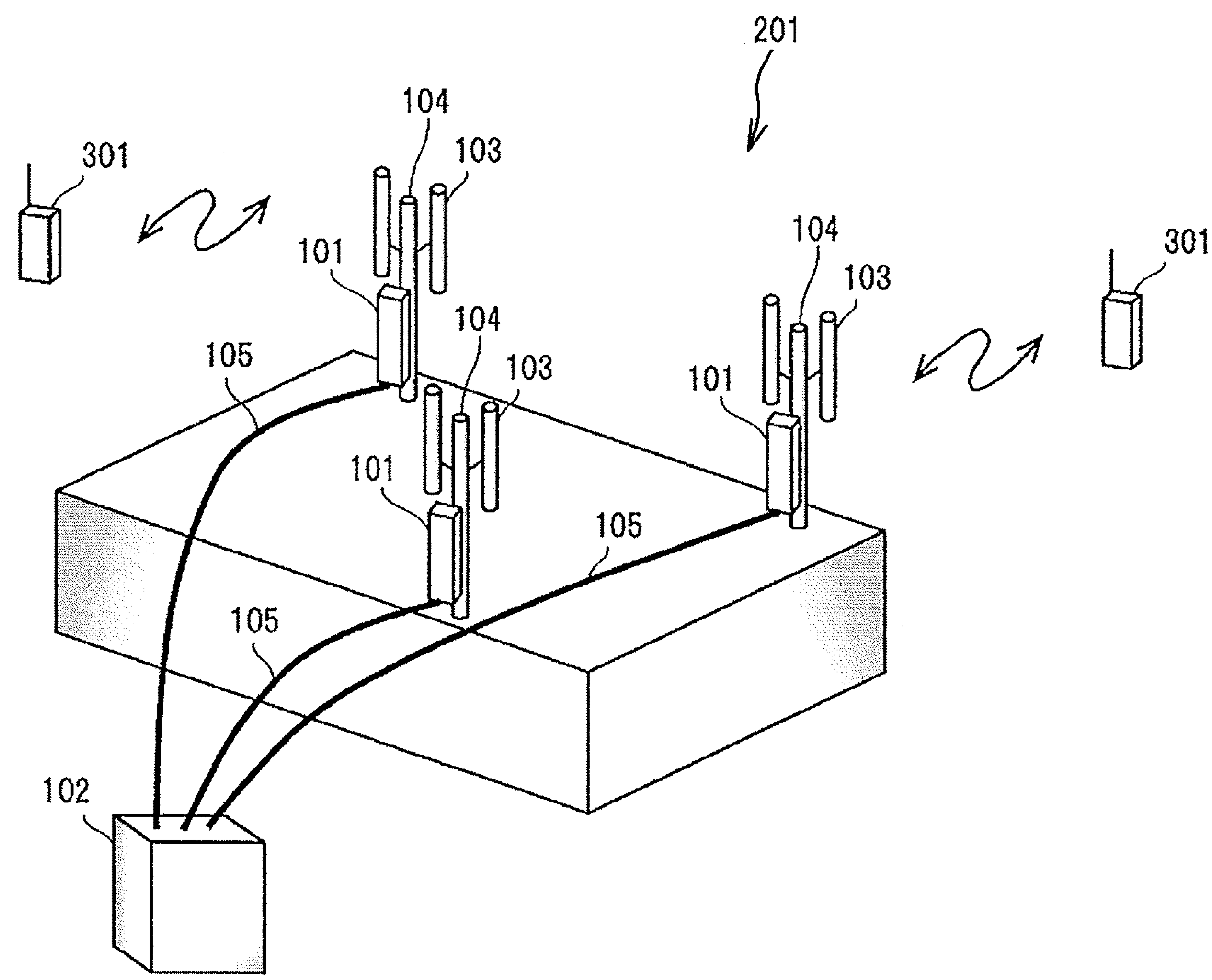
FIG. 1



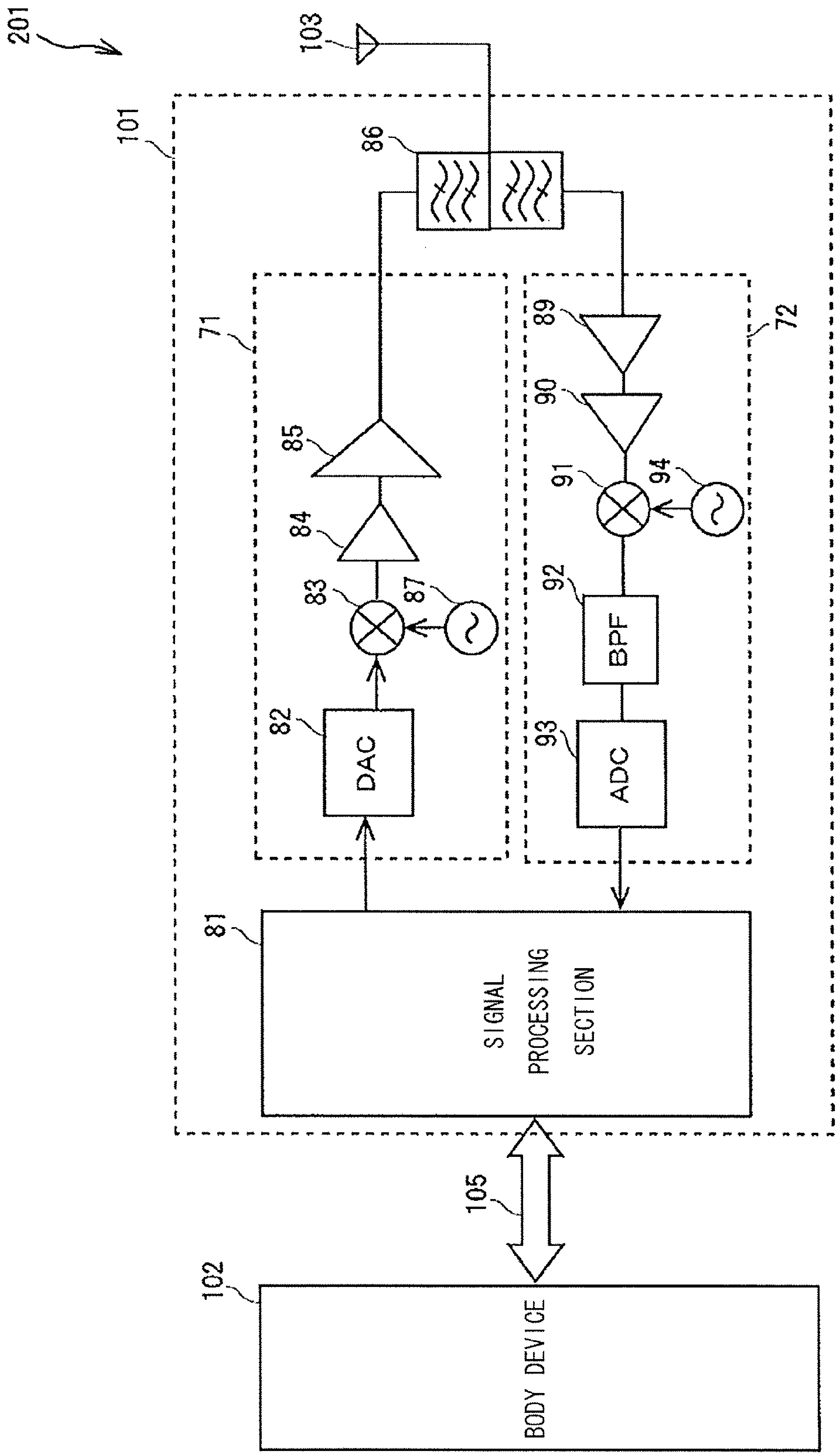

201
103
101
86
71
72
89
90
85
84
91
94
83
87
92
BPF
82
DAC
93
ADC
81
SIGNAL
PROCESSING
SECTION
105
102
BODY DEVICE

FIG. 2

FIG. 3

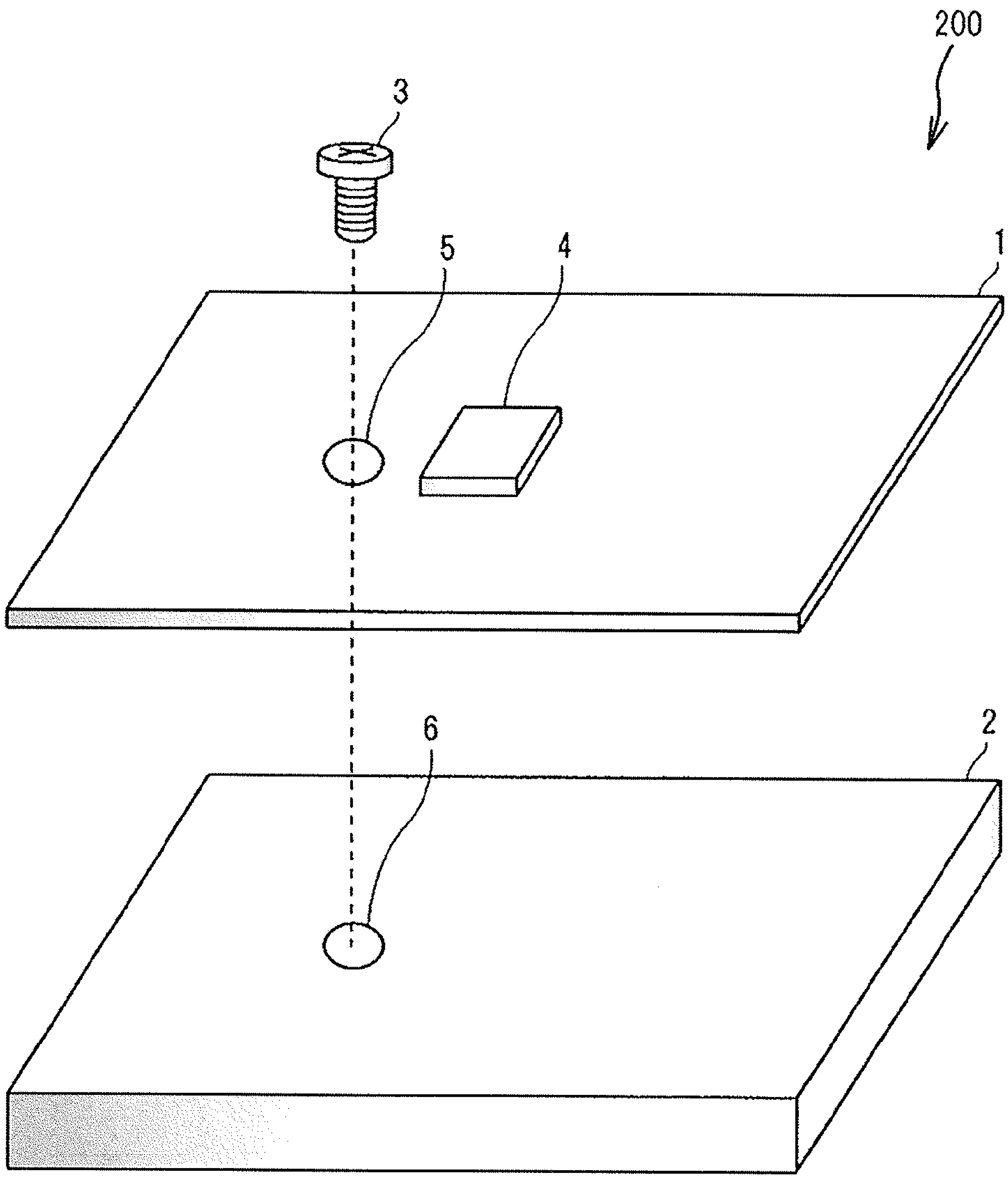


FIG. 4

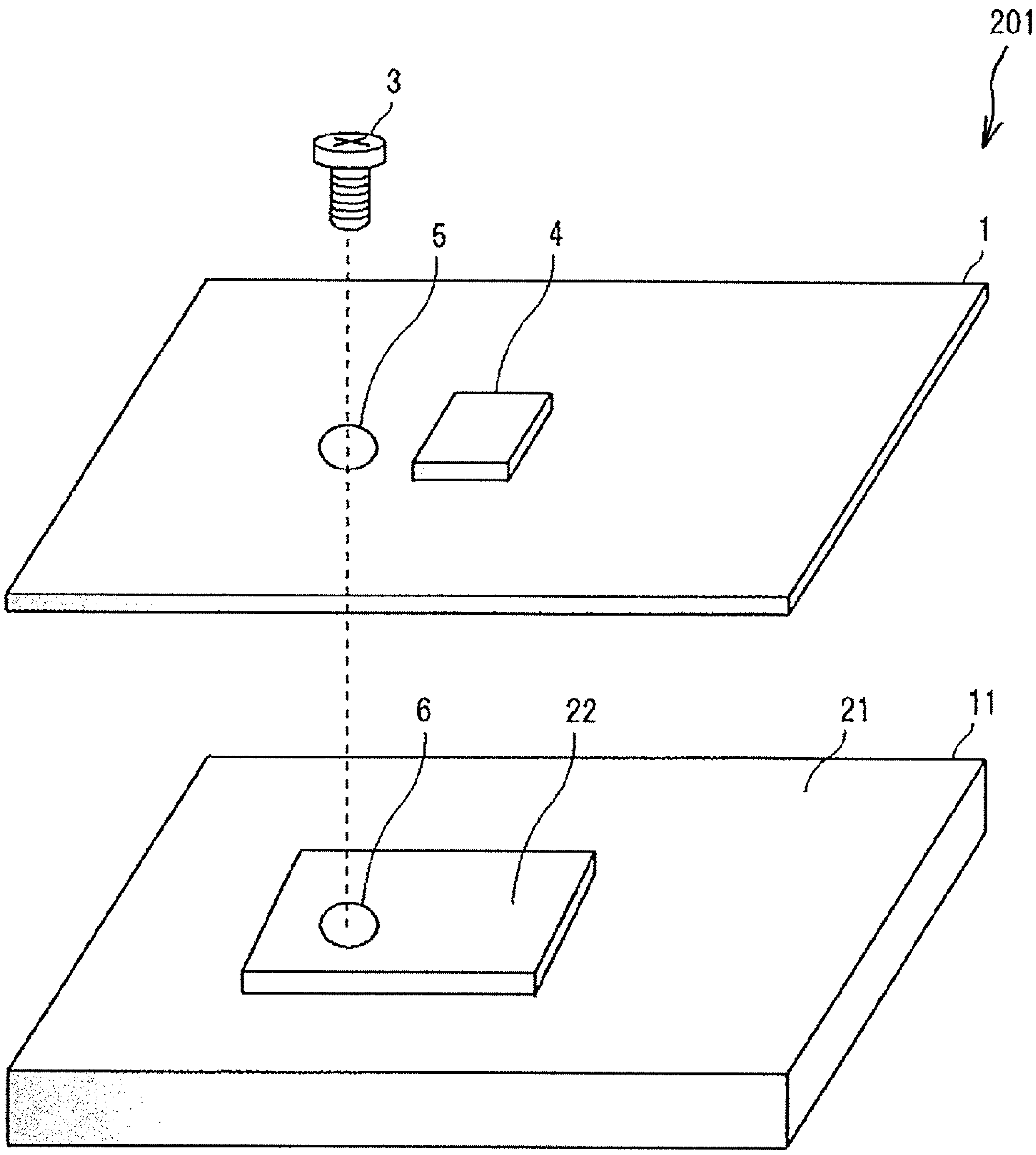


FIG. 5

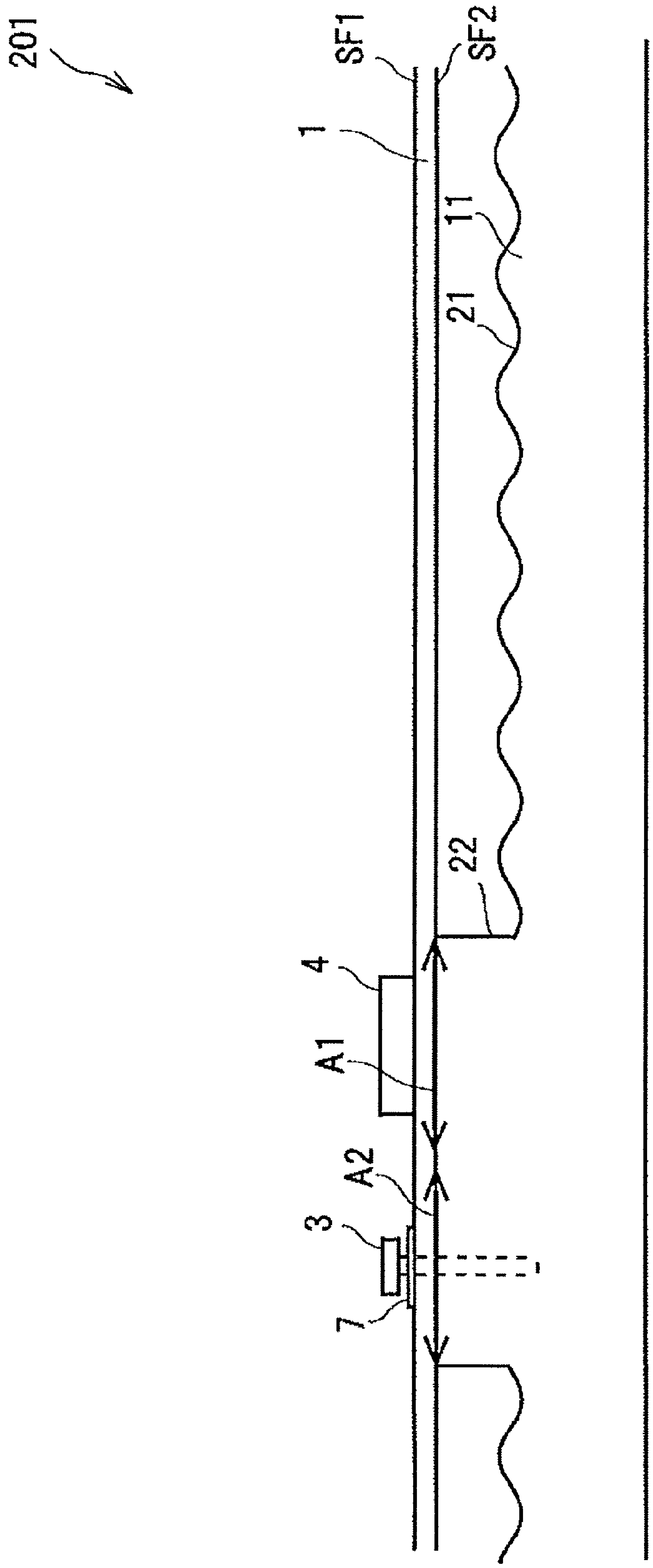
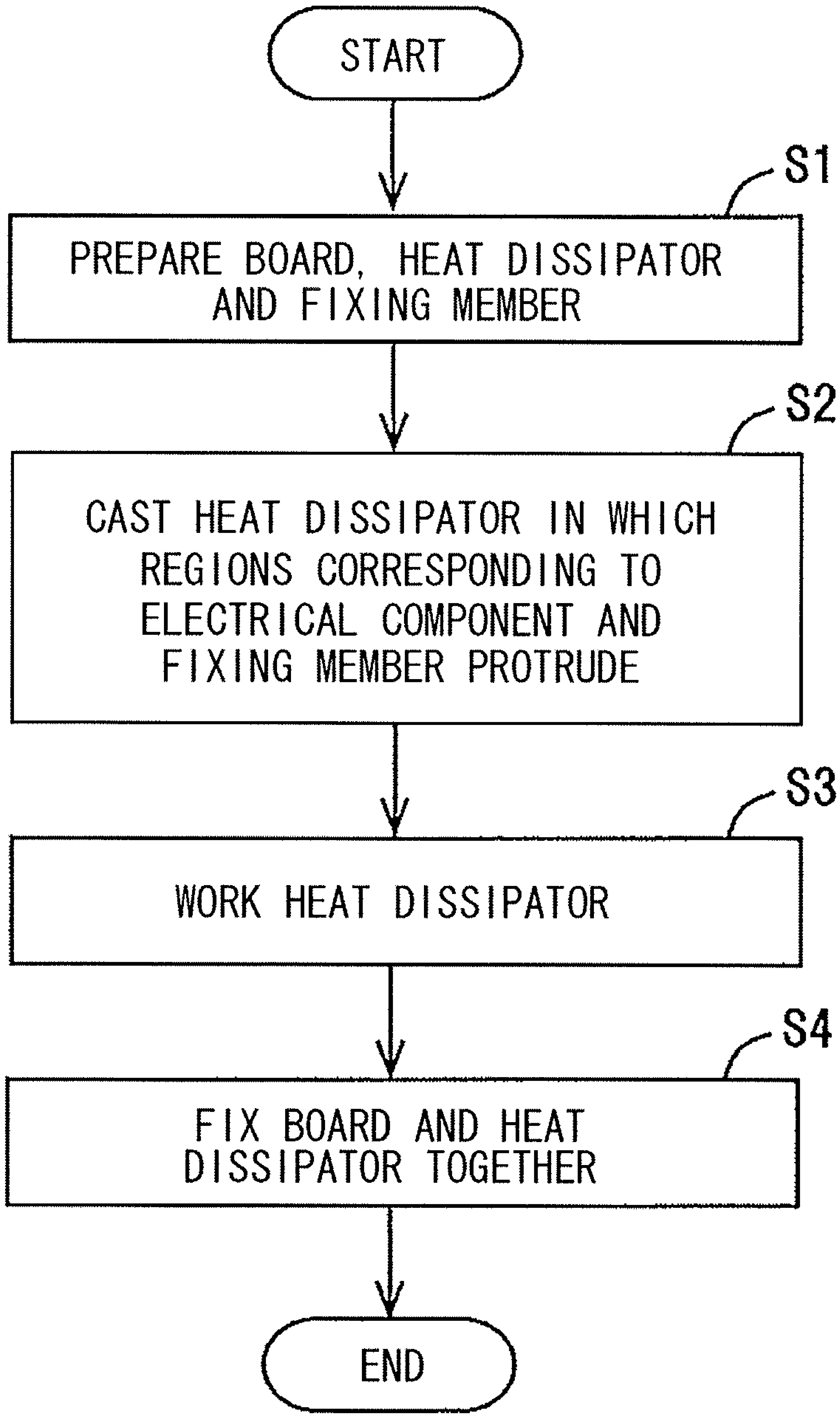


FIG. 6


START
S1
PREPARE BOARD, HEAT DISSIPATOR AND FIXING MEMBER
S2
CAST HEAT DISSIPATOR IN WHICH REGIONS CORRESPONDING TO ELECTRICAL COMPONENT AND FIXING MEMBER PROTRUDE
S3
WORK HEAT DISSIPATOR
S4
FIX BOARD AND HEAT DISSIPATOR TOGETHER
END

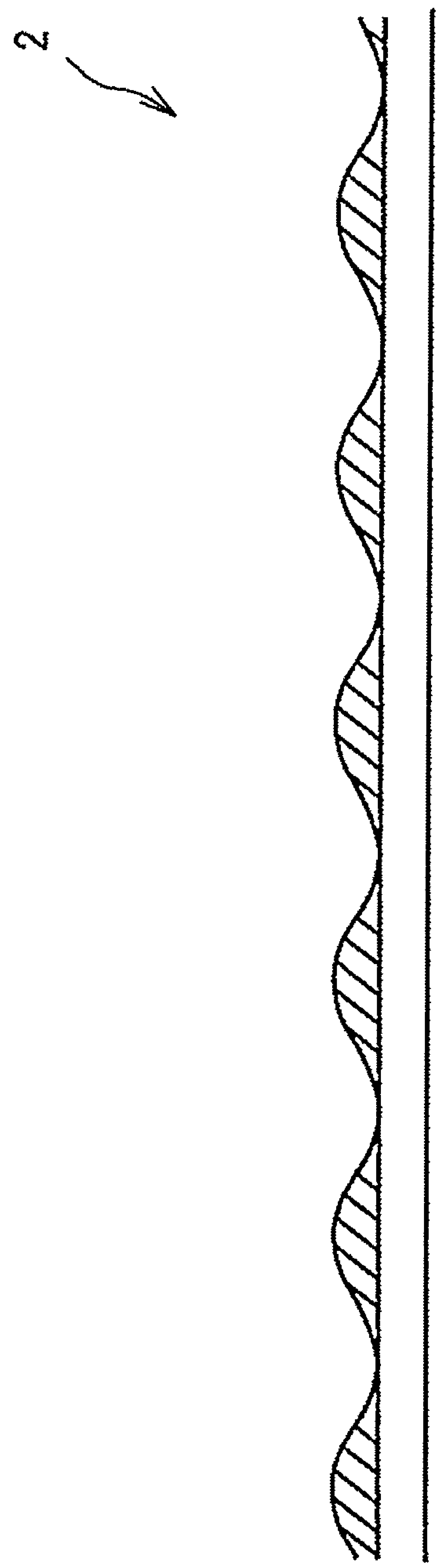


FIG. 7

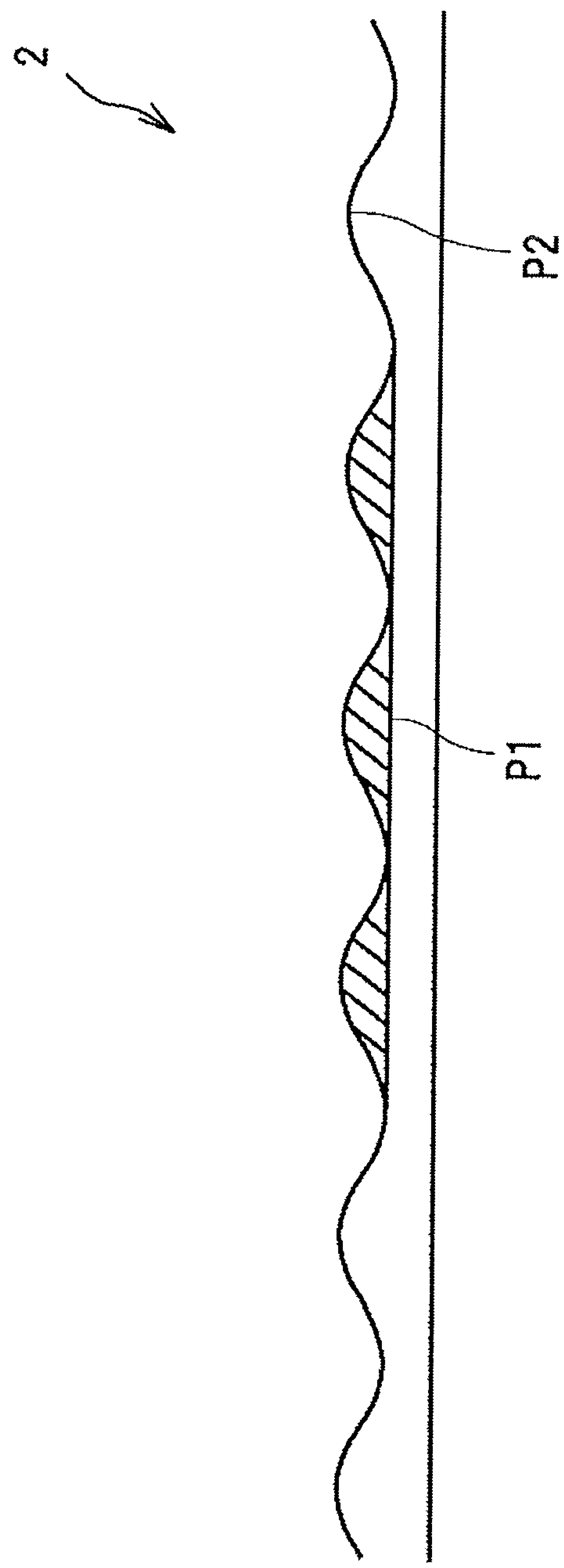


FIG. 8

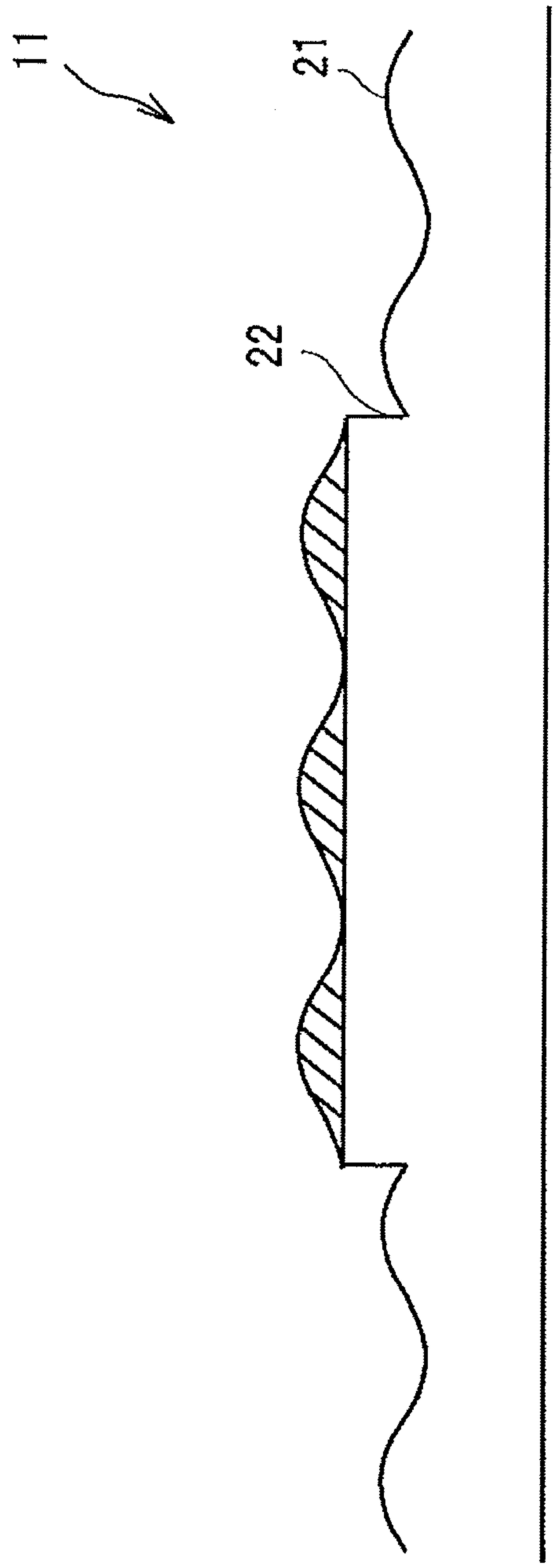


FIG. 9

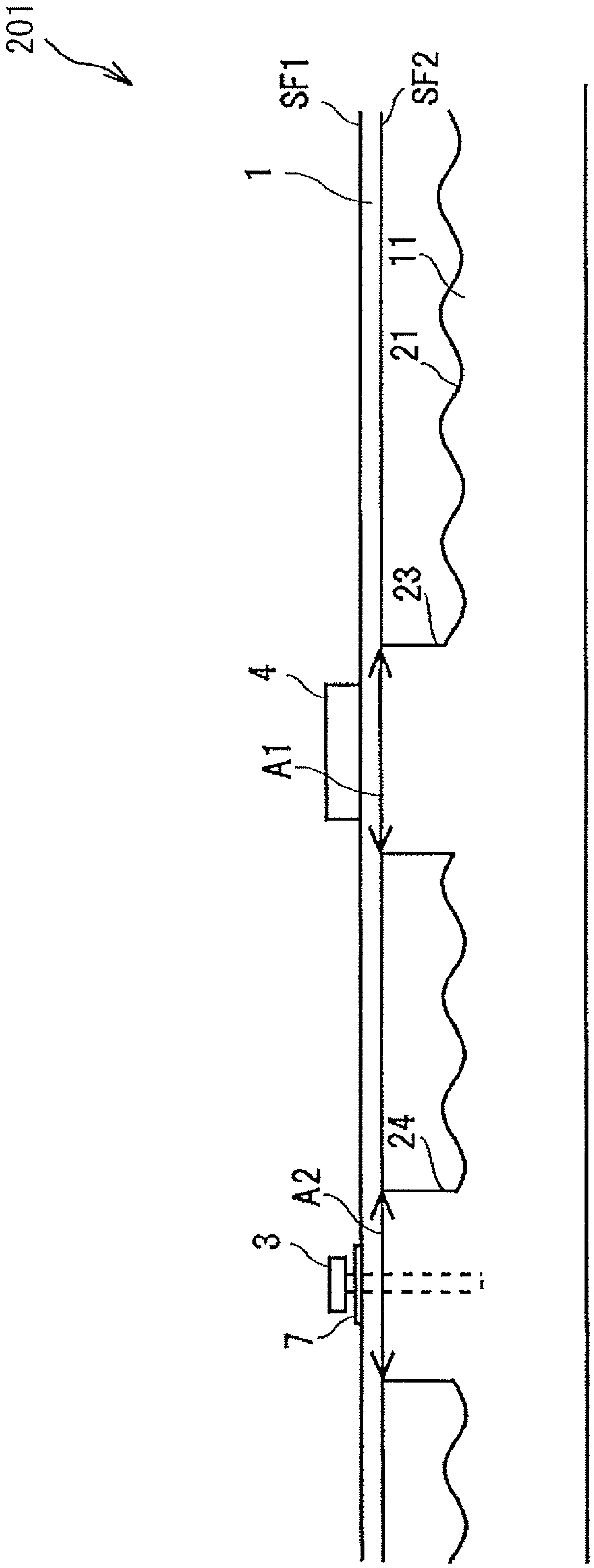


FIG. 10

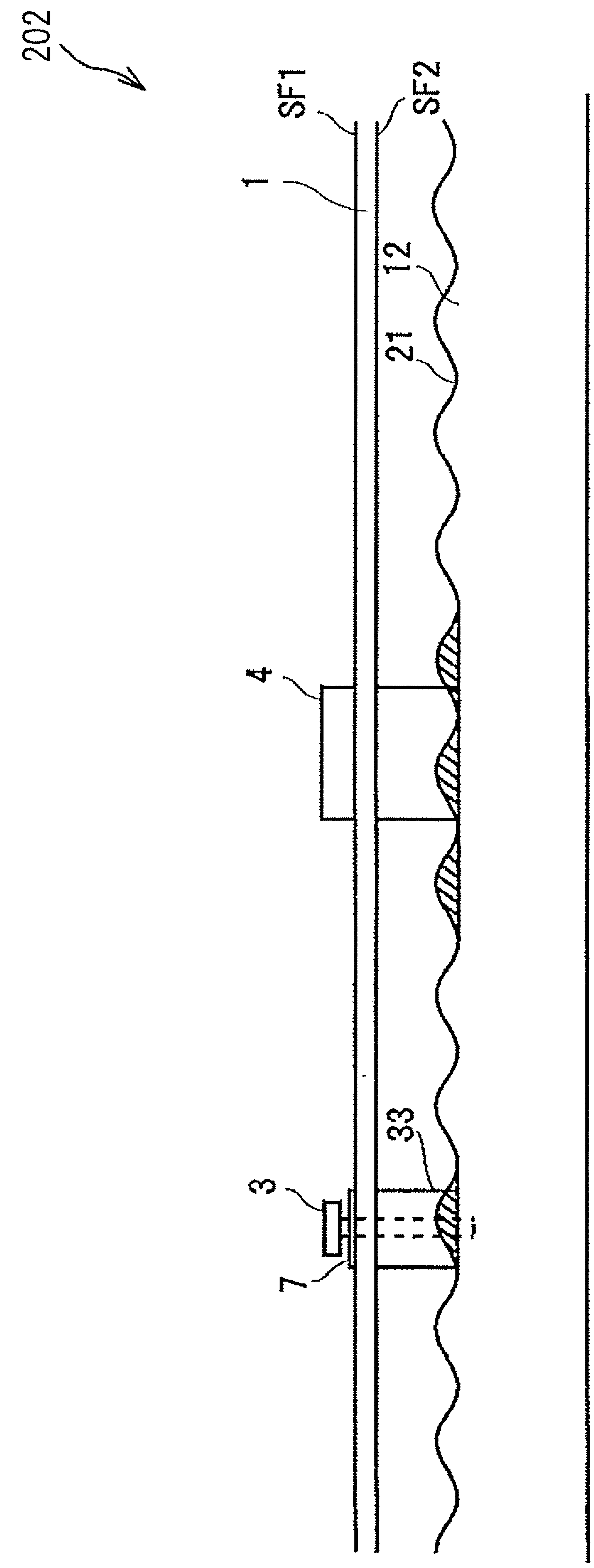
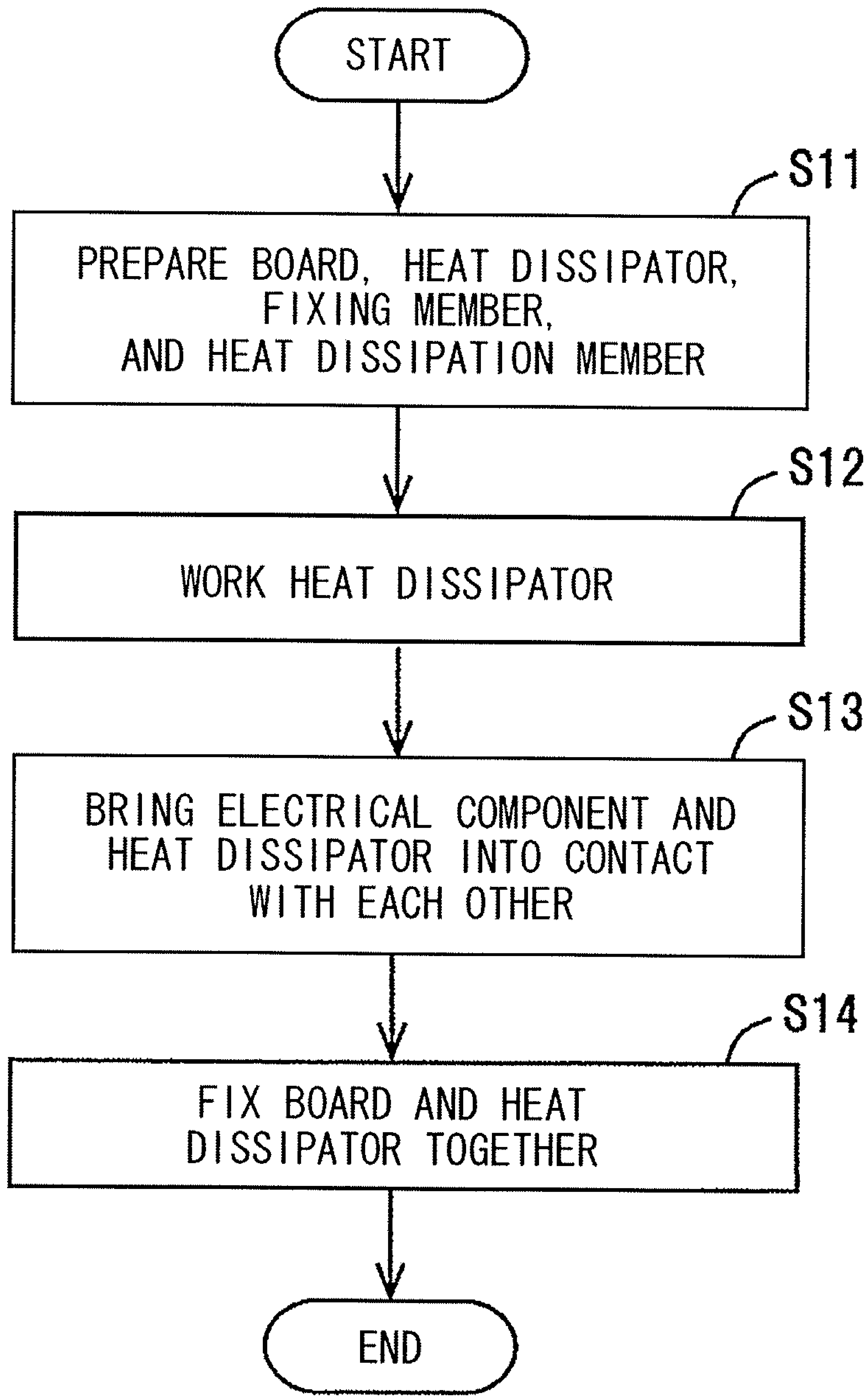


FIG. 11

FIG. 12


START
S11
PREPARE BOARD, HEAT DISSIPATOR, FIXING MEMBER, AND HEAT DISSIPATION MEMBER
S12
WORK HEAT DISSIPATOR
S13
BRING ELECTRICAL COMPONENT AND HEAT DISSIPATOR INTO CONTACT WITH EACH OTHER
S14
FIX BOARD AND HEAT DISSIPATOR TOGETHER
END

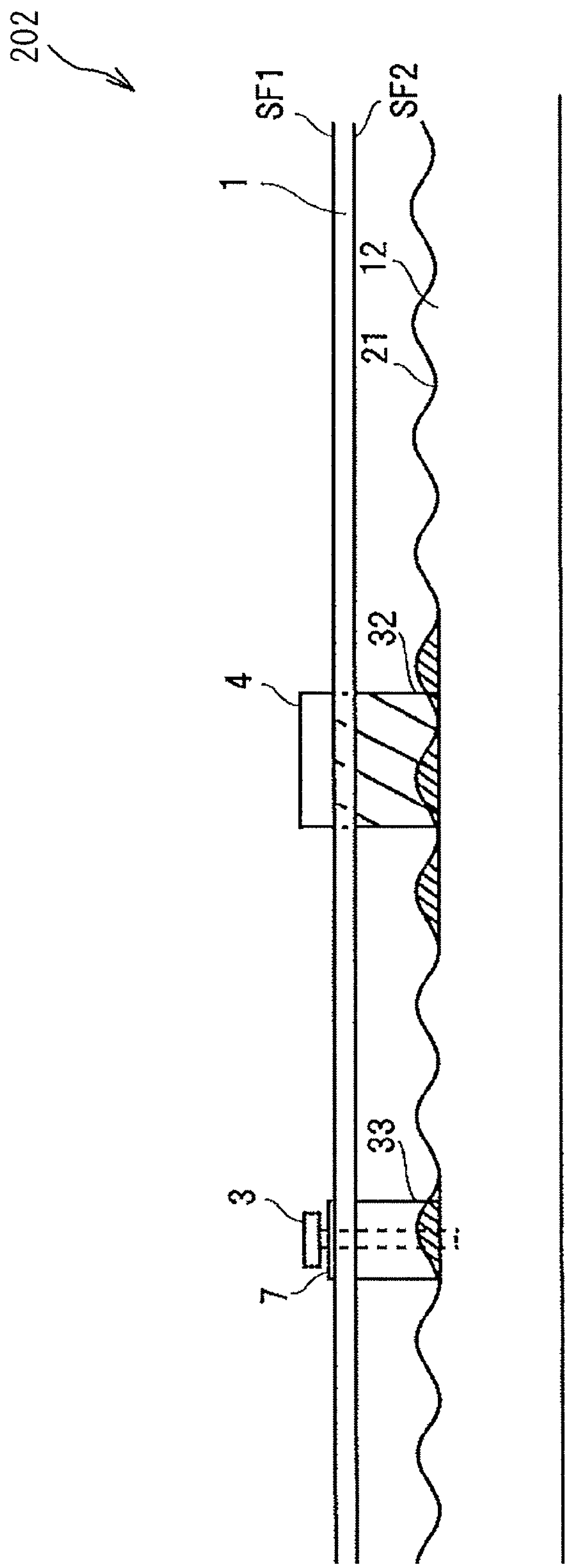


FIG. 13

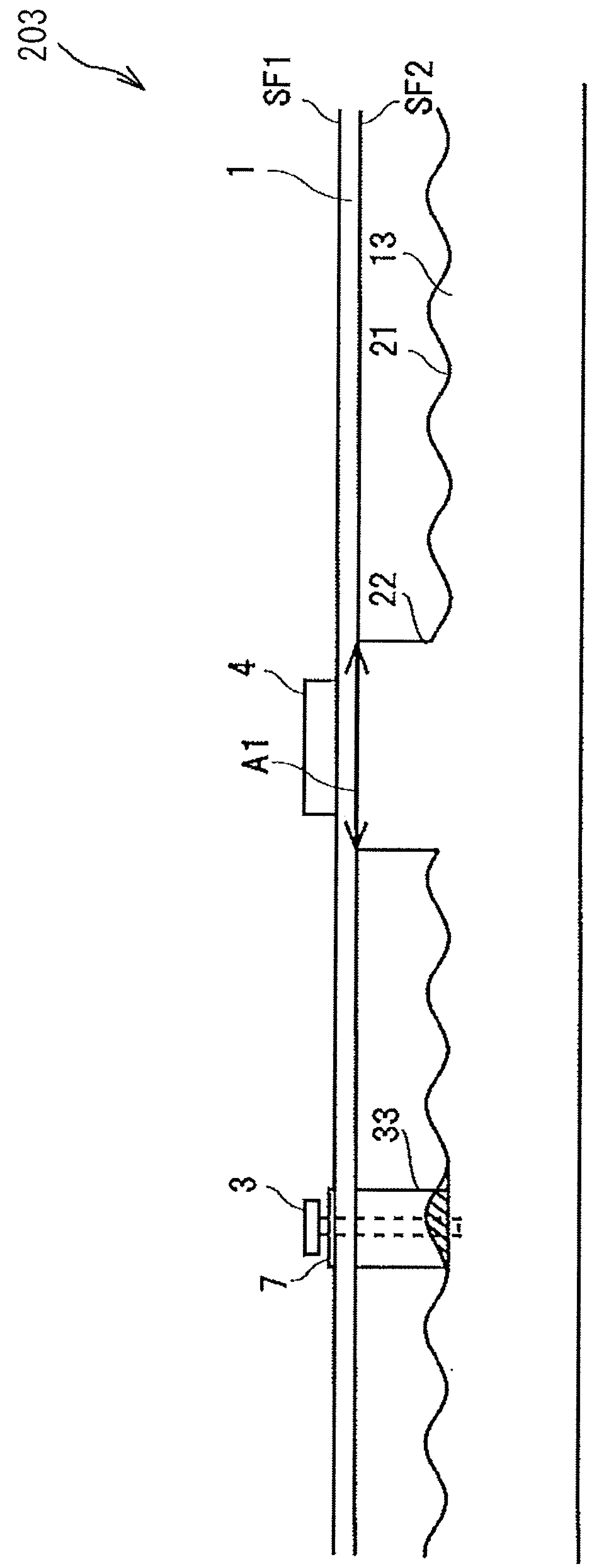
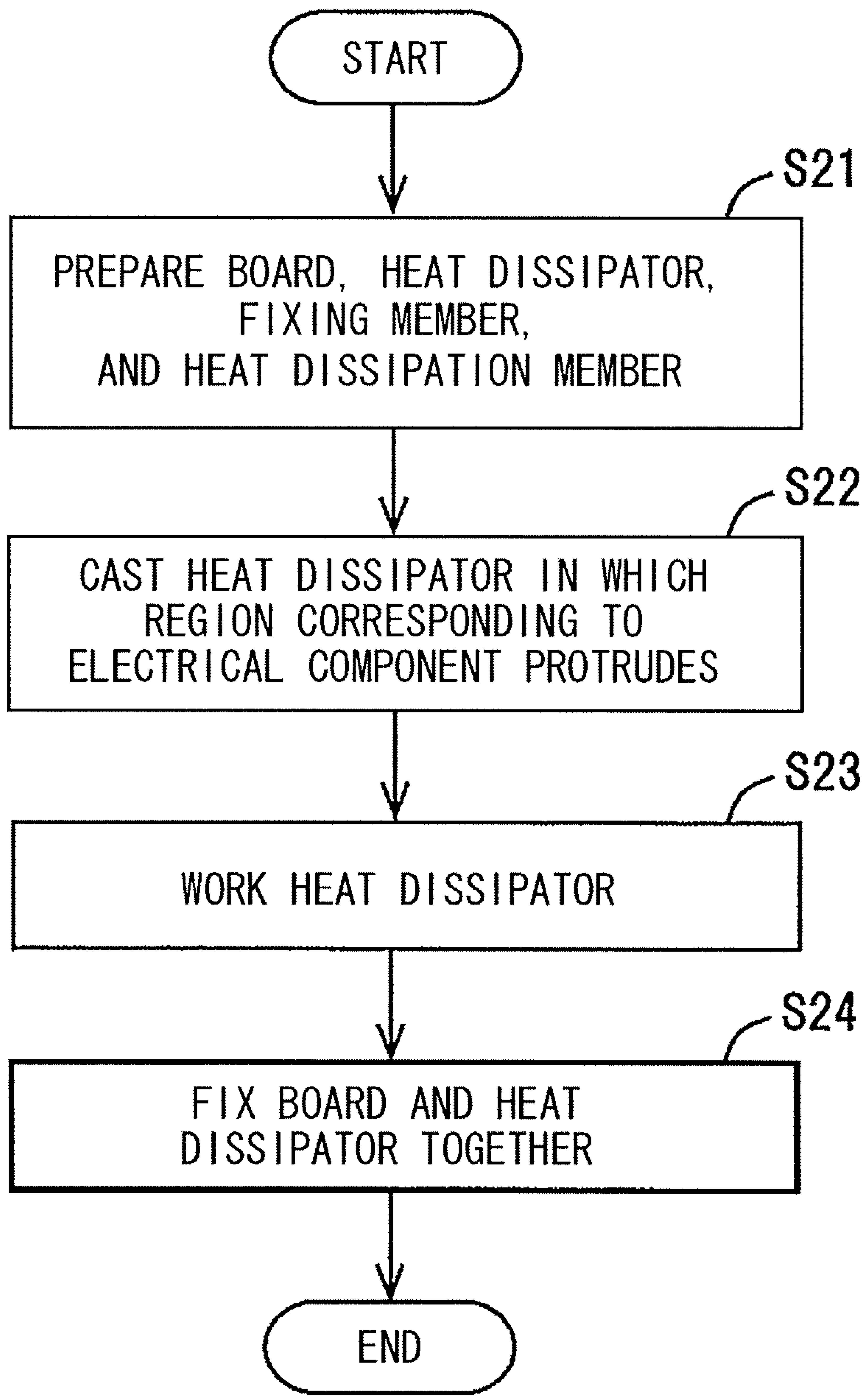


FIG. 14

FIG. 15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S21
PREPARE BOARD, HEAT DISSIPATOR, FIXING MEMBER, AND HEAT DISSIPATION MEMBER
S22
CAST HEAT DISSIPATOR IN WHICH REGION CORRESPONDING TO ELECTRICAL COMPONENT PROTRUDES
S23
WORK HEAT DISSIPATOR
S24
FIX BOARD AND HEAT DISSIPATOR TOGETHER
END

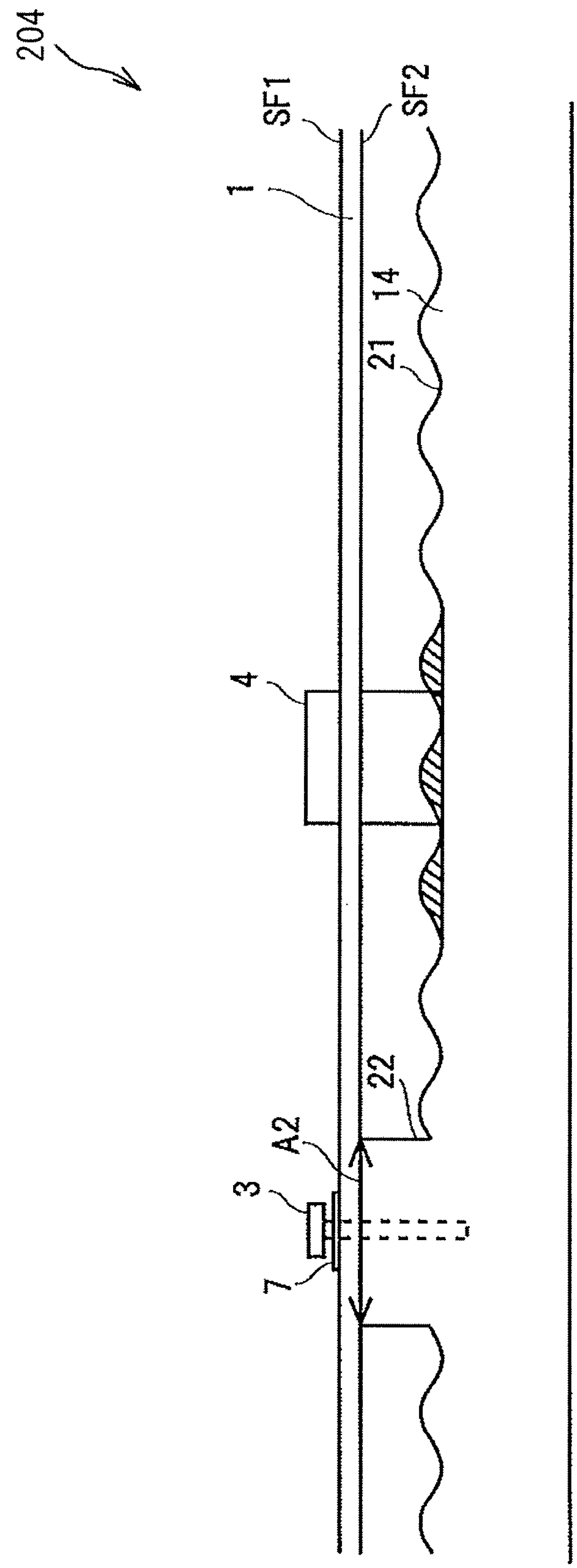
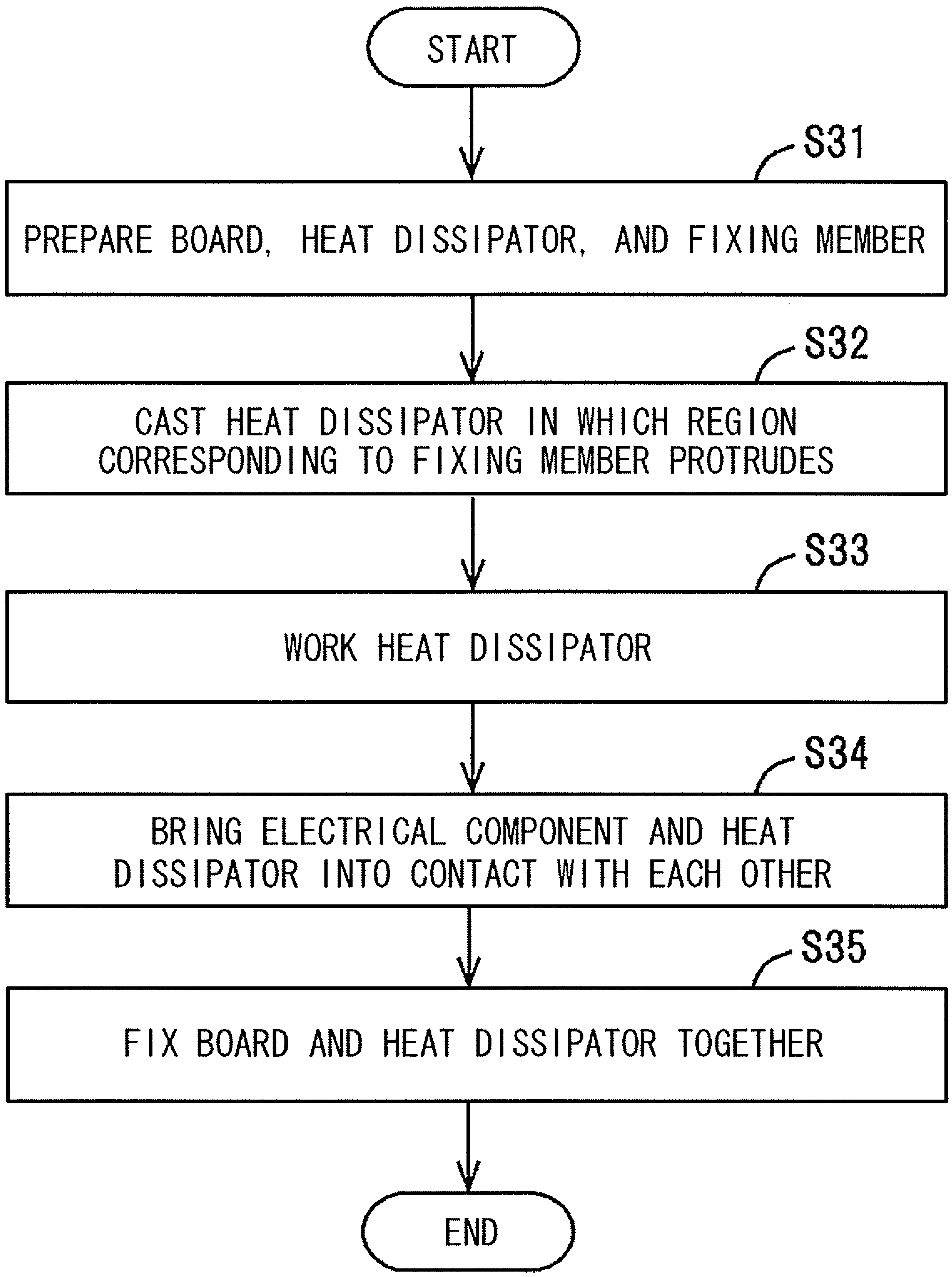


FIG. 16

FIG. 17


START
S31
PREPARE BOARD, HEAT DISSIPATOR, AND FIXING MEMBER
S32
CAST HEAT DISSIPATOR IN WHICH REGION CORRESPONDING TO FIXING MEMBER PROTRUDES
S33
WORK HEAT DISSIPATOR
S34
BRING ELECTRICAL COMPONENT AND HEAT DISSIPATOR INTO CONTACT WITH EACH OTHER
S35
FIX BOARD AND HEAT DISSIPATOR TOGETHER
END

ELECTRICAL APPARATUS AND METHOD FOR PRODUCING ELECTRICAL APPARATUS

TECHNICAL FIELD

The present invention relates to an electrical apparatus and a method for producing the electrical apparatus, and in particular, to an electrical apparatus provided with a heat dissipator, and a method for producing the electrical apparatus.

BACKGROUND ART

As an example for heat dissipation measures for electrical apparatuses, Japanese Laid-Open Patent Publication No. H11-195889 (Patent Literature 1) discloses the following technology, for example. That is, a printed circuit board heat dissipation component is attached to a printed circuit board for dissipating heat generated in an electronic component mounted on the printed circuit board, and the heat dissipation component includes: an attachment part which is inserted in a lead inserting hole of the printed circuit board and soldered on the printed circuit board together with a lead of the electronic component; and a heat dissipation part rising from the board surface as an integral body with the attachment part.

CITATION LIST

Patent Literature

[PTL 1] Japanese Laid-Open Patent Publication No. H11-195889

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

Here, a structure for mounting a power device is considered. Since a power device generates heat to a great extent, the following structure is conceivable, for example, in which: a board having a power device mounted thereon and a heat dissipator are brought into contact with each other, and the board and the heat dissipator are fixed together with a screw, to dissipate heat.

However, in such a mounting structure, when the evenness of the heat dissipator is low, the portions where the board and the heat dissipator are brought into contact with each other are reduced, and thus, a sufficient heat dissipation effect is not obtained. On the other hand, the greater the area of the heat dissipator having an increased evenness is, the greater the surface working costs become.

Patent Literature 1 does not disclose a structure for solving such a problem.

The present invention is made in order to solve the above problem. An object of the present invention is to provide an electrical apparatus and a method for producing the electrical apparatus that can improve the heat dissipation performance and can prevent increase of production costs.

Solution to the Problems

(1) In order to solve the above problem, an electrical apparatus according to an aspect of this invention is an electrical apparatus including: a board which includes a first main surface and a second main surface and in which an electrical component is attached to the first main surface; a heat dissipator; and a fixing member which fixes the second main

surface of the board and the heat dissipator together in such a manner as to be in contact with each other, by passing through the board from the first main surface to the second main surface to be inserted in the heat dissipator, wherein in an opposing part facing the board, the opposing part being on a surface of the heat dissipator, a contact part which is brought into contact with a first region of the second main surface corresponding to the electrical component and a surrounding region of the electrical component and which is brought into contact with a second region of the second main surface corresponding to the fixing member and a surrounding region of the fixing member protrudes relative to a portion of the opposing part other than the contact part, and the degree of flatness of a contact surface, in the contact part, that is brought into contact with the first region and the second region is higher than the degree of flatness of a surface of the opposing part other than the contact surface.

With this structure, it is possible to realize both low surface working costs and a high heat dissipation effect. That is, it is possible to minimize the area having an increased degree of flatness, and to obtain a sufficient heat dissipation effect. Therefore, it is possible to improve the heat dissipation performance and to prevent increase of production costs. Further, by bringing the heat dissipator, and the portion of the board corresponding to the electrical component and its surrounding region and the portion of the board corresponding to the fixing member and its surrounding region into contact with each other, compared with a structure where one of the above two portions is brought into contact with the heat dissipator, the heat dissipation performance can be improved.

(2) Further, the electrical apparatus according to another aspect of this invention is an electrical apparatus including: a board which includes a first main surface and a second main surface and to which an electrical component is attached; a heat dissipator, and a fixing member which fixes the board and the heat dissipator together by passing through the board from the first main surface to the second main surface to be inserted in the heat dissipator, wherein the electrical component projects from the second main surface of the board, and is in contact with the heat dissipator at a tip of a projecting portion of the electrical component or in contact with the heat dissipator via a first heat dissipation member provided between the electrical component and the heat dissipator, and on the surface of the heat dissipator, the degree of flatness of a contact surface that is brought into contact with the electrical component or the first heat dissipation member is higher than the degree of flatness of a surface of an opposing part other than the contact surface, the opposing part facing the board.

With this structure, it is possible to realize both low surface working costs and a high heat dissipation effect. That is, it is possible to minimize the area having an increased degree of flatness, and to obtain a sufficient heat dissipation effect. Therefore, it is possible to improve the heat dissipation performance and to prevent increase of production costs. Further, on the surface of the heat dissipator, it is sufficient to increase the degree of flatness only of the portion corresponding to the electrical component or the first heat dissipation member. Thus, surface working costs can be reduced. Further, since heat from the electrical component is conveyed to the heat dissipator directly or via the first heat dissipation member, the necessity for a structure that promotes heat conduction from the fixing member to the heat dissipator is reduced.

(3) Preferably, the fixing member reaches the heat dissipator by being inserted through a second heat dissipation member which is in close contact with the board and the heat dissipator between the board and the heat dissipator, and on

the surface of the heat dissipator, the degree of flatness of the contact surface that is brought into contact with the electrical component or the first heat dissipation member and the degree of flatness of a contact surface that is brought into contact with the second heat dissipation member are higher than the degree of flatness of a surface of the opposing part other than these contact surfaces.

As described above, by providing the second heat dissipation member and by increasing the degree of flatness of the contact surface, on the surface of the heat dissipator, that is brought into contact with the second heat dissipation member, it is possible to promote heat conduction from the electrical component to the heat dissipator. Thus, the heat dissipation effect can be further enhanced.

(4) Preferably, in the opposing part, a contact part which is brought into contact with a member region of the second main surface corresponding to the fixing member and a surrounding region of the fixing member protrudes relative to a portion of the opposing part other than the contact part, and the degree of flatness of the contact surface, on the surface of the heat dissipator, that is brought into contact with the electrical component or the first heat dissipation member, and the degree of flatness of a contact surface, in the contact part, that is brought into contact with the member region are higher than the degree of flatness of a surface of the opposing part other than these contact surfaces.

With this structure, it is possible to realize both low surface working costs and a high heat dissipation effect. That is, it is possible to minimize the area having an increased degree of flatness, and to obtain a sufficient heat dissipation effect. Therefore, it is possible to improve the heat dissipation performance and to prevent increase of production costs. Further, by bringing the heat dissipator, and the portion of the board corresponding to the electrical component or the heat dissipation member and the portion of the board corresponding to the fixing member and its surrounding region, into contact with each other, compared with a structure where the heat dissipator is brought into contact with one of the portion of the board corresponding to the electrical component or the heat dissipation member and the portion of the board corresponding to the fixing member and its surrounding region, the heat dissipation performance can be improved.

(5) Further, the electrical apparatus according to still another aspect of this invention is an electrical apparatus including: a board which includes a first main surface and a second main surface and in which an electrical component is attached to the first main surface; a heat dissipator; and a fixing member which fixes the second main surface of the board and the heat dissipator together in such a manner as to be in contact with each other, by passing through the board from the first main surface to the second main surface to be inserted in the heat dissipator, wherein in an opposing part facing the board , the opposing part being on a surface of the heat dissipator, a contact part which is brought into contact with a component region of the second main surface corresponding to the electrical component and a surrounding region of the electrical component protrudes relative to a portion of the opposing part other than the contact part, and the fixing member reaches the heat dissipator by being inserted through a heat dissipation member which is in close contact with the board and the heat dissipator between the board and the heat dissipator, and the degree of flatness of a contact surface, in the contact part, that is brought into contact with the component region, and the degree of flatness of contact surface, in the heat dissipator, that is brought into contact with the heat dissipation member are higher than the degree of flatness of a surface of the opposing part other than these contact surfaces.

With this structure, it is possible to realize both low surface working costs and a high heat dissipation effect. That is, by increasing the degree of flatness of the protruding contact part, the degree of contact between the board and the heat dissipator is increased in the portion where the heat dissipation effect is especially enhanced. Further, by providing the heat dissipation member and by increasing the degree of flatness of the contact surface, in the heat dissipator, that is brought into contact with the heat dissipation member, heat conduction from the electrical component to the heat dissipator can be promoted. Thus, the heat dissipation effect can be enhanced. Accordingly, it is possible to minimize the area having an increased degree of flatness, and to obtain a sufficient heat dissipation effect. Therefore, it is possible to improve the heat dissipation performance and to prevent increase of production costs.

(6) Preferably, the electrical component is attached to a vicinity of the fixing member.

With this structure, it is possible to arrange the electrical component in a region having a high degree of contact with the heat dissipator, and heat generated from the electrical component can be conducted to the heat dissipator via the fixing member. Thus, the heat dissipation effect can further be enhanced.

(7) Preferably, the electrical apparatus is a radio communication device which includes an amplifier for amplifying a radio signal, as the electrical component.

With this structure, it is possible to appropriately take heat dissipation measures for the amplifier whose temperature is especially increased in the radio communication device.

(8) In order to solve the above mentioned problem, a method for producing an electrical apparatus according to an aspect of this invention is a method for producing an electrical apparatus, the method including: a step of preparing a board which includes a first main surface and a second main surface and in which an electrical component is attached to the first main surface, and a fixing member to be passed through the board from the first main surface to the second main surface; a step of casting a heat dissipator in which, in an opposing part facing the board, the opposing part being on a surface of the heat dissipator, a contact part which is brought into contact with a first region of the second main surface corresponding to the electrical component and a surrounding region of the electrical component and which is brought into contact with a second region of the second main surface corresponding to the fixing member and a surrounding region of the fixing member protrudes relative to a portion of the opposing part other than the contact part; a step of working the heat dissipator such that the degree of flatness of a contact surface, in the contact part, that is brought into contact with the first region and the second region is higher than the degree of flatness of a surface of the opposing part other than the contact surface; and a step of fixing the second main surface of the board and the heat dissipator together in such a manner as to be in contact with each other, by passing the fixing member through the board from the first main surface to the second main surface to be inserted in the heat dissipator.

With this structure, it is possible to realize both low surface working costs and a high heat dissipation effect. That is, it is possible to minimize the area having an increased degree of flatness, and to obtain a sufficient heat dissipation effect. Therefore, it is possible to improve the heat dissipation performance and to prevent increase of production costs. Further, in the board, by bring the heat dissipator, and the portion corresponding to the electrical component and its surrounding region and the portion corresponding to the fixing member and its surrounding region, into contact with each other, compared with a structure where one of the above two portions are brought into contact with the heat dissipator, the heat dissipation performance can be improved.

(9) Further, a method for producing an electrical apparatus according to another aspect of this invention is a method for producing an electrical apparatus, the method including: a step of preparing a board which includes a first main surface and a second main surface and to which an electrical component is attached, and a fixing member to be passed through the board from the first main surface to the second main surface; a step of causing the electrical component to project from the second main surface of the board to be brought into contact with a heat dissipator at a tip of a projecting portion of the electrical component, or bringing the electrical component into contact with the heat dissipator via a heat dissipation member provided between the electrical component and the heat dissipator; a step of fixing the second main surface of the board and the electrical component, and the heat dissipator together, by passing the fixing member through the board from the first main surface to the second main surface to be inserted in the heat dissipator; and a step of working, before the step of bringing the electrical component into contact and the step of fixing the electrical component using the fixing member, the heat dissipator such that, in an opposing part facing the board, the opposing part being on a surface of the heat dissipator, the degree of flatness of a contact surface that is brought into contact with the electrical component or the heat dissipation member is higher than the degree of flatness of a surface of the opposing part other than the contact surface.

With this structure, it is possible to realize both low surface working costs and a high heat dissipation effect. That is, it is possible to minimize the area having an increased degree of flatness, and to obtain a sufficient heat dissipation effect. Therefore, it is possible to improve the heat dissipation performance and to prevent increase of production costs. Further, on the surface of the heat dissipator, it is sufficient to increase the degree of flatness only of the portion corresponding to the electrical component or the heat dissipation member. Thus, surface working costs can be reduced. Further, since heat from the electrical component is conveyed to the heat dissipator directly or via the heat dissipation member, the necessity for a structure that promotes heat conduction from the fixing member to the heat dissipator is reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a structure of an electrical apparatus according to a first embodiment.

FIG. **2** is a functional block diagram of a remote radio head according to the first embodiment.

FIG. **3** shows a mounting structure of a comparative example of the electrical apparatus according to the first embodiment.

FIG. **4** is a perspective view showing a mounting structure of the electrical apparatus according to the first embodiment.

FIG. **5** is a cross-sectional view showing the mounting structure of the electrical apparatus according to the first embodiment.

FIG. **6** is a flow chart defining the procedure for producing the electrical apparatus according to the first embodiment.

FIG. **7** is a cross-sectional view showing a method for working a surface of a heat dissipator in comparative example **1** of the electrical apparatus according to the first embodiment.

FIG. **8** is a cross-sectional view showing a method for working a surface of the heat dissipator in comparative example **2** of the electrical apparatus according to the first embodiment.

FIG. **9** is a cross-sectional view showing a method for working a surface of a heat dissipator in the electrical apparatus according to the first embodiment of the present invention.

FIG. **10** is a cross-sectional view showing a mounting structure of a modification of the electrical apparatus according to the first embodiment of the present invention.

FIG. **11** is a cross-sectional view showing a mounting structure of an electrical apparatus according to a second embodiment of the present invention.

FIG. **12** is a flow chart defining the procedure for producing the electrical apparatus according to the second embodiment of the present invention.

FIG. **13** is a cross-sectional view showing a mounting structure of a modification of the electrical apparatus according to the second embodiment of the present invention.

FIG. **14** is a cross-sectional view showing a mounting structure of an electrical apparatus according to a third embodiment of the present invention.

FIG. **15** is a flow chart defining the procedure for producing the electrical apparatus according to the third embodiment of the present invention.

FIG. **16** is a cross-sectional view showing a mounting structure of an electrical apparatus according to a fourth embodiment of the present invention.

FIG. **17** is a flow chart defining the procedure for producing the electrical apparatus according to the fourth embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

Hereinafter, embodiments of the present invention will be described with reference to the drawings. Note that, in the drawings, the same or corresponding parts are denoted by the same reference characters, and description thereof is not repeated.

<First embodiment>

FIG. **1** shows a structure of an electrical apparatus according to a first embodiment of the present invention.

With reference to FIG. **1**, an electrical apparatus **201** is a radio communication device, for example, and includes one or a plurality of remote radio heads (RRH) **101**, and a body device **102**.

Each remote radio head **101** is a device obtained by separating a part that performs transmission and reception of radio signals, from a radio base station device used in mobile communication. The remote radio head **101** is attached to an antenna pole **104** installed on the roof of a building or the like. Further, an antenna **103** is attached to the antenna pole **104**.

The remote radio head **101** converts a radio signal received from a radio terminal device **301** via the antenna **103** into a digital signal, and outputs the digital signal to the body device **102** via an optical fiber **105**. Further, the remote radio head **101** converts a digital signal received from the body device **102** via the optical fiber **105** into a radio signal, and transmits the radio signal to the radio terminal device **301** via the antenna **103**.

FIG. **2** is a functional block diagram of a remote radio head according to the first embodiment of the present invention.

With reference to FIG. **2**, the remote radio head **101** includes a signal processing section **81**, a radio transmission section **71**, a radio reception section **72**, and a transmission and reception filter **86**. The radio transmission section **71** includes a digital/analog converter (DAC) **82**, a modulator **83**, a driver amplifier **84**, a power amplifier **85**, and an oscillator **87**. The radio reception section **72** includes reception amplifiers **89** and **90**, a mixer **91**, a BPF (Band Pass Filter) **92**, an analog/digital converter (ADC) **93**, and an oscillator **94**. The signal processing section **81** is a DSP (Digital Signal Processor), for example.

The signal processing section **81** performs signal processing on a digital signal received from the body device **102** via the optical fiber **105**, and outputs the resultant signal to the radio transmission section **71**.

The radio transmission section **71** converts the digital signal received from the signal processing section **81** into an analog signal, converts the converted analog signal into a radio signal, that is, a signal in an RF (Radio Frequency) band, and transmits the radio signal to the radio terminal device **301**.

The radio reception section **72** receives a radio signal from the radio terminal device **301**, converts the radio signal into an IF (Intermediate Frequency) signal, converts the converted IF signal into a digital signal, and outputs the digital signal to the signal processing section **81**.

The signal processing section **81** performs various types of signal processing on the digital signal received from the radio reception section **72**, and outputs the resultant signal to the body device **102** via the optical fiber **105**.

More specifically, the signal processing section **81** outputs a digital signal received from the body device **102** to the digital/analog converter **82**.

The digital/analog converter **82** converts the digital signal received from the signal processing section **81** into an analog signal, and outputs the analog signal to the modulator **83**.

The oscillator **87** generates a locally generated signal and outputs this signal to the modulator **83**. The modulator **83** multiples the analog signal in a baseband received from the digital/analog converter **82** by the locally generated signal received from the oscillator **87**, thereby performing, for example, a quadrature modulation on the analog signal received from the digital/analog converter **82** to be converted into a radio signal, and outputs the radio signal to the driver amplifier **84**.

The driver amplifier **84** amplifies the radio signal received from the modulator **83**, and outputs the resultant signal to the power amplifier **85**.

The power amplifier **85** further amplifies the radio signal received from the driver amplifier **84**. The radio signal amplified by the power amplifier **85** is transmitted, via the transmission and reception filter **86** and the antenna **103**, to the radio terminal device **301**.

The transmission and reception filter **86** removes an unwanted signal from the radio signal received from the power amplifier **85**, and outputs the resultant signal to the antenna **103**. Further, the transmission and reception filter **86** removes noise from a radio signal received from the antenna **103**, and outputs the resultant signal to the reception amplifier **89**. The transmission and reception filter **86** is a band-pass filter, for example, and outputs a signal obtained by attenuating, from among frequency components of the received radio signal, components outside a predetermined frequency band.

The reception amplifier **89** is an LNA (Low Noise Amplifier), for example, and receives the radio signal from the radio terminal device **301** via the antenna **103** and the transmission and reception filter **86**, amplifies the received radio signal, and outputs the resultant signal to the reception amplifier **90**.

The reception amplifier **90** is an LNA, for example, and further amplifies the radio signal received from the reception amplifier **89** and outputs the resultant signal to the mixer **91**.

The oscillator **94** generates a locally generated signal and outputs this signal to the mixer **91**. The mixer **91** multiplies the radio signal received from the reception amplifier **90** by the locally generated signal received from the oscillator **94**, thereby converting the radio signal received from the reception amplifier **90** into an IF signal, and outputting the IF signal to the band-pass filter **92**.

The band-pass filter **92** outputs, to the analog/digital converter **93**, a signal obtained by attenuating, from among frequency components of the IF signal received from the mixer **91**, components outside a predetermined frequency band.

The analog/digital converter **93** converts the IF signal received from the band-pass filter **92** into a digital signal, and outputs the digital signal to the signal processing section **81**.

The signal processing section **81** converts the digital signal in the IF band received from the analog/digital converter **93** into a digital signal in the baseband, through quadrature demodulation, for example, and outputs the digital signal to the body device **102** via the optical fiber **105**.

FIG. **3** shows a mounting structure of a comparative example of the electrical apparatus according to the first embodiment of the present invention.

With reference to FIG. **3**, an electrical apparatus **200** includes a printed circuit board **1**, a heat dissipator **2**, a fixing member **3**, and an electrical component **4**.

The electrical component **4** is the power amplifier **85** shown in FIG. **2**, for example. The fixing member **3** is a screw, for example.

The printed circuit board **1** and the heat dissipator **2** are provided with tapped holes **5** and **6**, respectively. The fixing member **3** fixes the printed circuit board **1** and the heat dissipator **2** together in such a manner as to be in contact with each other, by passing through the printed circuit board **1** via the tapped hole **5** to be inserted in the tapped hole **6** in the heat dissipator **2**.

Thus, in the electrical apparatus **200**, heat dissipation is performed by bringing the printed circuit board **1** having the electrical component **4** mounted thereon and the heat dissipator **2** into contact with each other and by fixing them with a screw.

In this mounting structure, in a case where the evenness, i.e., the degree of flatness, of the contact surface in the heat dissipator **2** which is brought into contact with the printed circuit board **1** is low, the portions where the printed circuit board **1** and the heat dissipator **2** are brought into contact with each other are reduced. This prevents a sufficient heat dissipation effect from being obtained. On the other hand, the greater the area having an increased degree of flatness in the above contact surface is, the greater the surface working costs become.

Therefore, the electrical apparatus according to the first embodiment of the present invention solves the above problem, by adopting the following mounting structure. Hereinafter, parts that are the same as or correspond to those in FIG. **3** are denoted by the same reference characters, and description thereof is not repeated.

FIG. **4** is a perspective view showing a mounting structure of the electrical apparatus according to the first embodiment of the present invention. FIG. **5** is a cross-sectional view showing the mounting structure of the electrical apparatus according to the first embodiment of the present invention.

With reference to FIG. **4**, the electrical apparatus **201** includes the printed circuit board **1**, a heat dissipator **11**, the fixing member **3**, and the electrical component **4**.

The printed circuit board **1** includes a main surface SF**1** and a main surface SF**2**, and to the main surface SF**1**, the electrical component **4** is attached.

The fixing member **3** fixes the main surface SF**2** of the printed circuit board **1** and the heat dissipator **11** together in such a manner as to be in contact with each other, by passing through the printed circuit board **1** from the main surface SF**1** to the main surface SF**2** to be inserted in the heat dissipator **11**.

In an opposing part **21** facing the printed circuit board **1**, the opposing part **21** being on a surface of the heat dissipator **11**, a contact part **22**, which is brought into contact with a component region A**1** of the main surface SF**2** corresponding to the electrical component **4** and its surrounding region and which is brought into contact with a screw region A**2** of the main surface SF**2** corresponding to the fixing member **3** and its surrounding region, protrudes relative to the portion of the opposing part **21** other than the contact part **22**. The screw region A**2** is a region corresponding to the fixing member **3** being a screw and a washer **7**, for example.

The degree of flatness of the contact surface, in the contact part **22**, that is brought into contact with the component region A**1** and the screw region A**2** is higher than the degree of flatness of the surface of the opposing part **21** other than the contact surface.

Further, in the vicinity of the tapped hole **5** and the tapped hole **6**, the degree of contact between the printed circuit board **1** and the heat dissipator **11** is highest. Further, the fixing member **3** itself promotes heat conduction from the printed circuit board **1** to the heat dissipator **11**. Accordingly, in the vicinity of the tapped hole **5** and the tapped hole **6**, the heat dissipation effect is significantly enhanced.

In the electrical apparatus **201**, the electrical component **4** is attached in the vicinity of the fixing member **3**. That is, in the electrical apparatus **201**, a tapped hole is provided in the vicinity of the electrical component **4**, in addition to portions where tapped holes are structurally needed. With this structure, the heat dissipation effect can further be enhanced.

FIG. **6** is a flow chart defining the procedure for producing the electrical apparatus according to the first embodiment of the present invention.

With reference to FIG. **6**, first, the printed circuit board **1** which includes the main surface SF**1** and the main surface SF**2** and in which the electrical component **4** is attached to the main surface SF**1** is prepared. Further, the fixing member **3** to be passed through the printed circuit board **1** from the main surface SF**1** to the main surface SF**2** is prepared (step S**1**).

Next, the heat dissipator **11** is cast in which, in the opposing part **21** facing the printed circuit board **1**, the contact part **22**, which is brought into contact with the component region A**1** of the main surface SF**2** corresponding to the electrical component **4** and its surrounding region and which is brought into contact with the screw region A**2** of the main surface SF**2** corresponding to the fixing member **3** and its surrounding region, protrudes relative to the portion of the opposing part **21** other than the contact part **22** (step S**2**).

Next, the heat dissipator **11** is worked such that the degree of flatness of the contact surface, in the contact part **22**, that is brought into contact with the component region A **1** and the screw region A**2** becomes higher than the degree of flatness of the surface of the opposing part **21** other than the contact surface (step S**3**).

Next, by passing the fixing member **3** through the printed circuit board **1** from the main surface SF**1** to the main surface SF**2** to be inserted in the heat dissipator **11**, the main surface SF**2** of the printed circuit board **1** and the heat dissipator **11** are fixed together in such a manner as to be in contact with each other (step S**4**).

FIG. **7** is a cross-sectional view showing a method for working a surface of a heat dissipator in comparative example **1** of the electrical apparatus according to the first embodiment of the present invention.

With reference to FIG. **7**, in order to improve the heat dissipation performance in the electrical apparatus **200**, it is conceivable to perform surface working on the entirety of the opposing part **21**. However, such a method will increase surface working costs.

FIG. **8** is a cross-sectional view showing a method for working a surface of the heat dissipator in comparative example **2** of the electrical apparatus according to the first embodiment of the present invention.

With reference to FIG. **8**, in order to reduce working costs for the electrical apparatus **200**, it is conceivable to perform surface working, in the heat dissipator **2**, on only a portion that corresponds to the electrical component **4** or the fixing member **3**. However, the level of a portion P**1** where such surface working has been performed becomes lower than the level of the surrounding portion P**2**, which is the portion of the heat dissipator **2** other than the portion P**1**. Thus, in the portion P**1**, bringing the heat dissipator **2** and the printed circuit board **1** into contact with each other becomes difficult itself.

FIG. **9** is a cross-sectional view showing a method for working a surface of a heat dissipator in the electrical apparatus according to the first embodiment of the present invention.

With reference to FIG. **9**, with respect to the electrical apparatus **201**, surface working such as grinding and polishing is performed on the contact part **22**, in the opposing part **21**, which protrudes relative to the portion of the opposing part **21** other than the contact part **22**, thereby increasing the degree of flatness of the surface of the contact part **22**. As a result of this surface working, the level of the contact part **22** is lowered than that before the working. However, since the contact part **22** protrudes relative to the portion of the opposing part **21** other than the contact part **22** from the beginning, it is possible to bring the contact part **22** and the printed circuit board **1** into close contact with each other.

FIG. **10** is a cross-sectional view showing a mounting structure of a modification of the electrical apparatus according to the first embodiment of the present invention.

With reference to FIG. **10**, the present invention is not limited to the structure provided with the contact part **22** which is brought into contact with both the region A**1** and the region A**2** and which protrudes relative to the portion of the opposing part **21** other than the contact part **22**. The present invention may have a structure in which a contact part **23** which is brought into contact with the region A**1** and a contact part **24** which is brought into contact with the region A**2** may be separately provided.

Meanwhile, in the case of the structure in which heat dissipation is performed by bringing a board having a power device mounted thereon into contact with a heat dissipator and by fixing them together using a screw, if the evenness of the heat dissipator is low, the portions where the board is brought into contact with the heat dissipator are reduced, and thus, a sufficient heat dissipation effect is not obtained. On the other hand, in a heat dissipator, the greater the area having an increased evenness is, the greater the surface working costs become.

In contrast, in the electrical apparatus according to the first embodiment of the present invention, the fixing member **3** fixes the main surface SF**2** of the printed circuit board **1** and the heat dissipator **11** together in such a manner as to be in contact with each other, by passing through the printed circuit board **1** from the main surface SF**1** to the main surface SF**2** to be inserted in the heat dissipator **11**. In the opposing part **21** facing the printed circuit board **1**, the opposing part **21** being on the surface of the heat dissipator **11**, the contact part **22**, which is brought into contact with the component region A**1** of the main surface SF**2** corresponding to the electrical component **4** and its surrounding region and which is brought into contact with the screw region A**2** of the main surface SF**2** corresponding to the fixing member **3** and its surrounding region, protrudes relative to the portion of the opposing part **21** other than the contact part **22**. Further, the degree of flatness of the contact surface, in the contact part **22**, that is brought into contact with the component region A**1** and the screw region A**2** is higher than the degree of flatness of the surface of the opposing part **21** other than the contact surface.

That is, in the first embodiment of the present invention, the heat dissipator **11** is produced through casting such that only the vicinity of the tapped hole and the vicinity of the power device protrude in the opposing part **21**. Then, by increasing the degree of flatness only of the protruding contact part **22**, the degree of contact between the printed circuit board **1** and the heat dissipator **11** is increased in the portion where the heat dissipation effect is especially enhanced.

This structure can realize both low surface working costs and a high heat dissipation effect. That is, it is possible to minimize the area having an increased degree of flatness, and to obtain a sufficient heat dissipation effect.

Therefore, in the electrical apparatus according to the first embodiment of the present invention, it is possible to improve the heat dissipation performance and to prevent increase of production costs.

Further, in the electrical apparatus according to the first embodiment of the present invention, the electrical component **4** is attached to the vicinity of the fixing member **3**.

With this structure, the electrical component **4** can be arranged in a region having a high degree of contact with the heat dissipator **11**, and heat generated from the electrical component **4** can be conducted to the heat dissipator **11** via the fixing member **3**. Thus, the heat dissipation effect can further be enhanced.

Further, the electrical apparatus according to the first embodiment of the present invention is a radio communication device including, as the electrical component **4**, an amplifier such as the power amplifier **85** for amplifying a radio signal.

With this structure, it is possible to appropriately take heat dissipation measures for the amplifier whose temperature is especially increased in the radio communication device.

Next, another embodiment of the present invention will be described with reference to the drawings. Note that the same or corresponding parts in the drawings are denoted by the same reference characters, and description thereof is not repeated.

<Second embodiment>

The present embodiment relates to an electrical apparatus in which the heat dissipation structure is changed compared with the electrical apparatus according to the first embodiment. The content other than that described below is the same as described with respect to the electrical apparatus according to the first embodiment.

FIG. **11** is a cross-sectional view showing a mounting structure of an electrical apparatus according to a second embodiment of the present invention.

With reference to FIG. **11**, compared with the electrical apparatus according to the first embodiment of the present invention, an electrical apparatus **202** further includes a heat dissipation member **33**, and includes a heat dissipator **12** instead of the heat dissipator **11**.

The printed circuit board **1** includes the main surface SF**1** and the main surface SF**2**, and the electrical component **4** is attached to the printed circuit board **1**.

The fixing member **3** fixes the printed circuit board **1** and the heat dissipator **12** in such a manner as to be spaced apart from each other, by passing through the printed circuit board **1** from the main surface SF**1** to the main surface SF**2** to be inserted in the heat dissipator **12**. The fixing member **3** reaches the heat dissipator **12** by being inserted through the heat dissipation member **33** which is in close contact with the printed circuit board **1** and the heat dissipator **12** between the printed circuit board **1** and the heat dissipator **12**.

The electrical component **4** includes a projecting portion projected from the main surface SF**2** of the printed circuit board **1** and a tip of the projecting portion is in contact with the heat dissipator **12**.

On a surface of the heat dissipator **12**, the degree of flatness of the contact surface that is brought into contact with the electrical component **4** and the degree of flatness of the contact surface that is brought into contact with the heat dissipation member **33** are higher than the degree of flatness of the surface of the opposing part **21** other than these contact surfaces, the opposing part **21** facing the printed circuit board **1**.

FIG. **12** is a flow chart defining the procedure for producing the electrical apparatus according to the second embodiment of the present invention.

With reference to FIG. **12**, first, the printed circuit board **1** which includes the main surface SF**1** and the main surface SF**2** and to which the electrical component **4** is attached, the heat dissipator **12**, the fixing member **3**, and the heat dissipation member **33** are prepared (step S**11**).

Next, the heat dissipator **12** is worked such that, on the surface of the heat dissipator **12**, the degree of flatness of the contact surface that is brought into contact with the electrical component **4** and the degree of flatness of the contact surface that is brought into contact with the heat dissipation member **33** become higher than the degree of flatness of the surface of the opposing part **21** other than these contact surfaces, the opposing part **21** facing the printed circuit board **1** (step S**12**).

Next, the electrical component **4** is caused to project from the main surface SF**2** of the printed circuit board **1** to be brought into contact with the heat dissipator **12**, at the tip of the projecting portion of the electrical component **4** (step S**13**).

Next, by passing the fixing member **3** through the printed circuit board **1** from the main surface SF**1** to the main surface SF**2** to be inserted in the heat dissipator **12** via the heat dissipation member **33**, the printed circuit board **1** and the heat dissipator **12** are fixed in such a manner as to be spaced apart from each other (step S**14**).

FIG. **13** is a cross-sectional view showing a mounting structure of a modification of the electrical apparatus according to the second embodiment of the present invention.

With reference to FIG. **13**, the electrical apparatus **202** further includes a heat dissipation member **32**. The present invention is not limited to the structure in which the electrical component **4** is directly brought into contact with the heat dissipator **12**, as shown in FIG. **11**. The present invention may have a structure in which the electrical component **4** is brought into contact with the heat dissipator **12** via the heat dissipation member **32** provided between the electrical component **4** and the heat dissipator **12**.

In this case, on the surface of the heat dissipator **12**, the degree of flatness of the contact surface that is brought into contact with the heat dissipation member **32** and the degree of flatness of the contact surface that is brought into contact with the heat dissipation member **33** are higher than the degree of flatness of the surface of the opposing part **21** other than these contact surfaces, the opposing part **21** facing the printed circuit board **1**.

The other structures and operations are the same as those in the case of the electrical apparatus according to the first embodiment, and detailed description thereof is not repeated here.

As described above, in the electrical apparatus according to the second embodiment of the present invention, the fixing member **3** fixes the printed circuit board **1** and the heat dissipator **12** by passing through the printed circuit board **1** from the main surface SF**1** to the main surface SF**2** to be inserted in the heat dissipator **12**. The electrical component **4** projects from the main surface SF**2** of the printed circuit board **1** and is in contact with the heat dissipator **12** at the tip of the projecting portion of the electrical component **4**. Alternatively, the electrical component **4** is contact with the heat dissipator **12** via the heat dissipation member **32** provided between the electrical component **4** and the heat dissipator **12**. On the surface of the heat dissipator **12**, the degree of flatness of the contact surface that is brought into contact with the electrical component **4** or the heat dissipation member **32** is higher than the degree of flatness of the surface of the opposing part **21** other than the contact surface, the opposing part **21** facing the printed circuit board **1**.

That is, according to the second embodiment of the present invention, on the surface of the heat dissipator **12**, by increasing the degree of flatness of the contact surface that is brought into contact with the electrical component **4** or the heat dissipation member **32**, the degree of contact between the printed circuit board **1** and the heat dissipator **12** is increased in the portion where the heat dissipation effect is especially enhanced.

With this structure, as in the case of the electrical apparatus according to the first embodiment of the present invention, it is possible to improve the heat dissipation performance and to prevent increase of production costs.

Further, in the electrical apparatus according to the second embodiment of the present invention, the fixing member **3** reaches the heat dissipator **12** by being inserted through the heat dissipation member **33** which is in close contact with the printed circuit board **1** and the heat dissipator **12** between the printed circuit board **1** and the heat dissipator **12**. In addition, on the surface of the heat dissipator **12**, the degree of flatness of the contact surface that is brought into contact with the electrical component **4** or the heat dissipation member **32** and the degree of flatness of the contact surface that is brought into contact with the heat dissipation member **33** are higher than the degree of flatness of the surface of the opposing part **21** other than these contact surfaces.

As described above, by providing the heat dissipation member **33**, and by increasing the degree of flatness of the contact surface, in the heat dissipator **12**, that is brought into contact with the heat dissipation member **33**, heat conduction from the electrical component **4** to the heat dissipator **12** can be promoted. Thus, the heat dissipation effect can further be enhanced.

Note that, in FIG. **13**, it is sufficient that the heat dissipation member **32** is located between the heat dissipator **12** and the electrical component **4**, and that one end of the heat dissipation member **32** is in contact with the heat dissipator **12**. For example, the heat dissipation member **32** may be provided between the electrical component **4** projecting from the main surface SF**2** of the printed circuit board **1** and the heat dissipator **12**, the other end of the heat dissipation member **32** may be located inside the printed circuit board, or the other end of the heat dissipation member **32** may project from the main surface SF**1**.

Further, in the electrical apparatus according to the second embodiment of the present invention, heat from the electrical component **4** is conveyed directly or via the heat dissipation member **32** to the heat dissipator **12**. Thus, instead of the heat dissipation member **33**, a member having low heat dissipation ability may be provided.

Next, another embodiment of the present invention will be described with reference to the drawings. Note that the same or corresponding parts in the drawings are denoted by the same reference characters, and description thereof is not repeated.

<Third embodiment>

The present embodiment relates to an electrical apparatus in which the heat dissipation structure is changed compared with the electrical apparatus according to the first embodiment. The content other than that described below is the same as described with respect to the electrical apparatus according to the first embodiment.

FIG. **14** is a cross-sectional view showing a mounting structure of an electrical apparatus according to a third embodiment of the present invention.

With reference to FIG. **14**, compared with the electrical apparatus according to the first embodiment of the present invention, an electrical apparatus **203** further includes the heat dissipation member **33**, and includes a heat dissipator **13** instead of the heat dissipator **11**.

The printed circuit board **1** includes the main surface SF**1** and the main surface SF**2** and the electrical component **4** is attached to the main surface SF**1**.

The fixing member **3** fixes the main surface SF**2** of the printed circuit board **1** and the heat dissipator **13** together in such a manner as to be in contact with each other, by passing through the printed circuit board **1** from the main surface SF**1** to the main surface SF**2** to be inserted in the heat dissipator **13**. The fixing member **3** reaches the heat dissipator **13** by being inserted through the heat dissipation member **33** which is in close contact with the printed circuit board **1** and the heat dissipator **13** between the printed circuit board **1** and the heat dissipator **13**.

In the opposing part **21** facing the printed circuit board **1**, the opposing part **21** being on a surface of the heat dissipator **13**, the contact part **22**, which is brought into contact with the component region A**1** of the main surface SF**2** corresponding to the electrical component **4** and its surrounding region, protrudes relative to the portion of the opposing part **21** other than the contact part **22**.

The degree of flatness of the contact surface, in the contact part **22**, that is brought into contact with the component region A**1** and the degree of flatness of the contact surface, in the heat dissipator **13**, that is brought into contact with the heat dissipation member **33** are higher than the degree of flatness of the surface of the opposing part **21** other than these contact surfaces.

FIG. **15** is a flow chart defining the procedure for producing the electrical apparatus according to the third embodiment of the present invention.

With reference to FIG. **15**, first, the printed circuit board **1** which includes the main surface SF**1** and the main surface SF**2** and in which the electrical component **4** is attached to the main surface SF**1**, the heat dissipator **13**, the fixing member **3**, and the heat dissipation member **33** are prepared (step S**21**).

Next, the heat dissipator **13** is cast in which, in the opposing part **21** facing the printed circuit board **1**, the contact part **22**, which is brought into contact with the component region A**1** of the main surface SF**2** corresponding to the electrical component **4** and its surrounding region, protrudes relative to the portion of the opposing part **21** other than the contact part **22** (step S**22**).

Next, the heat dissipator **13** is worked such that the degree of flatness of the contact surface, in the contact part **22**, that is brought into contact with the component region Al, and the degree of flatness of the contact surface, in the heat dissipator **13**, that is brought into contact with the heat dissipation member **33** are higher than the degree of flatness of the surface of the opposing part **21** other than these contact surfaces (step S**23**).

Next, by passing the fixing member **3** through the printed circuit board **1** from the main surface SF**1** to the main surface SF**2** to be inserted in the heat dissipator **13** via the heat dissipation member **33**, the main surface SF**2** of the printed circuit board **1** and the heat dissipator **13** are fixed together in such as a manner as to be in contact with each other (step S**24**).

The other structures and operations are the same as those in the case of the electrical apparatus according to the first embodiment, and detailed description thereof is not repeated here.

As described above, in the electrical apparatus according to the third embodiment of the present invention, the fixing member **3** fixes the main surface SF**2** of the printed circuit board **1** and the heat dissipator **13** together, by passing through the printed circuit board **1** from the main surface SF**1** to the main surface SF**2** to be inserted in the heat dissipator **13**. In the opposing part **21** facing the printed circuit board **1**, the opposing part **21** being on the surface of the heat dissipator **13**, the contact part **22**, which is brought into contact with the component region A**1** of the main surface SF**2** corresponding to the electrical component **4** and its surrounding region, protrudes relative to the portion of the opposing part **21** other than the contact part **22**. In addition, the degree of flatness of the contact surface, in the contact part **22**, that is brought into contact with the component region A**1** is higher than the degree of flatness of the surface of the opposing part **21** other than the contact surface.

That is, in the third embodiment of the present invention, the heat dissipator **13** is produced through casting such that only the vicinity of the power device protrudes in the opposing part **21**. Then, by increasing the degree of flatness of the protruding contact part **22**, the degree of contact between the printed circuit board **1** and the heat dissipator **13** is increased in the portion where the heat dissipation effect is especially enhanced.

Further, in the electrical apparatus according to the third embodiment of the present invention, the fixing member **3** reaches the heat dissipator **13** by being inserted through the heat dissipation member **33** which is in close contact with the printed circuit board **1** and the heat dissipator **13** between the printed circuit board **1** and the heat dissipator **13**. In addition, the degree of flatness of the contact surface, in the contact part, that is brought into contact with the component region A**1**, and the degree of flatness of the contact surface, in the heat dissipator **13**, that is brought into contact with the heat dissipation member **33** are higher than the degree of flatness of the surface of the opposing part **21** other than these contact surfaces.

As described above, by providing the heat dissipation member **33**, and by increasing the degree of flatness of the contact surface, in the heat dissipator **13**, that is brought into contact with the heat dissipation member **33**, heat conduction from the electrical component **4** to the heat dissipator **13** is promoted. Thus, the heat dissipation effect can be enhanced.

Therefore, in the electrical apparatus according to the third embodiment of the present invention, as in the case of the electrical apparatus according to the first embodiment of the present invention, it is possible to improve the heat dissipation performance and to prevent increase of production costs.

Next, another embodiment of the present invention will be described with reference to the drawings. Note that the same or corresponding parts in the drawings are denoted by the same reference characters, and description thereof is not repeated.

<Fourth embodiment>

The present embodiment relates to an electrical apparatus in which the heat dissipation structure is changed compared with the electrical apparatus according to the first embodiment. The content other than that described below is the same as described with respect to the electrical apparatus according to the first embodiment.

FIG. **16** is a cross-sectional view showing a mounting structure of an electrical apparatus according to a fourth embodiment of the present invention.

With reference to FIG. **16**, an electrical apparatus **204** includes a heat dissipator **14** instead of the heat dissipator **11**, compared with the electrical apparatus according to the first embodiment of the present invention.

The printed circuit board **1** includes the main surface SF**1** and the main surface SF**2**, and the electrical component **4** is attached to the printed circuit board **1**.

The fixing member **3** fixes the main surface SF**2** of the printed circuit board **1** and the heat dissipator **14** together in such a manner as to be in contact with each other, by passing through the printed circuit board **1** from the main surface SF**1** to the main surface SF**2** to be inserted in the heat dissipator **14**.

In the opposing part **21** facing the printed circuit board **1**, the opposing part **21** being on a surface of the heat dissipator **14**, the contact part **22**, which is brought into contact with the screw region A**2** of the main surface SF**2** corresponding to the fixing member **3** and its surrounding region, protrudes relative to the portion of the opposing part **21** other than the contact part **22**.

The electrical component **4** includes a projecting, portion from the main surface SF**2** of the printed circuit board **1**, and a tip of the projecting portion is in contact with the heat dissipator **14**.

The degree of flatness of the contact surface, in the contact part **22**, that is brought into contact with the screw region A**2** and the degree of flatness of the contact surface, in the opposing part **21**, that is brought into contact with the electrical component **4** or the heat dissipation member **32** are higher than the degree of flatness of the surface of the opposing part **21** other than these contact surfaces.

FIG. **17** is a flow chart defining the procedure for producing the electrical apparatus according to the fourth embodiment of the present invention.

With reference to FIG. **17**, first, the printed circuit board **1** which includes the main surface SF**1** and the main surface SF**2** and to which the electrical component **4** is attached, the heat dissipator **14**, the fixing member **3** to be passed through the printed circuit board **1** from the main surface SF**1** to the main surface SF**2** are prepared (step S**31**).

Next, the heat dissipator **14** is cast in which, in the opposing part **21** facing the printed circuit board **1**, the contact part **22**, which is brought into contact with the screw region A**2** of the main surface SF**2** corresponding to the fixing member **3** and its surrounding region, protrudes relative to the portion of the opposing part **21** other than the contact part **22** (step S**32**).

Next, the heat dissipator **14** is worked such that the degree of flatness of the contact surface, in the contact part **22**, that is brought into contact with the screw region A**2**, and the degree of flatness of the contact surface, in the opposing part **21**, that is brought into contact with the electrical component **4** or the heat dissipation member **32** are higher than the degree of flatness of the surface of the opposing part **21** other than these contact surfaces (step S**33**).

Next, the electrical component **4** is caused to project from the main surface SF**2** of the printed circuit board **1** to be brought into contact with the heat dissipator **14**, at the tip of the projecting portion of the electrical component **4**, or the electrical component **4** is brought into contact with the heat dissipator **14**, via the heat dissipation member **32** provided between the electrical component **4** and the heat dissipator **14** (step S**34**).

Next, by passing the fixing member **3** through the printed circuit board **1** from the main surface SF**1** to the main surface SF**2** to be inserted in the heat dissipator **14**, the main surface SF**2** of the printed circuit board **1** and the electrical component **4**, and the heat dissipator **14** are fixed together in such a manner as to be contact with each other (step S**35**).

The other structures and operations are the same as those in the case of the electrical apparatus according to the first embodiment, and detailed description thereof is not repeated here.

As described above, in the electrical apparatus according to the fourth embodiment of the present invention, the fixing member **3** fixes the main surface SF**2** of the printed circuit board **1** and the heat dissipator **14** together in such a manner as to be in contact with each other, by passing through the printed circuit board **1** from the main surface SF**1** to the main surface SF**2** to be inserted in the heat dissipator **14**. In the opposing part **21** facing the printed circuit board **1**, the opposing part **21** being on the surface of the heat dissipator **14**, the contact part **22**, which is brought into contact with the screw region A**2** of the main surface SF**2** corresponding to the fixing member **3** and its surrounding region, protrudes relative to the portion of the opposing part **21** other than the contact part **22**. The electrical component **4** projects from the main surface SF**2** of the printed circuit board **1**, and is in contact with the heat dissipator **14** at the tip of the projecting portion of the electrical component **4** or is in contact with the heat dissipator **14** via the heat dissipation member **32** provided between the electrical component **4** and the heat dissipator **14**. Further, the degree of flatness of the contact surface, in the contact part **22**, that is brought into contact with the screw region A**2**, and the degree of flatness of the contact surface, in the opposing part **21**, that is brought into contact with the electrical component **4** or the heat dissipation member **32** are higher than the degree of flatness of the surface of the opposing part **21** other than these contact surfaces.

That is, in the fourth embodiment of the present invention, the heat dissipator **14** is produced through casting such that only the vicinity of the tapped hole protrudes in the opposing part **21**. Then, by increasing, on the surface of the heat dissipator **14**, the degree of flatness only of the contact surface of the protruding contact part **22** and the contact surface that is brought into contact with the electrical component **4** or the heat dissipation member **32**, the degree of contact between the printed circuit board **1** and the heat dissipator **14** is increased in the portion where the heat dissipation effect is especially enhanced.

With this structure, as in the case of the electrical apparatus according to the first embodiment of the present invention, it is possible to improve the heat dissipation performance and to prevent increase of production costs.

The above embodiments are to be considered in all respects as illustrative and not restrictive. The scope of the present invention is indicated by the appended claims rather than by the foregoing description, and all changes that come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

Description of the Reference Characters

1 printed circuit board
2 heat dissipator
3 fixing member
4 electrical component
7 washer
11, 12, 13, 14 heat dissipator
21 opposing part
22 contact part
32, 33 heat dissipation member
71 radio transmission section
72 radio reception section
81 signal processing section
82 digital/analog converter (DAC)
83 modulator
84 driver amplifier
85 power amplifier
86 transmission and reception filter
87 oscillator
89, 90 reception amplifier
91 mixer
92 BPF
93 analog/digital converter (ADC)
94 oscillator
101 remote radio head
102 body device
103 antenna
104 antenna pole
201, 202, 203, 204 electrical apparatus
A**1** component region
A**2** screw region
SF**1**, SF**2** main surface

The invention claimed is:

1. An electrical apparatus comprising:

a board which includes a first main surface and a second main surface and in which an electrical component is attached to the first main surface;

a heat dissipator; and

a fixing member which fixes the second main surface of the board and the heat dissipator together in such a manner as to be in contact with each other, by passing through the board from the first main surface to the second main surface to be inserted in the heat dissipator, wherein

in an opposing part facing the board, the opposing part being on a surface of the heat dissipator, a contact part which is directly brought into contact with a first region of the second main surface corresponding to the electrical component and a surrounding region of the electrical component and which is directly brought into contact with a second region of the second main surface corresponding to the fixing member and a surrounding region of the fixing member protrudes relative to a portion of the opposing part other than the contact part, and

the degree of flatness of a contact surface, in the contact part, that is brought into contact with the first region and the second region is higher than the degree of flatness of a surface of the opposing part other than the contact surface.

2. An electrical apparatus comprising:

a board which includes a first main surface and a second main surface and to which an electrical component is attached;

a heat dissipator, and

a fixing member which fixes the board and the heat dissipator together by passing through the board from the first main surface to the second main surface to be inserted in the heat dissipator, wherein

the electrical component includes a projecting portion projecting from the second main surface of the board, and a tip of the projecting portion is directly in contact with the heat dissipater, and

on the surface of the heat dissipator, the degree of flatness of a contact surface that is brought into contact with the projecting portion of the electrical component is higher than the degree of flatness of a surface of an opposing part other than the contact surface, the opposing part facing the board.

3. The electrical apparatus according to claim **2**, wherein

the fixing member reaches the heat dissipator by being inserted through a first heat dissipation member which is in close contact with the board and the heat dissipator between the board and the heat dissipator, and

on the surface of the heat dissipator, the degree of flatness of the contact surface that is brought into contact with the projecting portion of the electrical component and the degree of flatness of a contact surface that is brought into contact with the first heat dissipation member are higher than the degree of flatness of a surface of the opposing part other than these contact surfaces.

4. The electrical apparatus according to claim **2**, wherein

in the opposing part, a contact part which is directly brought into contact with a member region of the second main surface corresponding to the fixing member and a surrounding region of the fixing member protrudes relative to a portion of the opposing part other than the contact part, and

the degree of flatness of the contact surface, on the surface of the heat dissipator, that is directly brought into contact with the projecting portion of the electrical component or the first heat dissipation member, and the degree of flatness of a contact surface, in the contact part, that is brought into contact with the member region are higher than the degree of flatness of a surface of the opposing part other than these contact surfaces.

5. An electrical apparatus comprising:

a board which includes a first main surface and a second main surface and in which an electrical component is attached to the first main surface;

a heat dissipator; and

a fixing member which fixes the second main surface of the board and the heat dissipator together in such a manner as to be in contact with each other, by passing through the board from the first main surface to the second main surface to be inserted in the heat dissipator, wherein

in an opposing part facing the board, the opposing part being on a surface of the heat dissipator, a contact part which is directly brought into contact with a component region of the second main surface corresponding to the electrical component and a surrounding region of the electrical component protrudes relative to a portion of the opposing part other than the contact part, and

the fixing member reaches the heat dissipator by being inserted through a second heat dissipation member which is in close contact with the board and the heat dissipator between the board and the heat dissipator, and

the degree of flatness of a contact surface, in the contact part, that is brought into contact with the component region, and the degree of flatness of a contact surface, in the heat dissipator, that is brought into contact with the second heat dissipation member are higher than the degree of flatness of a surface of the opposing part other than these contact surfaces.

6. The electrical apparatus according to claim **1**, wherein

the electrical component is attached to a vicinity of the fixing member.

7. The electrical apparatus according to claim **1**, wherein

the electrical apparatus is a radio communication device which includes an amplifier for amplifying a radio signal, as the electrical component.

8. The electrical apparatus according to claim **2**, wherein

the electrical component is attached to a vicinity of the fixing member.

9. The electrical apparatus according to claim **5**, wherein

the electrical component is attached to a vicinity of the fixing member.

10. The electrical apparatus according to claim **2**, wherein

the electrical apparatus is a radio communication device which includes an amplifier for amplifying a radio signal, as the electrical component.

11. The electrical apparatus according to claim **5**, wherein

the electrical apparatus is a radio communication device which includes an amplifier for amplifying a radio signal, as the electrical component.

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