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(72) Inventors:

- **SOMEYA, Yukimichi**
Tokyo, 143-8555 (JP)
- **SHIMADA, Hiroyuki**
Tokyo, 143-8555 (JP)
- **FURUICHI, Yuusuke**
Tokyo, 143-8555 (JP)

(74) Representative: **J A Kemp LLP**
80 Turnmill Street
London EC1M 5QU (GB)

(71) Applicant: **Ricoh Company, Ltd.**
Tokyo 143-8555 (JP)

(57) A heating device (9) includes a rotator (20) and a heater (22) that is laminated and disposed opposite an inner face (20a) of the rotator (20). A thermal conductor (28) is disposed opposite the heater (22). A temperature detector (25) contacts the thermal conductor (28). A power breaker (27) interrupts power supply to the heater (22). The power breaker (27) is separated from the thermal conductor (28) and contacts the heater (22).

Description

BACKGROUND

Technical Field

[0001] Embodiments of this disclosure relate to a heating device and an image forming apparatus.

Related Art

[0002] Related-art image forming apparatuses, such as copiers, facsimile machines, printers, and multifunction peripherals (MFP) having two or more of copying, printing, scanning, facsimile, plotter, and other functions, typically form an image on a recording medium according to image data.

[0003] Such image forming apparatuses are installed with a heating device. As one example, the heating device is a fixing device that heats a recording medium such as a sheet to fix an unfixed image on the recording medium.

[0004] The fixing device includes a thermistor serving as a temperature detector, a thermostat serving as a power breaker, a heater, a fixing belt serving as a rotator, and a controller. Based on a temperature of the heater, that is detected by the thermistor, the controller controls power supply to the heater so that the heater heats the fixing belt to a proper temperature. If the heater overheats the fixing belt due to failure or the like, the thermostat interrupts power supply to the heater. Thus, the controller controls the heater that heats the fixing belt by using the thermistor and the thermostat.

[0005] For example, Japanese Unexamined Patent Application Publication No. 2014-102429 discloses a fixing device that includes a fixing film serving as a rotator, a laminated, ceramic heater serving as a heater, and a graphite sheet. The ceramic heater is disposed within a loop formed by the fixing film. The graphite sheet contacts the ceramic heater. The fixing device further includes a temperature detector and a power breaker. The temperature detector and the power breaker contact the ceramic heater directly through a slot of the graphite sheet. Accordingly, the temperature detector and the power breaker improve responsiveness.

[0006] In the fixing device disclosed by Japanese Unexamined Patent Application Publication No. 2014-102429, the temperature detector and the power breaker contact the ceramic heater directly. As the temperature detector contacts the ceramic heater, the temperature detector may cause uneven temperature of the ceramic heater in a longitudinal direction thereof, resulting in uneven temperature of the fixing film in a longitudinal direction thereof.

SUMMARY

[0007] It is a general object of the present disclosure

to provide an improved and useful heating device in which the above-mentioned problems are eliminated. In order to achieve the above-mentioned object, there is provided the heating device according to claim 1. Advantageous embodiments are defined by the dependent claims.

[0008] Advantageously, the heating device includes a rotator and a heater that is laminated and disposed opposite an inner face of the rotator. A thermal conductor is disposed opposite the heater. A temperature detector contacts the thermal conductor. A power breaker interrupts power supply to the heater. The power breaker is separated from the thermal conductor and contacts the heater.

[0009] It is another object of the present disclosure to provide an improved and useful image forming apparatus in which the above-mentioned problems are eliminated.

[0010] Advantageously, the image forming apparatus includes the heating device described above.

[0011] Accordingly, the temperature detector and the power breaker are disposed inside the heating device properly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] A more complete appreciation of embodiments of the present disclosure and many of the attendant advantages and features thereof can be readily obtained and understood from the following detailed description with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic cross-sectional view of an image forming apparatus according to an embodiment of the present disclosure;

FIG. 2 is a schematic side cross-sectional view of a fixing device according to an embodiment of the present disclosure, that is incorporated in the image forming apparatus depicted in FIG. 1;

FIG. 3 is a plan view of a heater incorporated in the fixing device depicted in FIG. 2, illustrating resistive heat generators incorporated in the heater;

FIG. 4 is a plan view of a heater including resistive heat generators having a shape that is different from a shape of the resistive heat generators of the heater depicted in FIG. 3;

FIG. 5 is a plan view of a heater including resistive heat generators having a shape that is different from the shapes of the resistive heat generators of the heaters depicted in FIGS. 3 and 4;

FIG. 6 is a diagram of a power supply circuit that supplies power to the heater depicted in FIG. 3;

FIG. 7 is a perspective view of a thermistor incorporated in the fixing device depicted in FIG. 2;

FIG. 8 is a cross-sectional view of a thermal element and peripheral elements of the thermistor depicted in FIG. 7;

FIG. 9 is a cross-sectional view of a thermostat and peripheral elements incorporated in the fixing device depicted in FIG. 2;

FIG. 10 is a side cross-sectional view of the fixing device depicted in FIG. 2, illustrating a heater holder, a first thermal equalization plate, and the heater incorporated therein;

FIG. 11 is a cross-sectional view of the fixing device, taken on line D1-D1 in FIG. 10;

FIG. 12 is a side cross-sectional view of a fixing device as a first modification example of the fixing device depicted in FIG. 2, illustrating the heater holder and the first thermal equalization plate incorporated therein;

FIG. 13 is a cross-sectional view of the fixing device, taken on line D2-D2 in FIG. 12;

FIG. 14 is a side cross-sectional view of a fixing device as a second modification example of the fixing device depicted in FIG. 2, illustrating a heater holder and a first thermal equalization plate incorporated therein;

FIG. 15 is a cross-sectional view of the fixing device, taken on line D3-D3 in FIG. 14;

FIG. 16 is a side cross-sectional view of a fixing device as a third modification example of the fixing device depicted in FIG. 2, illustrating a heater holder and a first thermal equalization plate incorporated therein;

FIG. 17 is a cross-sectional view of the fixing device, taken on line D4-D4 in FIG. 16;

FIG. 18 is a side cross-sectional view of a fixing device as a fourth modification example of the fixing device depicted in FIG. 2, illustrating a thermal insulator incorporated therein;

FIG. 19 is a plan view of a fixing device as a fifth modification example of the fixing device depicted in FIG. 2, illustrating bent portions of a first thermal equalization plate incorporated therein;

FIG. 20 is a side cross-sectional view of a fixing device as a sixth modification example of the fixing device depicted in FIG. 2, illustrating a heater holder incorporated therein;

FIG. 21 is a plan view of the heater depicted in FIG. 3, illustrating a temperature profile of a fixing belt incorporated in the fixing device depicted in FIG. 2 in a longitudinal direction of the fixing belt;

FIG. 22 is a diagram of the heater depicted in FIG. 4, illustrating a dividing region between the resistive heat generators;

FIG. 23 is a diagram of a heater including resistive heat generators that define a dividing region different from the dividing region depicted in FIG. 22;

FIG. 24 is a diagram of the heater depicted in FIG. 5, illustrating a dividing region between the resistive heat generators;

FIG. 25 is a perspective view of the heater, the first thermal equalization plate, and the heater holder incorporated in the fixing device depicted in FIG. 2;

FIG. 26 is a plan view of the heater depicted in FIG. 3, illustrating an arrangement of a first thermal equalization plate as a variation of the first thermal equal-

ization plate depicted in FIG. 25;

FIG. 27 is a schematic side cross-sectional view of a fixing device according to another embodiment of the present disclosure, that is different from the fixing device depicted in FIG. 2;

FIG. 28 is a perspective view of the heater, the first thermal equalization plate, second thermal equalization plates, and a heater holder incorporated in the fixing device depicted in FIG. 27;

FIG. 29 is a plan view of the heater depicted in FIG. 28, illustrating an arrangement of the first thermal equalization plate and the second thermal equalization plates;

FIG. 30 is a diagram of a crystalline structure of atoms of graphene;

FIG. 31 is a diagram of a crystalline structure of atoms of graphite;

FIG. 32 is a plan view of the heater depicted in FIG. 29, illustrating an arrangement of second thermal equalization plates as a variation of the second thermal equalization plates depicted in FIG. 29;

FIG. 33 is a schematic side cross-sectional view of a fixing device according to yet another embodiment of the present disclosure, that is different from the fixing devices depicted in FIGS. 2 and 27, respectively;

FIG. 34 is a side cross-sectional view of a fixing device as a seventh modification example of the fixing device depicted in FIG. 2, illustrating the first thermal equalization plate interposed between a thermal insulator and the heater incorporated therein;

FIG. 35 is a schematic side cross-sectional view of a fixing device according to yet another embodiment of the present disclosure, that is different from the fixing device depicted in FIG. 2;

FIG. 36 is a schematic side cross-sectional view of a fixing device according to yet another embodiment of the present disclosure, that is different from the fixing device depicted in FIG. 2;

FIG. 37 is a schematic side cross-sectional view of a fixing device according to yet another embodiment of the present disclosure, that is different from the fixing device depicted in FIG. 2;

FIG. 38 is a schematic cross-sectional view of an image forming apparatus according to another embodiment of the present disclosure, that is different from the image forming apparatus depicted in FIG. 1;

FIG. 39 is a schematic side cross-sectional view of a fixing device according to yet another embodiment of the present disclosure, that is incorporated in the image forming apparatus depicted in FIG. 38;

FIG. 40 is a plan view of a heater incorporated in the fixing device depicted in FIG. 39;

FIG. 41 is a perspective view of the heater depicted in FIG. 40 and a heater holder incorporated in the fixing device depicted in FIG. 39;

FIG. 42 is a perspective view of the heater depicted in FIG. 41 and a connector to be attached to the

heater;

FIG. 43 is a diagram of the thermistors, the thermostats, and flanges incorporated in the fixing device depicted in FIG. 39, illustrating an arrangement of the thermistors and the thermostats; and

FIG. 44 is a diagram of the flange depicted in FIG. 43, illustrating a slide groove of the flange.

[0013] The accompanying drawings are intended to depict embodiments of the present disclosure and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted. Also, identical or similar reference numerals designate identical or similar components throughout the several views.

DETAILED DESCRIPTION

[0014] In describing embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that have a similar function, operate in a similar manner, and achieve a similar result.

[0015] Referring now to the drawings, embodiments of the present disclosure are described below. As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

[0016] Referring to the attached drawings, the following describes the embodiments of the present disclosure. In the drawings, identical reference numerals are assigned to elements that are identical or equivalent and redundant descriptions of the elements are simplified or omitted properly. As one example of a heating device according to the embodiments of the present disclosure, the following describes a fixing device 9 that is installed in an image forming apparatus 100 and fixes a toner image on a sheet P serving as a recording medium.

[0017] FIG. 1 is a schematic cross-sectional view of the image forming apparatus 100 according to an embodiment of the present disclosure.

[0018] As illustrated in FIG. 1, the image forming apparatus 100 includes four image forming units 1Y, 1M, 1C, and 1Bk that are installed in an apparatus body of the image forming apparatus 100 such that the image forming units 1Y, 1M, 1C, and 1Bk are attached to and removed from the apparatus body of the image forming apparatus 100. The image forming units 1Y, 1M, 1C, and 1Bk have a similar construction. However, the image forming units 1Y, 1M, 1C, and 1Bk contain developers in different colors, that is, yellow, magenta, cyan, and black, respectively. The developers correspond to color separation components for a color image. Each of the image forming units 1Y, 1M, 1C, and 1Bk includes a photoconductor 2, a charger 3, a developing device 4, and a cleaner

5 er 5. The photoconductor 2 is drum-shaped and serves as an image bearer. The charger 3 charges a surface of the photoconductor 2. The developing device 4 supplies toner as the developer to the surface of the photoconductor 2 to form a toner image. The cleaner 5 cleans the surface of the photoconductor 2.

[0019] The image forming apparatus 100 further includes an exposure device 6, a sheet feeder 7 serving as a recording medium supply, a transfer device 8, the fixing device 9 serving as a heating device, and an output device 10. The exposure device 6 exposes the surface of each of the photoconductors 2 and forms an electrostatic latent image thereon. The image forming apparatus 100 further includes a sheet conveyance path 14. The sheet feeder 7 includes a sheet tray 16 (e.g., a paper tray), a feed roller 17, and a sheet detecting sensor 29. The sheet feeder 7 supplies a sheet P serving as a recording medium to the sheet conveyance path 14 serving as a recording medium conveyance path. The transfer device 8 transfers the toner image formed on each of the photoconductors 2 onto the sheet P. The fixing device 9 fixes the toner image transferred onto a surface of the sheet P thereon. The output device 10 ejects the sheet P onto an outside of the image forming apparatus 100. Each of the image forming units 1Y, 1M, 1C, and 1Bk, that includes the photoconductor 2 and the charger 3, the exposure device 6, the transfer device 8, and the like construct an image forming device that forms the toner image on the sheet P.

[0020] The transfer device 8 includes an intermediate transfer belt 11, four primary transfer rollers 12, and a secondary transfer roller 13. The intermediate transfer belt 11 is an endless belt serving as an intermediate transferor. The primary transfer rollers 12 serve as primary transferors. The secondary transfer roller 13 serves as a secondary transferor. The intermediate transfer belt 11 is stretched taut across a plurality of rollers. The primary transfer rollers 12 transfer yellow, magenta, cyan, and black toner images formed on the photoconductors 2 onto the intermediate transfer belt 11, respectively, thus forming a full color toner image on the intermediate transfer belt 11. The secondary transfer roller 13 transfers the full color toner image formed on the intermediate transfer belt 11 onto the sheet P. The plurality of primary transfer rollers 12 is pressed against the photoconductors 2, respectively, via the intermediate transfer belt 11. Accordingly, the intermediate transfer belt 11 contacts each of the photoconductors 2, forming a primary transfer nip therebetween. On the other hand, the secondary transfer roller 13 is pressed against one of the plurality of rollers across which the intermediate transfer belt 11 is stretched taut, via the intermediate transfer belt 11. Thus, a secondary transfer nip is formed between the secondary transfer roller 13 and the intermediate transfer belt 11.

[0021] The sheet conveyance path 14 is provided with a timing roller pair 15 at a position between the sheet feeder 7 and the secondary transfer nip defined by the secondary transfer roller 13. The sheet conveyance path

14 is provided with pairs of rollers, such as the timing roller pair 15, that serve as conveyors that convey the sheet P through the sheet conveyance path 14.

[0022] Referring to FIG. 1, a description is provided of printing processes performed by the image forming apparatus 100.

[0023] When the image forming apparatus 100 receives an instruction to start printing, a driver disposed inside the apparatus body of the image forming apparatus 100 drives and rotates the photoconductor 2 clockwise in FIG. 1 in each of the image forming units 1Y, 1M, 1C, and 1Bk. The charger 3 charges the surface of the photoconductor 2 uniformly at a high electric potential. The exposure device 6 exposes the charged surfaces of the photoconductors 2, respectively, according to image data (e.g., print data) sent from a terminal. Alternatively, if the image forming apparatus 100 is a copier, the exposure device 6 exposes the charged surfaces of the photoconductors 2, respectively, according to image data created by a scanner that reads an image on an original. Accordingly, the electric potential of an exposed portion on the surface of each of the photoconductors 2 decreases, forming an electrostatic latent image on the surface of each of the photoconductors 2. The developing device 4 of each of the image forming units 1Y, 1M, 1C, and 1Bk supplies toner to the electrostatic latent image formed on the photoconductor 2, forming a toner image thereon.

[0024] The toner images formed on the photoconductors 2 move and reach the primary transfer nips defined by the primary transfer rollers 12 in accordance with rotation of the photoconductors 2, respectively. The primary transfer rollers 12 transfer the toner images formed on the photoconductors 2 onto the intermediate transfer belt 11 driven and rotated counterclockwise in FIG. 1 successively such that the toner images are superimposed on the intermediate transfer belt 11, thus forming a full color toner image thereon. The full color toner image formed on the intermediate transfer belt 11 is conveyed to the secondary transfer nip defined by the secondary transfer roller 13 in accordance with rotation of the intermediate transfer belt 11. The secondary transfer roller 13 transfers the full color toner image onto a sheet P conveyed through the secondary transfer nip. The sheet P is supplied from the sheet tray 16. The timing roller pair 15 temporarily halts the sheet P supplied from the sheet feeder 7. Thereafter, the timing roller pair 15 conveys the sheet P to the secondary transfer nip at a time when the full color toner image formed on the intermediate transfer belt 11 reaches the secondary transfer nip. The secondary transfer roller 13 transfers the full color toner image onto the sheet P. Thus, the sheet P bears the full color toner image. After the toner image is transferred onto the intermediate transfer belt 11, the cleaner 5 removes residual toner remaining on the photoconductor 2 therefrom.

[0025] The sheet P transferred with the full color toner image is conveyed to the fixing device 9 that fixes the full

color toner image on the sheet P. Thereafter, the output device 10 ejects the sheet P onto the outside of the image forming apparatus 100, thus finishing a series of printing processes.

[0026] A description is provided of a construction of the fixing device 9.

[0027] As illustrated in FIG. 2, the fixing device 9 according to the embodiment includes a fixing belt 20, a pressure roller 21, a heater 22, a heater holder 23, a stay 24, thermistors 25, a first thermal equalization plate 28, and a thermostat. The fixing belt 20 serves as a rotator or a fixing rotator. The pressure roller 21 serves as an opposed rotator or a pressure rotator. The heater holder 23 serves as a holder. The stay 24 serves as a support. The thermistors 25 serve as temperature detectors. The first thermal equalization plate 28 serves as a thermal conductor. The fixing belt 20 is an endless belt. The pressure roller 21 contacts an outer circumferential face of the fixing belt 20 to form a fixing nip N between the fixing belt 20 and the pressure roller 21. The heater 22 heats the fixing belt 20. The heater holder 23 holds or supports the heater 22. The stay 24 supports the heater holder 23. Each of the thermistors 25 contacts a back face of a base 30 of the heater 22 and detects a temperature of the heater 22. The fixing device 9 is installed with the fixing rotator as an embodiment of a rotator installed in a heating device. The fixing device 9 according to the embodiment incorporates the fixing belt 20 as one example of the fixing rotator.

[0028] The fixing belt 20, the pressure roller 21, the heater 22, the heater holder 23, the stay 24, the first thermal equalization plate 28, and the fixing device 9 extend in a longitudinal direction that is perpendicular to a paper surface in FIG. 2. The longitudinal direction is parallel to a belt width direction of the fixing belt 20, an axial direction of the pressure roller 21, and a width direction of a sheet P conveyed through the fixing nip N. The width direction of the sheet P is perpendicular to a sheet conveyance direction A3 and a thickness direction of the sheet P.

[0029] The fixing belt 20 includes a base layer, as a tubular base, that is made of polyimide (PI) and has an outer diameter of 25 mm and a thickness in a range of from 40 μm to 120 μm , for example. The fixing belt 20 further includes a release layer serving as an outermost surface layer. The release layer is made of fluororesin, such as perfluoroalkoxy alkane (PFA) and polytetrafluoroethylene (PTFE), and has a thickness in a range of from 5 μm to 50 μm to enhance durability of the fixing belt 20 and facilitate separation of the sheet P and a foreign substance from the fixing belt 20. Optionally, an elastic layer that is made of rubber or the like and has a thickness in a range of from 50 μm to 500 μm may be interposed between the base layer and the release layer. According to the embodiment, the fixing belt 20 is a rubber-less belt that does not include the elastic layer. The base layer of the fixing belt 20 may be made of heat-resistant resin such as polyetheretherketone (PEEK) or metal such as nickel (Ni) and stainless used steel (SUS), instead of

polyimide. The fixing belt 20 may include an inner circumferential face 20a that is coated with polyimide, PTFE, or the like to produce a sliding layer.

[0030] The pressure roller 21 has an outer diameter of 25 mm, for example. The pressure roller 21 includes a core metal 21a, an elastic layer 21b disposed on a surface of the core metal 21a, and a release layer 21c disposed on an outer surface of the elastic layer 21b. The core metal 21a is solid and made of iron. The elastic layer 21b is made of silicone rubber and has a thickness of 3.5 mm, for example. In order to enhance separation of the sheet P from the pressure roller 21, the elastic layer 21b is preferably coated with the release layer 21c that is made of fluororesin and has a thickness of approximately 40 μm , for example.

[0031] The fixing device 9 further includes a biasing member that biases and moves the pressure roller 21 toward the fixing belt 20, pressing the pressure roller 21 against the heater 22 via the fixing belt 20. Thus, the fixing nip N serving as a nip is formed between the fixing belt 20 and the pressure roller 21. The fixing device 9 further includes a driver that drives and rotates the pressure roller 21. As the pressure roller 21 rotates in a rotation direction A1, the pressure roller 21 drives and rotates the fixing belt 20 in a rotation direction A2.

[0032] The heater 22 contacts the inner circumferential face 20a of the fixing belt 20. According to the embodiment, the heater 22 presses against the pressure roller 21 via the fixing belt 20, thus serving as a nip formation pad that forms the fixing nip N between the fixing belt 20 and the pressure roller 21. The fixing belt 20 also serves as a heated member that is heated by the heater 22. In other words, the heater 22 heats the sheet P conveyed through the fixing nip N through the fixing belt 20.

[0033] The heater 22 is a laminated heater that extends in the longitudinal direction thereof throughout an entire span of the fixing belt 20 in the longitudinal direction thereof. The heater 22 includes the base 30 (e.g., a substrate) that is platy, a plurality of resistive heat generators 31 that is disposed on the base 30, and an insulating layer 32 that coats the resistive heat generators 31. The insulating layer 32 of the heater 22 contacts the inner circumferential face 20a of the fixing belt 20. The resistive heat generators 31 generate heat that is conducted to the fixing belt 20 through the insulating layer 32. According to the embodiment, the resistive heat generators 31 and the insulating layer 32 are mounted on a fixing belt opposed face of the base 30, that is disposed opposite the fixing belt 20 and the fixing nip N. Alternatively, the resistive heat generators 31 and the insulating layer 32 may be mounted on a heater holder opposed face of the base 30, that is disposed opposite the heater holder 23. In this case, heat generated by the resistive heat generators 31 is conducted to the fixing belt 20 through the base 30. Hence, the base 30 is preferably made of a material having an enhanced thermal conductivity, such as aluminum nitride. Since the base 30 is made of the material having the enhanced thermal conductivity, even

if the resistive heat generators 31 are disposed opposite the fixing belt 20 via the base 30, the resistive heat generators 31 heat the fixing belt 20 sufficiently.

[0034] The heater holder 23 and the stay 24 are disposed within a loop formed by the fixing belt 20. The stay 24 includes a channel made of metal. The stay 24 has both lateral ends in the longitudinal direction thereof, that are supported by side plates of the fixing device 9, respectively. Since the stay 24 supports the heater holder 23 and the heater 22, in a state in which the pressure roller 21 is pressed against the fixing belt 20, the heater 22 receives pressure from the pressure roller 21 precisely. Thus, the fixing nip N is formed between the fixing belt 20 and the pressure roller 21 stably. According to the embodiment, the heater holder 23 has a thermal conductivity that is smaller than a thermal conductivity of the base 30.

[0035] Since the heater holder 23 is subject to high temperatures by heat from the heater 22, the heater holder 23 is preferably made of a heat-resistant material. For example, if the heater holder 23 is made of heat-resistant resin having a decreased thermal conductivity, such as liquid crystal polymer (LCP) and PEEK, the heater holder 23 suppresses conduction of heat thereto from the heater 22. Accordingly, the heater 22 heats the fixing belt 20 efficiently.

[0036] The heater holder 23 includes a holding recess 23b that holds the heater 22.

[0037] As illustrated in FIG. 2, the fixing device 9 further includes a plurality of guide ribs 26 that is combined with the heater holder 23 and guides the fixing belt 20. The guide rib 26 is disposed at each of an upstream part and a downstream part of the heater holder 23 in the sheet conveyance direction A3. The plurality of guide ribs 26 is arranged in the longitudinal direction of the heater holder 23.

[0038] The guide rib 26 is substantially fan-shaped. The guide rib 26 includes a guide face 260 that is curved along the inner circumferential face 20a of the fixing belt 20. The guide face 260 defines an arc or a projecting curved face that extends in a circumferential direction of the fixing belt 20.

[0039] The heater holder 23 includes a detecting portion through hole 23a1 that penetrates through a body of the heater holder 23 in a thickness direction thereof. The thermistor 25 is placed in the detecting portion through hole 23a1 as described below in detail. The fixing device 9 incorporates a lateral end thermistor 25A and a center thermistor 25B depicted in FIG. 6 that are referred to as the thermistors 25.

[0040] The first thermal equalization plate 28 is made of a material having a thermal conductivity greater than a thermal conductivity of the base 30. According to the embodiment, the first thermal equalization plate 28 is a plate that has a thickness of 0.3 mm and is made of aluminum. Alternatively, the first thermal equalization plate 28 may be made of copper, silver, graphene, or graphite, for example. Since the first thermal equalization plate 28

is platy, the first thermal equalization plate 28 improves accuracy of positioning of the heater 22 with respect to the heater holder 23 and the first thermal equalization plate 28. The first thermal equalization plate 28 facilitates conduction of heat generated by the heater 22 in the longitudinal direction thereof, achieving even temperature of the heater 22 and the fixing belt 20 in the longitudinal direction thereof. Since the first thermal equalization plate 28 is made of metal, the first thermal equalization plate 28 is machined readily with improved accuracy in dimension.

[0041] A description is provided of a method for calculating the thermal conductivity described above.

[0042] A thermal diffusivity of a target object was measured and a thermal conductivity was calculated based on the thermal diffusivity.

[0043] The thermal diffusivity was measured with a thermal diffusivity-thermal conductivity measurement device, ai-Phase Mobile 1u, manufactured by ai-Phase Co., Ltd.

[0044] The thermal diffusivity was converted into the thermal conductivity based on a density and a specific heat capacity. The density was measured with a dry-process pycnometer, Accupyc 1330, manufactured by Shimadzu Corporation. The specific heat capacity was measured with a differential scanning calorimeter, DSC-60, manufactured by Shimadzu Corporation. Sapphire was used as a reference material having a known specific heat capacity. According to an embodiment, the specific heat capacity was measured five times to obtain an average at 50 degrees Celsius. Based on a density ρ , a specific heat capacity S , and a thermal diffusivity α obtained by the above-described measurement of the thermal diffusivity, a thermal conductivity λ is obtained by a formula (1) below.

$$\lambda = \rho \times S \times \alpha \cdots \cdots \cdots (1)$$

[0045] In the fixing device 9 according to the embodiment, when printing starts, the driver drives and rotates the pressure roller 21 and the fixing belt 20 starts rotation in accordance with rotation of the pressure roller 21. Since the inner circumferential face 20a of the fixing belt 20 is contacted and guided by the guide faces 260 of the guide ribs 26, the fixing belt 20 rotates stably and smoothly. Additionally, as power is supplied to the resistive heat generators 31 of the heater 22, the heater 22 heats the fixing belt 20. In a state in which the temperature of the fixing belt 20 reaches a predetermined target temperature (e.g., a fixing temperature), as a sheet P bearing an unfixed toner image is conveyed through the fixing nip N formed between the fixing belt 20 and the pressure roller 21 in the sheet conveyance direction A3 as illustrated in FIG. 2, the fixing belt 20 and the pressure roller 21 fix the unfixed toner image on the sheet P under heat and pressure.

[0046] Referring to FIG. 3, a detailed description is pro-

vided of a construction of the heater 22 of the fixing device 9.

[0047] FIG. 3 is a plan view of the heater 22 according to the embodiment.

[0048] As illustrated in FIG. 3, the base 30 is platy and has a mount face (e.g., a surface) that mounts the plurality of resistive heat generators 31 (e.g., the four resistive heat generators 31), feeders 33A and 33B serving as conductors, a first electrode 34A, and a second electrode 34B. The number of the resistive heat generators 31 is not limited to four.

[0049] FIG. 3 illustrates a longitudinal direction X (e.g., a horizontal direction in FIG. 3) of the heater 22 and the like, that is perpendicular to the paper surface in FIG. 2. The longitudinal direction X also defines an arrangement direction in which the plurality of resistive heat generators 31 is arranged. FIG. 3 illustrates an orthogonal direction Y (e.g., a vertical direction in FIG. 3) that is perpendicular to or intersects the arrangement direction of the resistive heat generators 31 and is different from a thickness direction of the base 30.

[0050] The orthogonal direction Y extends along the mount face of the base 30, that mounts the resistive heat generators 31. The orthogonal direction Y is parallel to a short direction of the heater 22 or the sheet conveyance direction A3 in which the sheet P is conveyed through the fixing device 9.

[0051] The heater 22 includes a heat generation portion 35 that is divided into the plurality of resistive heat generators 31 arranged in the arrangement direction, that is, the longitudinal direction X of the heater 22. The resistive heat generators 31 are electrically connected in parallel to a pair of electrodes, that is, the first electrode 34A and the second electrode 34B, through the feeders 33A and 33B. The first electrode 34A and the second electrode 34B are mounted on one lateral end (e.g., a left end in FIG. 3) of the base 30 in the longitudinal direction X thereof. Each of the feeders 33A and 33B is made of a conductor having a resistance value smaller than a resistance value of the resistive heat generator 31. The adjacent resistive heat generators 31 define a gap therebetween, that is 0.2 mm or greater, preferably 0.4 mm or greater, in view of ensuring insulation between the adjacent resistive heat generators 31. If the gap between the adjacent resistive heat generators 31 is excessively great, the fixing belt 20 is subject to temperature decrease at an opposed portion thereof that is disposed opposite the gap. Hence, the gap is 5 mm or smaller, preferably 1 mm or smaller, in view of suppressing uneven temperature of the fixing belt 20 in the longitudinal direction X thereof.

[0052] The resistive heat generators 31 are made of a material having a positive temperature coefficient (PTC) property that is characterized in that the resistance value increases, that is, a heater output decreases, as the temperature increases.

[0053] Since the resistive heat generators 31 have the PTC property and the heat generation portion 35 is di-

vided into the plurality of resistive heat generators 31 in the longitudinal direction X of the heater 22, the heater 22 prevents overheating of the fixing belt 20 when sheets P having a decreased size are conveyed over the fixing belt 20. For example, if a sheet P having a decreased width that is smaller than an entire length of the heat generation portion 35 in the longitudinal direction X of the heater 22 is conveyed through the fixing nip N, since the sheet P does not draw heat from the fixing belt 20 in an outboard span that is outboard from the sheet P in the longitudinal direction X of the fixing belt 20, the resistive heat generators 31 in the outboard span are subject to temperature increase. Since a constant voltage is applied to the resistive heat generators 31, when the temperature of the resistive heat generators 31 in the outboard span increases and the resistance value thereof increases, conversely, an output (e.g., a heat generation amount) of the resistive heat generators 31 decreases relatively, suppressing temperature increase of the resistive heat generators 31 that are disposed in both lateral end spans of the heat generation portion 35 in the longitudinal direction X thereof. Additionally, the plurality of resistive heat generators 31 is electrically connected in parallel, suppressing temperature increase in a non-conveyance span where the sheet P is not conveyed over the fixing belt 20 while the fixing device 9 retains a printing speed at which a toner image is fixed on the sheet P. Alternatively, the heat generation portion 35 may include heat generators other than the resistive heat generators 31 having the PTC property. The resistive heat generators 31 may be arranged in a plurality of columns in the orthogonal direction Y of the heater 22.

[0054] For example, the resistive heat generator 31 is produced as below. Silver-palladium (AgPd), glass powder, and the like are mixed into paste. The paste coats the base 30 by screen printing or the like. Thereafter, the base 30 is subject to firing. According to the embodiment, the resistive heat generator 31 has a resistance value of 80 Ω at an ambient temperature. Alternatively, the resistive heat generator 31 may be made of a resistive material such as a silver alloy (AgPt) and ruthenium oxide (RuO_2). The feeders 33A and 33B, the first electrode 34A, and the second electrode 34B are made of a material prepared with silver (Ag) or silver-palladium (AgPd) by screen printing or the like. Each of the feeders 33A and 33B is made of a conductor having a resistance value smaller than a resistance value of the resistive heat generator 31.

[0055] The base 30 is preferably made of ceramics, such as alumina and aluminum nitride, or a nonmetallic material, such as glass and mica, having an enhanced heat resistance and an enhanced insulation. According to the embodiment, the base 30 is made of alumina and has a short width of 8 mm in the orthogonal direction Y, a longitudinal length of 270 mm in the longitudinal direction X, and a thickness of 1.0 mm. Alternatively, the base 30 may include a conductive layer made of metal or the like and an insulating layer disposed on the conductive

layer. The metal of the base 30 is preferably aluminum, stainless steel, or the like that is available at reduced costs. The base 30 made of a stainless steel plate suppresses breakage due to thermal stress. In order to improve evenness of heat conducted from the heater 22 so as to enhance quality of an image formed on a sheet P, the base 30 may be made of a material that has an increased thermal conductivity such as copper, graphite, and graphene.

[0056] The insulating layer 32 is made of heat-resistant glass and has a thickness of 75 μm , for example. The insulating layer 32 covers the resistive heat generators 31 and the feeders 33A and 33B and insulates and protects the resistive heat generators 31 and the feeders 33A and 33B. Additionally, the insulating layer 32 retains sliding of the fixing belt 20 over the heater 22.

[0057] According to the embodiment, the first electrode 34A and the second electrode 34B are disposed in an identical lateral end span of the heater 22 in the longitudinal direction X thereof. Alternatively, the first electrode 34A and the second electrode 34B may be disposed in one lateral end span and another lateral end span of the heater 22 in the longitudinal direction X thereof, respectively. The resistive heat generator 31 may have shapes that are not limited to a shape according to the embodiment. For example, FIG. 4 illustrates a heater 22A that includes resistive heat generators 31A, each of which is rectangular. FIG. 5 illustrates a heater 22B that includes resistive heat generators 31B, each of which includes a linear portion. The linear portion turns to define a parallelogram substantially. As illustrated in FIG. 4, the heater 22A includes an extension that extends from the resistive heat generator 31A having a block shape to the feeder 33A or 33B in the orthogonal direction Y. The extension may be a part of the resistive heat generator 31A or may be made of a material equivalent to a material of the feeder 33A or 33B.

[0058] FIG. 6 is a diagram of the heater 22 according to the embodiment, illustrating a power supply circuit that supplies power to the heater 22.

[0059] As illustrated in FIG. 6, according to the embodiment, the power supply circuit for supplying power to the resistive heat generators 31 includes an alternating current power supply 200 that is electrically connected to the first electrode 34A and the second electrode 34B of the heater 22. The power supply circuit further includes a triac 210 that controls an amount of power supplied to the resistive heat generators 31. The power supply circuit further includes a controller 220 that controls the amount of power supplied to each of the resistive heat generators 31 through the triac 210 based on temperatures of the resistive heat generators 31, that are detected by the lateral end thermistor 25A and the center thermistor 25B, respectively. The controller 220 includes a microcomputer that includes a central processing unit (CPU), a read only memory (ROM), a random access memory (RAM), and an input-output (I/O) interface. The controller 220 may be located inside the fixing device 9 or the apparatus

body of the image forming apparatus 100.

[0060] According to the embodiment, the lateral end thermistor 25A serving as a first temperature detector is disposed opposite one lateral end span of the heater 22 in the longitudinal direction X thereof. The center thermistor 25B serving as a second temperature detector is disposed opposite a center span of the heater 22 in the longitudinal direction X thereof, that is, a minimum sheet conveyance span where a minimum size sheet P available in the fixing device 9 is conveyed. The fixing device 9 further includes a thermostat 27 that is disposed opposite another lateral end span of the heater 22 in the longitudinal direction X thereof. The thermostat 27 serves as a power breaker that interrupts power supply to the resistive heat generators 31 when a temperature of the heater 22 is a predetermined temperature or higher.

[0061] A description is provided of a construction of the thermistors 25 and the thermostat 27 according to the embodiment in more detail.

[0062] As illustrated in FIG. 2, the fixing device 9 further includes a spring 255 that generates a biasing force that presses a thermal element 251 depicted in FIG. 7 of the thermistor 25 against a back face of the first thermal equalization plate 28 through the detecting portion through hole 23a1 of the heater holder 23.

[0063] As illustrated in FIG. 7, the thermistor 25 includes the thermal element 251 serving as a detecting portion, a frame 252, conducting wires 253, a heat-resistant film 254, the spring 255 depicted in FIG. 2, and a thermal insulator 256 depicted in FIG. 8.

[0064] The frame 252 is made of an insulating material. According to the embodiment, the frame 252 is made of resin. Alternatively, the frame 252 may be made of other materials. The frame 252 is provided with a slot 252a serving as a through hole that penetrates through the frame 252.

[0065] The thermistor 25 includes a pair of lead wires that extends from an interior of the frame 252. The lead wires support the thermal element 251 at a substantially center of the slot 252a in a width direction of the frame 252. The thermal element 251 includes an outer circumferential face that is coated with glass that absorbs infrared light. Instead of the thermal element 251 according to the embodiment, general thermistors, such as a diode-shape thermistor, a bead-shape thermistor, a chip-shape thermistor, and a thin film thermistor, may be employed properly.

[0066] The two conducting wires 253 supply power from a power supply disposed outside the thermistor 25 to the thermistor 25. The conducting wires 253 extend from one end of the frame 252 to an outside of the frame 252. The conducting wires 253 are electrically connected to the thermal element 251 through a metal plate and lead wires disposed inside the frame 252.

[0067] The heat-resistant film 254 is attached to a bottom face of the frame 252. The bottom face is a back face of the frame 252, that is on a surface of the paper on which FIG. 7 is drawn. The heat-resistant film 254

seals a hypothetical bottom face of the slot 252a. The heat-resistant film 254 is made of polyimide resin, for example.

[0068] As illustrated in FIG. 8, the thermal insulator 256 is disposed opposite the first thermal equalization plate 28 via the heat-resistant film 254 and covers a circumference of the thermal element 251. The thermal insulator 256 is made of nonwoven fabric having heat resistance and elasticity, for example.

[0069] As illustrated in FIG. 9, the thermostat 27 includes a thermosensitive portion 271, a holding portion 272, and a spring 273. The thermosensitive portion 271 is made of metal. The spring 273 biases the holding portion 272 and the thermosensitive portion 271 against the heater 22. When the thermosensitive portion 271 is deformed in a predetermined amount or more by heat from the heater 22, the thermostat 27 interrupts power supply to the heater 22.

[0070] FIG. 10 is a cross-sectional view of the heater holder 23, the first thermal equalization plate 28, and the heater 22, seen from an upper position or a lower position of the fixing device 9 depicted in FIG. 2. FIG. 11 is a cross-sectional view of the heater holder 23 and the first thermal equalization plate 28, taken on line D1-D1 in FIG. 10. FIGS. 10 and 11 illustrate the longitudinal direction X of the heater 22, the heater holder 23, and the first thermal equalization plate 28 of the fixing device 9. FIG. 10 illustrates a thickness direction Z of the heater 22 and the first thermal equalization plate 28 of the fixing device 9. FIG. 11 illustrates the orthogonal direction Y (e.g., the short direction) of the heater 22 and the first thermal equalization plate 28 of the fixing device 9. The orthogonal direction Y of the heater 22 and the first thermal equalization plate 28 intersects the longitudinal direction X thereof. According to the embodiment, the orthogonal direction Y is perpendicular to the longitudinal direction X.

[0071] As illustrated in FIGS. 10 and 11, the first thermal equalization plate 28 includes bent portions 28b that are disposed at both lateral ends of the first thermal equalization plate 28 in the longitudinal direction X thereof, respectively. As the bent portions 28b are inserted into holes of the heater holder 23, respectively, the heater holder 23 holds the first thermal equalization plate 28. The lateral end thermistor 25A, the center thermistor 25B, and the thermostat 27 contact a back face of the first thermal equalization plate 28 or the heater 22 and are arranged in the longitudinal direction X. The lateral end thermistor 25A, the center thermistor 25B, and the thermostat 27 are disposed opposite a heating region E of the heater 22. The heating region E is defined by the resistive heat generators 31 arranged in the longitudinal direction X of the heater 22. The first thermal equalization plate 28 is longer than the heating region E in the longitudinal direction X of the heater 22.

[0072] The first thermal equalization plate 28 and the heater 22 are fitted to the holding recess 23b of the heater holder 23. The holding recess 23b is longer than the heater 22 and the first thermal equalization plate 28 in the

longitudinal direction X thereof. Hence, the holding recess 23b allows thermal expansion of the heater 22 and the first thermal equalization plate 28.

[0073] The thermal element 251 depicted in FIG. 7 of each of the lateral end thermistor 25A and the center thermistor 25B is disposed opposite the first thermal equalization plate 28 through the detecting portion through hole 23a1 of the heater holder 23. One end of the detecting portion through hole 23a1 is open and faces the first thermal equalization plate 28. As illustrated in FIG. 9, the heater holder 23 includes a first thermosensitive portion through hole 23a2. The first thermal equalization plate 28 includes a second thermosensitive portion through hole 28a. The thermosensitive portion 271 of the thermostat 27 contacts the back face of the base 30 of the heater 22 through the first thermosensitive portion through hole 23a2 and the second thermosensitive portion through hole 28a. Thus, the first thermosensitive portion through hole 23a2 and the second thermosensitive portion through hole 28a define holes that cause the thermosensitive portion 271 of the thermostat 27 to contact the heater 22. The first thermosensitive portion through hole 23a2 communicates with one end of the second thermosensitive portion through hole 28a. Another end of the second thermosensitive portion through hole 28a is open and faces the heater 22.

[0074] The thermal element 251 of the thermistor 25 is disposed opposite the first thermal equalization plate 28, suppressing uneven temperature of the fixing belt 20. For example, as illustrated in FIG. 8, the thermal insulator 256 having an enhanced thermal insulation covers the circumference of the thermal element 251 of the thermistor 25. The heat-resistant film 254 is interposed between the first thermal equalization plate 28 and the thermal element 251. Hence, if the thermistor 25 penetrates through the first thermal equalization plate 28 and contacts the heater 22, the thermistor 25 may degrade conduction of heat from the heater 22 by the first thermal equalization plate 28 in the longitudinal direction X thereof, generating uneven temperature of the heater 22 and the fixing belt 20 in the longitudinal direction X thereof. To address the circumstance, according to the embodiment, the thermal element 251 is disposed opposite the first thermal equalization plate 28, suppressing uneven temperature of the fixing belt 20 and uneven gloss of a toner image formed on a sheet P.

[0075] Since the thermostat 27 contacts the heater 22 directly, the thermostat 27 improves responsiveness. For example, with a configuration in which the thermostat 27 contacts the first thermal equalization plate 28 like the thermistor 25, if the heater 22 generates heat excessively, the first thermal equalization plate 28 may conduct and equalize the heat generated by the heater 22 in the longitudinal direction X thereof, elongating a time taken before the thermostat 27 interrupts power supply to the heater 22. To address the circumstance, according to the embodiment, the thermostat 27 improves responsiveness and detects overheating of the heater 22 earlier,

suppressing breakage of an element that is disposed inside the fixing device 9 and is easily affected by heat such as the thermal element 251 of the thermistor 25.

[0076] As described above, according to the embodiment, the thermistor 25 and the thermostat 27 are disposed inside the fixing device 9 properly according to a property of each of the thermistor 25 and the thermostat 27, achieving even temperature of the fixing belt 20 in the longitudinal direction X thereof and improving responsiveness of the thermostat 27. According to the embodiment, as illustrated in FIG. 2, the thermistor 25 disposed within the loop formed by the fixing belt 20 contacts the first thermal equalization plate 28 through the detecting portion through hole 23a1 of the heater holder 23. The thermostat 27 disposed within the loop formed by the fixing belt 20 contacts the heater 22 through the first thermosensitive portion through hole 23a2 of the heater holder 23 and the second thermosensitive portion through hole 28a of the first thermal equalization plate 28.

[0077] The embodiment of the present disclosure described above is preferably applied to the heater 22 incorporating the base 30 made of ceramics. The base 30 is subject to breakage caused by thermal stress due to sharp temperature increase. The fixing device 9 according to the embodiment suppresses breakage of the thermistor 25 effectively.

[0078] With a configuration of a heating device including a rotator (e.g., the fixing belt 20) that does not incorporate an elastic layer, the rotator has a decreased thermal capacity and is subject to uneven temperature in the longitudinal direction X thereof. Hence, the heating device is preferably applied with the embodiment described above.

[0079] Each of the first thermal equalization plate 28 and the thermosensitive portion 271 of the thermostat 27 is preferably made of metal. The first thermal equalization plate 28 and the thermosensitive portion 271 of the thermostat 27 are made of a common material more preferably. Accordingly, a difference in thermal conductivity decreases between an opposed portion of the heater 22, that is disposed opposite the thermostat 27, and other portion of the heater 22, that is disposed outboard from the opposed portion in the longitudinal direction X of the heater 22, thus suppressing uneven temperature of the heater 22 in the longitudinal direction X thereof. The first thermal equalization plate 28 is made of metal, facilitating machining, improving assembly, and reducing manufacturing costs.

[0080] As illustrated in FIG. 9, the base 30 of the heater 22 includes a downstream face 30a in the rotation direction A2 of the fixing belt 20. The heater holder 23 includes a downstream face 23e in the rotation direction A2 of the fixing belt 20. The downstream face 23e abuts on the holding recess 23b. As the downstream face 30a of the base 30 of the heater 22 contacts the downstream face 23e of the heater holder 23, the heater holder 23 positions the heater 22. As the fixing belt 20 rotates in the rotation direction A2, a rotation force of the fixing belt 20 presses

the downstream face 30a of the base 30 against the downstream face 23e of the heater holder 23, positioning the heater 22 with respect to the heater holder 23. Hence, while the fixing belt 20 rotates in the rotation direction A2, the fixing belt 20 prevents the heater 22 from shifting from the heater holder 23. Accordingly, the heater 22 is positioned with respect to the first thermal equalization plate 28 precisely, causing the first thermal equalization plate 28 to equalize heat generated by the heater 22 in the longitudinal direction X thereof properly.

[0081] A description is provided of modification examples of the first thermal equalization plate 28 and the like.

[0082] The following describes constructions that are different from the construction of the fixing device 9 described above. A description of other constructions that are common to the construction described above is omitted properly.

[0083] FIGS. 12 and 13 illustrate a fixing device 9A according to an embodiment of the present disclosure as a first modification example of the fixing device 9. FIG. 12 is a side cross-sectional view of the fixing device 9A. FIG. 13 is a cross-sectional view of the fixing device 9A, taken on line D2-D2 in FIG. 12.

[0084] The fixing device 9A includes a heater holder 23A incorporating a plurality of projections 23b 1 that is disposed opposite the thermostat 27 and extended in a span of the thermostat 27 in the longitudinal direction X of the heater holder 23A. The projections 23b1 decrease a width of the holding recess 23b in the orthogonal direction Y of the heater holder 23A. The projections 23b1 are mounted on both ends of the holding recess 23b in the orthogonal direction Y of the heater holder 23A, respectively. The fixing device 9A further includes a first thermal equalization plate 28A that has a width smaller than a width of the heater 22 in the orthogonal direction Y of the first thermal equalization plate 28A.

[0085] According to the embodiment, the projections 23b1 disposed opposite the thermostat 27 and extended in the span of the thermostat 27 in the longitudinal direction X of the heater holder 23A position the first thermal equalization plate 28A with respect to the heater holder 23A. Accordingly, the first thermal equalization plate 28A is positioned with respect to the heater holder 23A with improved accuracy. The thermostat 27 is positioned with respect to the first thermal equalization plate 28A with improved accuracy. The thermosensitive portion 271 of the thermostat 27 is separated from the first thermal equalization plate 28A precisely. According to the embodiment, the projections 23b 1 disposed opposite the thermostat 27 and extended in the span of the thermostat 27 in the longitudinal direction X of the heater holder 23A position the first thermal equalization plate 28A with respect to the heater holder 23A. While the heater 22 heats the first thermal equalization plate 28A, the first thermal equalization plate 28A thermally expands from a bent portion 28c (e.g., a folded portion) depicted in FIG. 14 bidirectionally in the longitudinal direction X of the first thermal equalization plate 28A. Hence, the projections

23b 1 position the thermostat 27 with respect to the first thermal equalization plate 28A with improved accuracy.

[0086] Alternatively, conversely to the projections 23b1 depicted in FIG. 13, the first thermal equalization plate 28A may include projections that project vertically in FIG. 13. The first thermal equalization plate 28A may be disposed opposite the heater holder 23A with a decreased interval therebetween so that the projections position the first thermal equalization plate 28A with respect to the heater holder 23A. However, according to the embodiment, the heater holder 23A incorporates the projections 23b1 that are manufactured at reduced costs compared to the projections produced by machining the first thermal equalization plate 28A made of a plate. Alternatively, instead of the projections 23b1 that are extended in a part of the holding recess 23b in the longitudinal direction X thereof, the holding recess 23b may include a holding portion that holds the first thermal equalization plate 28A. The holding portion may have a decreased width in the orthogonal direction Y throughout an entire span of the holding portion in the longitudinal direction X of the holding recess 23b. Yet alternatively, the projection 23b1 may be mounted on one end of the holding recess 23b in the orthogonal direction Y of the heater holder 23A.

[0087] FIGS. 14 and 15 illustrate a fixing device 9B according to an embodiment of the present disclosure as a second modification example of the fixing device 9. FIG. 14 is a side cross-sectional view of the fixing device 9B. FIG. 15 is a cross-sectional view of the fixing device 9B, taken on line D3-D3 in FIG. 14.

[0088] The fixing device 9B includes a first thermal equalization plate 28B incorporating the bent portion 28c serving as a projection that is disposed opposite the thermostat 27 and extended in the span of the thermostat 27 in the longitudinal direction X of the first thermal equalization plate 28B. As illustrated in FIG. 14, the fixing device 9B includes a heater holder 23B including a groove 23b2 serving as a recess disposed in a part of the holding recess 23b in the longitudinal direction X of the heater holder 23B. The bent portion 28c engages the groove 23b2. Hence, the bent portion 28c and the groove 23b2 position the first thermal equalization plate 28B with respect to the heater holder 23B. Accordingly, the first thermal equalization plate 28B is positioned with respect to the heater holder 23B with improved accuracy. The thermostat 27 is positioned with respect to the first thermal equalization plate 28B with improved accuracy. The thermosensitive portion 271 of the thermostat 27 is separated from the first thermal equalization plate 28B precisely. According to the embodiment, the bent portion 28c disposed opposite the thermostat 27 and extended in the span of the thermostat 27 in the longitudinal direction X of the heater holder 23B positions the first thermal equalization plate 28B with respect to the heater holder 23B. While the heater 22 heats the first thermal equalization plate 28B, the first thermal equalization plate 28B thermally expands from the bent portion 28c bidirectionally in the longitudinal direction X of the first thermal equalization plate 28B.

zation plate 28B. Hence, the bent portion 28c positions the thermostat 27 with respect to the first thermal equalization plate 28B with improved accuracy. Alternatively, the first thermal equalization plate 28B may include a through hole serving as a recess. The heater holder 23B may include a projection that engages the recess. The bent portion 28c and the groove 23b2 may be disposed with an arrangement in the longitudinal direction X of the first thermal equalization plate 28B, that is other than an arrangement depicted in FIG. 14. According to the embodiment, the first thermal equalization plate 28B is made of a plate. The bent portion 28c is produced by bending a part of the plate. Alternatively, conversely to the bent portion 28c and the groove 23b2 depicted in FIG. 14, the first thermal equalization plate 28B may include a recess. The heater holder 23B may include a projection that engages the recess. In this case, the projection and the recess are disposed at one lateral end of the first thermal equalization plate 28B and the heater holder 23B in the longitudinal direction X thereof, preferably conducting heat to the fixing belt 20 evenly in the longitudinal direction X thereof.

[0089] The bent portion 28c and the groove 23b2 are disposed downstream from the thermostat 27 in the rotation direction A2 of the fixing belt 20. The bent portion 28c and the groove 23b2 position the first thermal equalization plate 28B with respect to the heater holder 23B at a downstream position disposed downstream from the thermostat 27 in the rotation direction A2 of the fixing belt 20 with improved accuracy. Alternatively, the bent portion 28c and the groove 23b2 may be disposed upstream from the thermostat 27 in the rotation direction A2 of the fixing belt 20.

[0090] FIGS. 16 and 17 illustrate a fixing device 9C according to an embodiment of the present disclosure as a third modification example of the fixing device 9. FIG. 16 is a side cross-sectional view of the fixing device 9C. FIG. 17 is a cross-sectional view of the fixing device 9C, taken on line D4-D4 in FIG. 16.

[0091] The fixing device 9C includes a first thermal equalization plate 28C including a plurality of bent portions 28d serving as a contact portion and a heater holder 23C. The bent portions 28d are bent into both ends of the first thermosensitive portion through hole 23a2 of the heater holder 23C in the orthogonal direction Y thereof, respectively. The first thermosensitive portion through hole 23a2 accommodates the thermostat 27. The heater holder 23C includes a plurality of walls 23f that contacts the bent portions 28d, respectively. The walls 23f are disposed at both ends of the heater holder 23C in the orthogonal direction Y thereof, respectively, and abut on and define the first thermosensitive portion through hole 23a2. Accordingly, the first thermal equalization plate 28C is positioned with respect to the heater holder 23C with improved accuracy. The thermostat 27 is separated from the first thermal equalization plate 28C precisely. Compared to the embodiments described above, the bent portions 28d supplement a thermal capacity of a

part of the first thermal equalization plate 28C, that is provided with the second thermosensitive portion through hole 28a in the longitudinal direction X of the first thermal equalization plate 28C, thus equalizing heat conducted to the fixing belt 20 in the longitudinal direction X thereof. The bent portions 28d are separated from the thermosensitive portion 271 of the thermostat 27. According to the embodiment, the first thermal equalization plate 28C is made of a plate. The bent portions 28d are produced by bending a part of the plate.

[0092] FIG. 18 illustrates a fixing device 9D according to an embodiment of the present disclosure as a fourth modification example of the fixing device 9. The fixing device 9D includes a plurality of thermal insulators 40. Each of the thermal insulators 40 is interposed between the thermostat 27 and the bent portion 28d. The thermal insulators 40 thermally insulate the thermostat 27 from the bent portions 28d precisely. The thermal insulators 40 position the thermostat 27 with respect to the first thermal equalization plate 28C.

[0093] FIG. 19 illustrates a fixing device 9E according to an embodiment of the present disclosure as a fifth modification example of the fixing device 9. The fixing device 9E includes a first thermal equalization plate 28D that includes a plurality of bent portions 28dA. The bent portions 28dA are disposed at both lateral ends of the second thermosensitive portion through hole 28a in the longitudinal direction X of the first thermal equalization plate 28D, respectively. Accordingly, the first thermal equalization plate 28D is positioned with respect to the heater holder 23C with improved accuracy. The thermostat 27 is separated from the first thermal equalization plate 28D precisely. Alternatively, the bent portion 28dA may be disposed at one end or another end of the second thermosensitive portion through hole 28a in the orthogonal direction Y of the first thermal equalization plate 28D. Like the fixing device 9D depicted in FIG. 18, the fixing device 9E depicted in FIG. 19 may include the thermal insulators 40, each of which is interposed between the thermostat 27 and the bent portion 28dA.

[0094] FIG. 20 illustrates a fixing device 9F according to an embodiment of the present disclosure as a sixth modification example of the fixing device 9. The fixing device 9F includes a heater holder 23D that includes a first thermosensitive portion through hole 23a2A. The holding portion 272 of the thermostat 27 engages the first thermosensitive portion through hole 23a2A substantially, positioning the thermostat 27 with respect to the heater holder 23D. Thus, the thermostat 27 is positioned with respect to the heater holder 23D precisely. The thermostat 27 positioned with respect to the heater holder 23D is not secured to the heater holder 23D stationarily. For example, the thermostat 27 is movable vertically in FIG. 20. The spring 273 presses the thermosensitive portion 271 of the thermostat 27 against the heater 22.

[0095] The embodiments described above that improve accuracy of positioning a first thermal equalization plate (e.g., the first thermal equalization plates 28, 28A,

28B, 28C, and 28D) with respect to a heater holder (e.g., the heater holders 23, 23A, 23B, 23C, and 23D) are preferably applied to a fixing device (e.g., the fixing devices 9, 9A, 9B, 9C, 9D, 9E, and 9F) serving as a heating device that includes a heater (e.g., the heaters 22, 22A, and 22B) including a plurality of resistive heat generators (e.g., the resistive heat generators 31, 31A, and 31B) that is arranged in the longitudinal direction X of the heater. Since the heater has an increased length in the longitudinal direction X thereof, the first thermal equalization plate serving as a thermal conductor also has an increased length in the longitudinal direction X thereof. Accordingly, the first thermal equalization plate is positioned with respect to the heater holder with improved accuracy.

[0096] FIG. 21 is a diagram illustrating a temperature profile of the fixing belt 20 in the longitudinal direction X thereof. FIG. 21 illustrates, in a section (a), an arrangement of the resistive heat generators 31 of the heater 22. FIG. 21 illustrates, in a section (b), a vertical axis that represents a temperature T of the fixing belt 20 and a horizontal axis that represents the longitudinal direction X of the fixing belt 20.

[0097] As illustrated in the sections (a) and (b) in FIG. 21, the heater 22 includes the plurality of resistive heat generators 31 separated and arranged in the longitudinal direction X of the heater 22 to produce a gap B (e.g., a dividing region) between the adjacent resistive heat generators 31 in the longitudinal direction X of the heater 22. In other words, the plurality of resistive heat generators 31 of the heater 22 is arranged with the gap B between the adjacent resistive heat generators 31. The gap B defines a dividing region or a dividing span. The resistive heat generators 31 and the gaps B define the heating region E in the longitudinal direction X of the heater 22. The heating region E is a main heat generation span of the heater 22.

[0098] An opposed portion of each of the resistive heat generators 31, that is disposed opposite the gap B, occupies an area smaller than an area of other portion of each of the resistive heat generators 31, thus generating a decreased amount of heat. Accordingly, an opposed portion of the fixing belt 20, that is disposed opposite the gap B, has a lower temperature compared to other portion of the fixing belt 20 in the longitudinal direction X thereof. The adjacent resistive heat generators 31 define an enlarged gap region C (e.g., an enlarged dividing region) encompassing the gap B, serving as the dividing region, and a peripheral region thereof. The heater 22 and the fixing belt 20 suffer from temperature decrease also in opposed portions thereof, that are disposed opposite the enlarged gap region C, respectively. Similarly, the heater 22 suffers from temperature decrease also in an opposed portion thereof, that is disposed opposite the gap B. As illustrated in an enlarged view in the section (a) in FIG. 21, the gap B indicates a region encompassing an entirety of the dividing region between the adjacent resistive heat generators 31 serving as a main heat generation

portion of the heater 22 in the longitudinal direction X thereof. The resistive heat generator 31 includes a joint 311 that is coupled with the feeder 33A or 33B. The enlarged gap region C encompasses the joints 311 in addition to the gap B. The joint 311 defines a part of the resistive heat generator 31, that extends substantially in the orthogonal direction Y of the heater 22 and is coupled with the feeder 33A or 33B.

[0099] FIG. 22 illustrates the heater 22A depicted in FIG. 4 that includes the resistive heat generators 31A that are rectangular. In the heater 22A also, a temperature of an opposed portion of the heater 22A, that is disposed opposite the gap B, is lower than a temperature of other portion of the heater 22A. FIG. 23 illustrates a heater 22C that includes a plurality of resistive heat generators 31C that is zigzag. In the heater 22C also, a temperature of an opposed portion of the heater 22C, that is disposed opposite the gap B, is lower than a temperature of other portion of the heater 22C. FIG. 24 illustrates the heater 22B depicted in FIG. 5 that includes the resistive heat generators 31B including the linear portion that defines the parallelogram. In the heater 22B also, a temperature of an opposed portion of the heater 22B, that is disposed opposite the gap B, is lower than a temperature of other portion of the heater 22B. As illustrated in FIGS. 21, 23, and 24, the adjacent resistive heat generators 31, 31C, and 31B overlap each other in the longitudinal direction X of the heaters 22, 22C, and 22B, suppressing temperature decrease of the opposed portion of each of the heaters 22, 22C, and 22B, that is disposed opposite the gap B, compared to other portion of each of the heaters 22, 22C, and 22B.

[0100] The fixing device 9 according to the embodiment incorporates the first thermal equalization plate 28 that suppresses temperature decrease at the gap B and thereby suppresses uneven temperature of the fixing belt 20 in the longitudinal direction X thereof.

[0101] A description is provided of a configuration of the first thermal equalization plate 28 in detail.

[0102] As illustrated in FIG. 2, the first thermal equalization plate 28 is interposed between the heater 22 and the stay 24 in a horizontal direction in FIG. 2. Specifically, the first thermal equalization plate 28 is sandwiched between the heater 22 and the heater holder 23. For example, the first thermal equalization plate 28 has one face that contacts the back face of the base 30 of the heater 22 and another face that contacts the heater holder 23.

[0103] The stay 24 includes two arms 24a (e.g., perpendicular portions) that extend in a thickness direction of the heater 22 and the like. Each of the arms 24a has a contact face 24a1 that contacts the heater holder 23 directly, thus supporting the heater holder 23, the first thermal equalization plate 28, and the heater 22. The contact faces 24a1 of the arms 24a are disposed outboard from the resistive heat generators 31 in the orthogonal direction Y (e.g., a vertical direction in FIG. 2) of the heater 22. Thus, the stay 24 suppresses conduction of heat thereto from the heater 22, causing the heater 22

to heat the fixing belt 20 efficiently.

[0104] As illustrated in FIG. 25, the first thermal equalization plate 28 is a plate having a thickness of 0.3 mm, a length of 222 mm in the longitudinal direction X of the first thermal equalization plate 28, and a width of 10 mm in the orthogonal direction Y. According to the embodiment, the first thermal equalization plate 28 is constructed of a single plate. Alternatively, the first thermal equalization plate 28 may be constructed of a plurality of members. FIG. 25 omits illustration of the guide ribs 26 depicted in FIG. 2.

[0105] The first thermal equalization plate 28 is fitted to the holding recess 23b of the heater holder 23. The heater 22 is attached to the heater holder 23 from above the first thermal equalization plate 28. Thus, the heater holder 23 and the heater 22 sandwich and hold the first thermal equalization plate 28. The heater holder 23 includes side walls 23b1A, serving as longitudinal direction restrictors, that are disposed at both lateral ends of the heater holder 23 in the longitudinal direction X thereof, respectively, and define the holding recess 23b. The side walls 23b1A restrict motion of the first thermal equalization plate 28 and the heater 22 in the longitudinal direction X thereof. Thus, the side walls 23b1A restrict shifting of the first thermal equalization plate 28 in the longitudinal direction X thereof inside the fixing device 9, improving efficiency in thermal conduction in a target span in the longitudinal direction X of the first thermal equalization plate 28. The heater holder 23 further includes side walls 23b2A, serving as orthogonal direction restrictors, that are disposed at both ends of the heater holder 23 in the orthogonal direction Y thereof, respectively, and define the holding recess 23b. The side walls 23b2A restrict motion of the first thermal equalization plate 28 and the heater 22 in the orthogonal direction Y thereof.

[0106] The first thermal equalization plate 28 may extend in a span other than a span in which the first thermal equalization plate 28 extends in the longitudinal direction X thereof as illustrated in FIG. 25. For example, FIG. 26 illustrates a fixing device 9G incorporating a first thermal equalization plate 28E that extends in a span that is hatched in FIG. 26 and is defined by the heat generation portion 35 in the longitudinal direction X of the heater 22.

[0107] As illustrated in FIG. 2, as the pressure roller 21 applies pressure to a heater (e.g., the heaters 22, 22A, 22B, and 22C), the heater and a heater holder (e.g., the heater holders 23, 23A, 23B, 23C, and 23D) sandwich a first thermal equalization plate (e.g., the first thermal equalization plates 28, 28A, 28B, 28C, 28D, and 28E) such that the first thermal equalization plate contacts the heater and the heater holder. As the first thermal equalization plate contacts the heater, the first thermal equalization plate conducts heat generated by the heater in the longitudinal direction X thereof with improved efficiency. The first thermal equalization plate is disposed opposite the gaps B between adjacent resistive heat generators (e.g., the resistive heat generators 31, 31A, 31B, and 31C) arranged in the longitudinal direction X of the heater.

Thus, the first thermal equalization plate improves efficiency in conduction of heat at the gaps B, increases an amount of heat conducted to the gaps B, and increases the temperature of the heater at the gaps B arranged in the longitudinal direction X of the heater, thus suppressing uneven temperature of the heater in the longitudinal direction X thereof. Accordingly, the first thermal equalization plate suppresses uneven temperature of the fixing belt 20 in the longitudinal direction X thereof. Consequently, the fixing belt 20 suppresses uneven fixing and uneven gloss of a toner image fixed on a sheet P. The heater does not heat the fixing belt 20 redundantly to attain sufficient fixing performance at the gaps B, causing a fixing device (e.g., the fixing devices 9, 9A, 9B, 9C, 9D, 9E, 9F, and 9G) to save energy. The first thermal equalization plate extends throughout an entire span of the heat generation portion 35 in the longitudinal direction X of the heater. Accordingly, the first thermal equalization plate improves efficiency in conduction of heat of the heater in an entirety of a main heating span of the heater disposed opposite an imaging span of a toner image formed on a sheet P conveyed through the fixing nip N. Consequently, the first thermal equalization plate suppresses uneven temperature of the heater and the fixing belt 20 in the longitudinal direction X thereof.

[0108] According to the embodiments, the first thermal equalization plate is coupled with the resistive heat generators having the PTC property described above, suppressing overheating of the fixing belt 20 in the non-conveyance span where a sheet P having a decreased size is not conveyed effectively. For example, the PTC property suppresses an amount of heat generated by the resistive heat generators in the non-conveyance span. Additionally, the first thermal equalization plate efficiently conducts heat from the non-conveyance span on the fixing belt 20 that suffers from temperature increase to a sheet conveyance span on the fixing belt 20, where the sheet P is conveyed, thus suppressing overheating of the fixing belt 20 in the non-conveyance span effectively.

[0109] Since the heater generates heat in a decreased amount at the gap B between the adjacent resistive heat generators, the heater has a decreased temperature also in a periphery of the gap B. To address the circumstance, the first thermal equalization plate is preferably disposed also in the periphery of the gap B. For example, according to the embodiment illustrated in the section (a) of FIG. 21, the first thermal equalization plate 28 is disposed opposite the enlarged gap region C. Hence, the first thermal equalization plate 28 improves efficiency in conduction of heat at the gap B and the periphery thereof in the longitudinal direction X of the heater 22, suppressing uneven temperature of the heater 22 in the longitudinal direction X thereof. According to the embodiment, the first thermal equalization plate 28 extends throughout the entire span of the heat generation portion 35 in the longitudinal direction X of the heater 22. Accordingly, the first thermal equalization plate 28 suppresses uneven temperature of the heater 22 and the fixing belt 20 in the longitudinal

direction X thereof more effectively.

[0110] A description is provided of a construction of a fixing device 9H according to an embodiment of the present disclosure.

[0111] As illustrated in FIG. 27, the fixing device 9H according to the embodiment includes second thermal equalization plates 36 serving as second thermal conductors and a heater holder 23E. The second thermal equalization plates 36 are sandwiched between the heater holder 23E and the first thermal equalization plate 28. Each of the second thermal equalization plates 36 is disposed at a position different from a position of the first thermal equalization plate 28 in a laminating direction (e.g., a horizontal direction in FIG. 27) in which the stay 24, the heater holder 23E, the second thermal equalization plate 36, the first thermal equalization plate 28, and the heater 22 are arranged. Specifically, the second thermal equalization plates 36 are superimposed on the first thermal equalization plate 28. Unlike FIG. 2 illustrating the fixing device 9, FIG. 27 illustrates a cross section that crosses a longitudinal direction of the fixing device 9H in which the thermistor 25 is not disposed. For example, FIG. 27 illustrates the cross section where the second thermal equalization plate 36 is disposed.

[0112] The second thermal equalization plate 36 is made of a material having a thermal conductivity greater than a thermal conductivity of the base 30. For example, the second thermal equalization plate 36 is made of graphene or graphite. According to the embodiment, the second thermal equalization plate 36 is a graphite sheet having a thickness of 1 mm. Alternatively, the second thermal equalization plate 36 may be a plate made of aluminum, copper, silver, or the like.

[0113] As illustrated in FIG. 28, the plurality of second thermal equalization plates 36 is arranged on a plurality of parts on the heater holder 23E in the longitudinal direction X thereof, respectively. The heater holder 23E includes a holding recess 23bA that includes cavities placed with the second thermal equalization plates 36, respectively. The cavities are stepped down by one step from other portion of the holding recess 23bA. The second thermal equalization plate 36 and the heater holder 23E define a gap therebetween at both lateral ends of the second thermal equalization plate 36 in the longitudinal direction X of the heater holder 23E. Thus, the second thermal equalization plate 36 suppresses conduction of heat to the heater holder 23E from both lateral ends of the second thermal equalization plate 36 in the longitudinal direction X of the heater holder 23E, causing the heater 22 to heat the fixing belt 20 efficiently. FIG. 28 omits illustration of the guide ribs 26 depicted in FIG. 2.

[0114] As illustrated in FIG. 29, the second thermal equalization plate 36 that is hatched is disposed opposite the gap B between the adjacent resistive heat generators 31 and overlaps at least a part of the adjacent resistive heat generators 31 in the longitudinal direction X of the heater 22. According to the embodiment, the second thermal equalization plate 36 extends throughout an en-

tire span of the gap B. The second thermal equalization plate 36 is shifted from the lateral end thermistor 25A, the center thermistor 25B, and the thermostat 27 in the longitudinal direction X of the heater 22.

[0115] Unlike the embodiments described above, according to an embodiment of the present disclosure, each of a first thermal equalization plate (e.g., the first thermal equalization plates 28, 28A, 28B, 28C, 28D, and 28E) and a second thermal equalization plate (e.g., the second thermal equalization plate 36) is made of a graphene sheet. Hence, each of the first thermal equalization plate and the second thermal equalization plate has an enhanced thermal conductivity in a predetermined direction along a surface of the graphene sheet, that is, a longitudinal direction of a heater (e.g., the heaters 22, 22A, 22B, and 22C), not a thickness direction of the first thermal equalization plate and the second thermal equalization plate. Accordingly, the first thermal equalization plate and the second thermal equalization plate suppress uneven temperature of the heater and the fixing belt 20 in the longitudinal direction X thereof effectively.

[0116] Graphene is thin powder. As illustrated in FIG. 30, graphene is constructed of a plane of carbon atoms arranged in a two-dimensional honeycomb lattice. The graphene sheet is graphene in a sheet form and is usually constructed of a single layer. The graphene sheet may contain impurities in the single layer of carbon atoms. The graphene sheet may have a fullerene structure. The fullerene structure is generally recognized as a polycyclic compound constructed of an identical number of carbon atoms bonded to form a cage with fused rings of five and six atoms. For example, the fullerene structure is a closed cage structure formed of fullerene C₆₀, C₇₀, and C₈₀, 3-coordinated carbon atoms, or the like.

[0117] The graphene sheet is artificial and is produced by chemical vapor deposition (CVD), for example.

[0118] The graphene sheet is commercially available. A size and a thickness of the graphene sheet and a number of layers and the like of the graphite sheet described below are measured with a transmission electron microscope (TEM), for example.

[0119] Graphite is constructed of stacked layers of graphene and is highly anisotropic in thermal conduction. As illustrated in FIG. 31, graphite has a plurality of layers, each of which is constructed of hexagonal fused rings of carbon atoms, that are bonded planarly. The plurality of layers defines a crystalline structure. In the crystalline structure, adjacent carbon atoms in the layer are bonded with each other by a covalent bond. Bonding between layers of carbon atoms is established by the van der Waals bond. The covalent bond achieves bonding greater than bonding by the van der Waals bond. Graphite is highly anisotropic with bonding within the layer and bonding between the layers. For example, a first thermal equalization plate (e.g., the first thermal equalization plates 28, 28A, 28B, 28C, 28D, and 28E) or a second thermal equalization plate (e.g., the second thermal equalization plate 36) is made of graphite. Accordingly,

the first thermal equalization plate or the second thermal equalization plate attains an efficiency in conduction of heat in the longitudinal direction X of a heater (e.g., the heaters 22, 22A, 22B, and 22C), which is greater than an efficiency in conduction of heat in a thickness direction, that is, the laminating direction (e.g., the horizontal direction in FIG. 27) in which the stay 24, the heater holder 23E, the second thermal equalization plate 36, the first thermal equalization plate 28, and the heater 22 are arranged, thus suppressing conduction of heat to a heater holder (e.g., the heater holders 23, 23A, 23B, 23C, 23D, and 23E). Consequently, the first thermal equalization plate or the second thermal equalization plate suppresses uneven temperature of the heater in the longitudinal direction X thereof efficiently. Additionally, the first thermal equalization plate or the second thermal equalization plate minimizes heat conducted to the heater holder. The first thermal equalization plate or the second thermal equalization plate that is made of graphite attains enhanced heat resistance that inhibits oxidation at approximately 700 degrees Celsius.

[0120] The graphite sheet has a physical property and a dimension that are adjusted properly according to a function of the first thermal equalization plate or the second thermal equalization plate. For example, the graphite sheet is made of graphite having enhanced purity or single crystal graphite. The graphite sheet has an increased thickness to enhance anisotropic thermal conduction. In order to perform high speed fixing, a fixing device (e.g., the fixing devices 9, 9A, 9B, 9C, 9D, 9E, 9F, 9G, and 9H) employs the graphite sheet having a decreased thickness to decrease thermal capacity of the fixing device. If the fixing nip N and the heater have an increased length in the longitudinal direction X thereof, the first thermal equalization plate or the second thermal equalization plate also has an increased length in the longitudinal direction X of the heater.

[0121] In view of increasing mechanical strength, the graphite sheet preferably has a number of layers that is not smaller than 11 layers. The graphite sheet may include a part constructed of a single layer and another part constructed of a plurality of layers.

[0122] The second thermal equalization plate 36 is disposed opposite the gap B between the adjacent resistive heat generators 31 and the enlarged gap region C depicted in FIG. 21 and overlaps at least a part of the adjacent resistive heat generators 31 in the longitudinal direction X of the heater 22. Hence, the second thermal equalization plate 36 may be positioned with respect to the resistive heat generators 31 differently from the second thermal equalization plate 36 depicted in FIG. 29. For example, FIG. 32 illustrates a fixing device 9I including a second thermal equalization plate 36A that protrudes beyond the base 30 bidirectionally in the orthogonal direction Y of the heater 22. The fixing device 9I further includes a second thermal equalization plate 36B that is disposed in a span of the resistive heat generator 31 in the orthogonal direction Y of the heater 22. The

fixing device 9I further includes a second thermal equalization plate 36C that spans a part of the gap B.

[0123] FIG. 33 illustrates a fixing device 9J according to an embodiment of the present disclosure that includes a heater holder 23F including a retracted portion 23c (e.g., a clearance) that is interposed between the first thermal equalization plate 28 and a body of the heater holder 23F in a thickness direction of the heater holder 23F (e.g., a horizontal direction in FIG. 33). For example, the retracted portion 23c is disposed in a part of the holding recess 23bA depicted in FIG. 28, which accommodates the heater 22, the first thermal equalization plate 28, and the second thermal equalization plates 36. A part of the holding recess 23bA is stepped down from other part of the holding recess 23bA, that accommodates the first thermal equalization plate 28, to produce the retracted portion 23c serving as a thermal insulation layer. The part of the holding recess 23bA spans a part or an entirety of the heater holder 23F, that is disposed outboard from the second thermal equalization plate 36 in the longitudinal direction X of the heater 22, and spans a part of the heater holder 23F in the orthogonal direction Y of the heater 22. Accordingly, the heater holder 23F contacts the first thermal equalization plate 28 with a decreased contact area, thus suppressing conduction of heat from the first thermal equalization plate 28 to the heater holder 23F and causing the heater 22 to heat the fixing belt 20 efficiently. On a cross section that intersects a longitudinal direction of the fixing device 9J and is provided with the second thermal equalization plate 36, the second thermal equalization plate 36 contacts the heater holder 23F like the second thermal equalization plate 36 of the fixing device 9H according to the embodiment described above with reference to FIG. 27.

[0124] According to the embodiment, the retracted portion 23c spans an entirety of the resistive heat generator 31 in the orthogonal direction Y (e.g., a vertical direction in FIG. 33) of the heater 22. Thus, the retracted portion 23c suppresses conduction of heat from the first thermal equalization plate 28 to the heater holder 23F, causing the heater 22 to heat the fixing belt 20 efficiently. Alternatively, instead of the retracted portion 23c that defines the clearance, the fixing device 9J may incorporate a thermal insulator that has a thermal conductivity smaller than a thermal conductivity of the heater holder 23F, as the thermal insulation layer.

[0125] According to the embodiments described above, the second thermal equalization plate 36 is provided separately from the first thermal equalization plate 28. Alternatively, the fixing device 9J may have other configuration. For example, the first thermal equalization plate 28 may include an opposed portion that is disposed opposite the gap B and has a thickness greater than a thickness of an outboard portion of the first thermal equalization plate 28, which is other than the opposed portion.

[0126] FIG. 34 illustrates a fixing device 9K according to an embodiment of the present disclosure as a seventh modification example of the fixing device 9. The fixing

device 9K includes a thermal insulator 39 that is interposed between the first thermal equalization plate 28 and the heater holder 23. According to the embodiment depicted in FIG. 34, the thermal insulator 39 includes a plurality of detecting portion through holes 39a1 and a thermosensitive portion through hole 39a2. The thermal elements 251 of the lateral end thermistor 25A and the center thermistor 25B contact the first thermal equalization plate 28 through the detecting portion through holes 39a1 of the thermal insulator 39 and the detecting portion through holes 23a1 of the heater holder 23, respectively. The thermosensitive portion 271 of the thermostat 27 contacts the heater 22 through the first thermosensitive portion through hole 23a2 of the heater holder 23, the thermosensitive portion through hole 39a2 of the thermal insulator 39, and the second thermosensitive portion through hole 28a of the first thermal equalization plate 28.

[0127] Also in the fixing devices 9H, 9J, and 9K depicted in FIGS. 27, 33, and 34, respectively, like in the fixing device 9 depicted in FIG. 10, the lateral end thermistor 25A, the center thermistor 25B, and the thermostat 27 are disposed inside each of the fixing devices 9H, 9J, and 9K properly according to a property of each of the lateral end thermistor 25A, the center thermistor 25B, and the thermostat 27, achieving even temperature of the fixing belt 20 in the longitudinal direction X thereof and improving responsiveness of the thermostat 27.

[0128] The above describes the embodiments of the present disclosure. However, the technology of the present disclosure is not limited to the embodiments described above. For example, the embodiments may be modified within the scope of the technology of the present disclosure.

[0129] The embodiments of the present disclosure are also applied to fixing devices 9L, 9M, and 9N illustrated in FIGS. 35, 36, and 37, respectively, other than the fixing devices 9, 9A, 9B, 9C, 9D, 9E, 9F, 9G, 9H, 9I, 9J, and 9K described above. Referring to FIGS. 35, 36, and 37, the following describes a construction of each of the fixing devices 9L, 9M, and 9N briefly.

[0130] A description is provided of the construction of the fixing device 9L.

[0131] As illustrated in FIG. 35, the fixing device 9L includes a pressing roller 44 that is disposed opposite the pressure roller 21 via the fixing belt 20. The pressing roller 44 serves as an opposed rotator that is disposed opposite the fixing belt 20 serving as a rotator and rotates. The pressing roller 44 and the heater 22 sandwich the fixing belt 20 such that the heater 22 heats the fixing belt 20. The fixing device 9L further includes a nip formation pad 45 that is disposed opposite the inner circumferential face 20a of the fixing belt 20 and is disposed opposite the pressure roller 21 via the fixing belt 20. The stay 24 supports the nip formation pad 45. The nip formation pad 45 and the pressure roller 21 sandwich the fixing belt 20 to form the fixing nip N between the fixing belt 20 and the pressure roller 21.

[0132] A description is provided of the construction of

the fixing device 9M.

[0133] The fixing device 9M illustrated in FIG. 36 eliminates the pressing roller 44 depicted in FIG. 35. In order to attain a contact length with which the heater 22 contacts the fixing belt 20 in the circumferential direction thereof, the heater 22 is an arc having a curvature that is equivalent to a curvature of the fixing belt 20. Other construction of the fixing device 9M is equivalent to the construction of the fixing device 9L depicted in FIG. 35.

[0134] A description is provided of the construction of the fixing device 9N.

[0135] As illustrated in FIG. 37, the fixing device 9N includes a heating assembly 92, a fixing roller 93 serving as a fixing rotator, and a pressure assembly 94 serving as an opposed member. The heating assembly 92 includes the heater 22, the first thermal equalization plate 28, the heater holder 23, and the stay 24 that are described in the embodiments above and a heating belt 120 serving as a rotator. The fixing roller 93 serves as an opposed rotator that rotates and is disposed opposite the heating belt 120 serving as the rotator to form a heating nip N1 therebetween. The fixing roller 93 includes a core metal 93a, an elastic layer 93b, and a release layer 93c. The core metal 93a is solid and is made of iron. The elastic layer 93b is disposed on a surface of the core metal 93a. The release layer 93c is disposed on an outer face of the elastic layer 93b. The pressure assembly 94 is disposed opposite the heating assembly 92 via the fixing roller 93. The pressure assembly 94 includes a nip formation pad 95, a stay 96, and a pressure belt 97. The pressure belt 97 rotates and is formed into a loop within which the nip formation pad 95 and the stay 96 are disposed. The pressure belt 97 and the fixing roller 93 define a fixing nip N2 therebetween. As a sheet P is conveyed through the fixing nip N2, the fixing roller 93 heated at the heating nip N1 and the pressure belt 97 fix a toner image formed on the sheet P thereon under heat and pressure. The pressure belt 97 rotates in a rotation direction J.

[0136] Also in the fixing devices 9L, 9M, and 9N depicted in FIGS. 35 to 37, respectively, like in the fixing device 9 depicted in FIG. 10, the lateral end thermistor 25A, the center thermistor 25B, and the thermostat 27 are disposed inside each of the fixing devices 9L, 9M, and 9N properly according to the property of each of the lateral end thermistor 25A, the center thermistor 25B, and the thermostat 27, achieving even temperature of the fixing belt 20 and the heating belt 120 in the longitudinal direction X thereof and improving responsiveness of the thermostat 27. The thermostat 27 is superimposed on the thermistor 25 depicted in FIGS. 35 to 37 in a direction perpendicular to the longitudinal direction of the heater 22 and is shifted from the thermistor 25 in the longitudinal direction of the heater 22. As illustrated in FIG. 10, the thermostat 27 contacts the back face of the heater 22. In the fixing devices 9L and 9M depicted in FIGS. 35 and 36, respectively, the heater holder 23 serving as the holder is not superimposed on the thermistor

25 and the thermostat 27 in the direction perpendicular to the longitudinal direction of the heater 22.

[0137] The heating device applied with the technology of the present disclosure is not limited to the fixing devices 9, 9A, 9B, 9C, 9D, 9E, 9F, 9G, 9H, 9I, 9J, 9K, 9L, 9M, and 9N according to the embodiments described above. For example, the technology of the present disclosure is also applied to a heating device that is a dryer, a thermocompression device such as a laminator and a heat sealer, or the like. The dryer dries ink applied onto a sheet. The laminator bonds a coating member such as film onto a surface of a sheet by thermocompression. The heat sealer bonds sealing portions of a packaging material by thermocompression. As the technology of the present disclosure is applied to the heating device, a temperature detector (e.g., the lateral end thermistor 25A and the center thermistor 25B) and a power breaker (e.g., the thermostat 27) are disposed inside the heating device properly, attaining even temperature of a rotator (e.g., the fixing belt 20 and the heating belt 120) in a longitudinal direction thereof and improving responsiveness of the power breaker.

[0138] Application of the technology of the present disclosure is not limited to the color image forming apparatus 100 depicted in FIG. 1 that forms a color toner image. The technology of the present disclosure is also applied to a monochrome image forming apparatus that forms a monochrome toner image, a copier, a printer, a facsimile machine, a multifunction peripheral (MFP) having at least two of copying, printing, facsimile, scanning, and plotter functions, or the like.

[0139] For example, as illustrated in FIG. 38, an image forming apparatus 100A according to an embodiment of the present disclosure includes an image forming device 50 including a photoconductive drum, a sheet conveyance device including the timing roller pair 15, the sheet feeder 7, a fixing device 9P, the output device 10, and a scanner 51. The sheet feeder 7 includes the plurality of sheet trays 16 (e.g., paper trays), the feed rollers 17, and the sheet detecting sensors 29. Each of the sheet trays 16 is provided with the sheet detecting sensor 29 and the feed roller 17. The sheet trays 16 load a plurality of sheets P having different sizes, respectively.

[0140] According to the embodiment, the sheet detecting sensor 29 is disposed in the sheet tray 16. Alternatively, the sheet detecting sensor 29 may be disposed in a sheet conveyance path at a position that is upstream from and in proximity to the timing roller pair 15 in a sheet conveyance direction in which the sheet P is conveyed.

[0141] The scanner 51 reads an image on an original Q into image data. The sheet feeder 7 loads the plurality of sheets P and feeds the sheets P to the sheet conveyance path one by one. The timing roller pair 15 conveys the sheet P conveyed through the sheet conveyance path to the image forming device 50.

[0142] The image forming device 50 forms a toner image on the sheet P. For example, the image forming device 50 includes the photoconductive drum, a charging

roller, an exposure device, a developing device, a replenishing device, a transfer roller, a cleaner, and a discharger. The toner image is a reproduction of the image on the original Q, for example. The fixing device 9P fixes the toner image on the sheet P under heat and pressure. The sheet P bearing the fixed toner image is conveyed to the output device 10 by a conveyance roller and the like. The output device 10 ejects the sheet P onto an outside of the image forming apparatus 100A.

[0143] A description is provided of a construction of the fixing device 9P according to an embodiment of the present disclosure.

[0144] A description of elements of the fixing device 9P, which are common to the fixing device 9 depicted in FIG. 2, is omitted properly.

[0145] As illustrated in FIG. 39, the fixing device 9P includes the fixing belt 20, the pressure roller 21, a heater 22D, a heater holder 23G, the stay 24, the thermistors 25, and the first thermal equalization plate 28.

[0146] The fixing belt 20 and the pressure roller 21 define the fixing nip N therebetween. The fixing nip N has a nip width of 10 mm in the sheet conveyance direction A3. The fixing belt 20 and the pressure roller 21 convey the sheet P at a linear velocity of 240 mm/s.

[0147] The fixing belt 20 includes the base layer made of polyimide and the release layer and does not include an elastic layer. The release layer is heat-resistant film made of fluororesin, for example. The fixing belt 20 has an outer diameter of approximately 24 mm.

[0148] The pressure roller 21 includes the core metal 21a, the elastic layer 21b, and the release layer 21c. The pressure roller 21 has an outer diameter in a range of from 24 mm to 30 mm. The elastic layer 21b has a thickness in a range of from 3 mm to 4 mm.

[0149] As illustrated in FIG. 40, the heater 22D includes the base 30, a thermal insulation layer, a conductor layer including the resistive heat generators 31A, and an insulating layer. The heater 22D has a total thickness of 1 mm. The heater 22D has a width of 13 mm in the orthogonal direction Y thereof.

[0150] As illustrated in FIG. 40, the conductor layer of the heater 22D includes the plurality of resistive heat generators 31A, a plurality of feeders 33, the first electrode 34A, the second electrode 34B, and a third electrode 34C. According to the embodiment also, as illustrated in an enlarged view in FIG. 40, the gap B serving as the dividing region is interposed between the adjacent resistive heat generators 31A arranged in the longitudinal direction X of the heater 22D. FIG. 40 illustrates the two gaps B in the enlarged view. However, the gap B is disposed at each interval between the adjacent resistive heat generators 31A depicted in FIG. 40. The heater 22D further includes three heat generation portions 35A, 35B, and 35C, each of which is constructed of the resistive heat generators 31A. As the first electrode 34A and the second electrode 34B are energized, the heat generation portions 35A and 35C generate heat. As the first electrode 34A and the third electrode 34C are energized, the

heat generation portion 35B generates heat. For example, in order to fix a toner image on a sheet P having a decreased size not greater than a predetermined size, the heat generation portion 35B generates heat. In order to fix a toner image on a sheet P having an increased size greater than the predetermined size, the heat generation portions 35A, 35B, and 35C generate heat.

[0151] As illustrated in FIG. 41, the heater holder 23G includes a recess 23d that holds the heater 22D and the first thermal equalization plate 28. The recess 23d is disposed on a heater opposed face of the heater holder 23G, that is disposed opposite the heater 22D. The recess 23d includes a bottom face 23d1 and walls 23d2 and 23d3. The bottom face 23d1 is substantially parallel to the base 30 and recessed with respect to the heater 22D compared to other faces of the heater holder 23G. The wall 23d2 is disposed at least one of both lateral ends of the heater holder 23G in the longitudinal direction X thereof and serves as an interior wall of the heater holder 23G. The walls 23d3 are disposed at both ends of the heater holder 23G in the orthogonal direction Y thereof and serve as interior walls of the heater holder 23G, respectively. The heater holder 23G mounts the guide ribs 26. The heater holder 23G is made of LCP.

[0152] As illustrated in FIG. 42, the fixing device 9P further includes a connector 60 that includes a housing made of resin such as LCP and a plurality of contact terminals disposed in the housing.

[0153] The connector 60 is attached to the heater 22D and the heater holder 23G such that the connector 60 sandwiches the heater 22D and the heater holder 23G together at a front face and a back face of the heater 22D and the heater holder 23G. In a state in which the connector 60 sandwiches and holds the heater 22D and the heater holder 23G, as the contact terminals of the connector 60 contact and press against the first electrode 34A, the second electrode 34B, and the third electrode 34C of the heater 22D depicted in FIG. 40, the heat generation portions 35A, 35B, and 35C are electrically connected to a power supply disposed in the image forming apparatus 100A through the connector 60. Thus, the power supply is ready to supply power to the heat generation portions 35A, 35B, and 35C. At least a part of each of the first electrode 34A, the second electrode 34B, and the third electrode 34C is not coated with the insulating layer and is exposed so that each of the first electrode 34A, the second electrode 34B, and the third electrode 34C is coupled with the connector 60.

[0154] As illustrated in FIG. 43, the fixing device 9P further includes a flange 53 that is disposed on each lateral end of the fixing belt 20 in the longitudinal direction X thereof. The flange 53 contacts the inner circumferential face 20a depicted in FIG. 39 of the fixing belt 20 and holds or supports the fixing belt 20 at each lateral end of the fixing belt 20 in the longitudinal direction X thereof. The flanges 53 are secured to a frame of the fixing device 9P. The flange 53 is inserted into each lateral end of the stay 24 in the longitudinal direction X thereof in an inser-

tion direction I53 illustrated in FIG. 42.

[0155] The connector 60 is attached to the heater 22D and the heater holder 23G in an attachment direction A60 illustrated in FIG. 42 that is parallel to the orthogonal direction Y of the heater 22D. Alternatively, in order to attach the connector 60 to the heater holder 23G, one of the connector 60 and the heater holder 23G may include a projection that engages a recess disposed in another one of the connector 60 and the heater holder 23G such that the projection moves inside the recess relatively. The connector 60 is attached to one lateral end of the heater 22D and the heater holder 23G in the longitudinal direction X of the heater 22D. The one lateral end of the heater 22D and the heater holder 23G is opposite to another lateral end of the heater 22D and the heater holder 23G in the longitudinal direction X of the heater 22D, with which the driver (e.g., a motor) that drives the pressure roller 21 is coupled.

[0156] As illustrated in FIG. 43, the thermistors 25 are disposed opposite the inner circumferential face 20a of the fixing belt 20 at a position in proximity to a center line L and a position in one lateral end span of the fixing belt 20 in the longitudinal direction X thereof, respectively. The controller 220 depicted in FIG. 6 controls the heater 22D based on a temperature of the fixing belt 20, that is detected by the thermistor 25 disposed at the position in proximity to the center line L, and a temperature of the fixing belt 20, that is detected by the thermistor 25 disposed opposite the one lateral end span of the fixing belt 20 in the longitudinal direction X thereof, respectively.

[0157] The thermostats 27 are disposed opposite the inner circumferential face 20a of the fixing belt 20 at a position in proximity to the center line L and a position in another lateral end span of the fixing belt 20 in the longitudinal direction X thereof, respectively. If the thermostat 27 detects a temperature of the fixing belt 20, that is higher than a preset threshold, the thermostat 27 breaks power to the heater 22D.

[0158] The flanges 53 contact and support both lateral ends of the fixing belt 20 in the longitudinal direction X thereof, respectively. Each of the flanges 53 is made of LCP.

[0159] As illustrated in FIG. 44, the flange 53 includes a slide groove 53a. The slide groove 53a extends in a contact-separation direction in which the fixing belt 20 comes into contact with and separates from the pressure roller 21. The slide groove 53a engages an engagement mounted on the frame of the fixing device 9P. As the engagement moves relatively inside the slide groove 53a, the fixing belt 20 moves in the contact-separation direction with respect to the pressure roller 21.

[0160] Also in the fixing device 9P depicted in FIGS. 38 to 43, like in the fixing device 9 depicted in FIG. 10, the thermistors 25 and the thermostats 27 are disposed inside the fixing device 9P properly according to the property of each of the thermistors 25 and the thermostats 27, achieving even temperature of the fixing belt 20 in the longitudinal direction X thereof and improving respon-

siveness of the thermostats 27. The thermostats 27 are superimposed on the thermistor 25 depicted in FIG. 39 in a direction perpendicular to the longitudinal direction X of the heater 22D and shifted from the thermistor 25 in the longitudinal direction X of the heater 22D. As illustrated in FIG. 10, the thermostats 27 contact a back face of the heater 22D.

[0161] The recording media include, in addition to plain paper as a sheet P, thick paper, a postcard, an envelope, thin paper, coated paper, art paper, tracing paper, an overhead projector (OHP) transparency, plastic film, prepreg, and copper foil.

[0162] A description is provided of aspects of the embodiments of the present disclosure.

[0163] A description is provided of a first aspect of the embodiments of the present disclosure.

[0164] As illustrated in FIGS. 2 and 10, a heating device (e.g., the fixing devices 9, 9A, 9B, 9C, 9D, 9E, 9F, 9G, 9H, 9I, 9J, 9K, 9L, 9M, 9N, and 9P) includes a rotator (e.g., the fixing belt 20 and the heating belt 120), a laminated heater (e.g., the heaters 22, 22A, 22B, 22C, and 22D), a thermal conductor (e.g., the first thermal equalization plates 28, 28A, 28B, 28C, 28D, and 28E), a power breaker (e.g., the thermostat 27), and a temperature detector (e.g., the thermistor 25, the lateral end thermistor 25A, and the center thermistor 25B).

[0165] The heater is laminated and disposed opposite an inner face (e.g., the inner circumferential face 20a) of the rotator. The thermal conductor is disposed opposite the heater. The temperature detector contacts the thermal conductor. As illustrated in FIG. 9, the power breaker includes a thermosensitive portion (e.g., the thermosensitive portion 271). The power breaker interrupts power supply to the heater. As illustrated in FIG. 7, the temperature detector includes a detecting portion (e.g., the thermal element 251). The thermosensitive portion of the power breaker is separated from the thermal conductor and contacts the heater. For example, the thermosensitive portion of the power breaker does not contact the thermal conductor. The detecting portion of the temperature detector is disposed opposite the thermal conductor.

[0166] A description is provided of a second aspect of the embodiments of the present disclosure.

[0167] As illustrated in FIG. 9, in the heating device according to the first aspect, the thermosensitive portion of the power breaker and the thermal conductor are made of metal.

[0168] A description is provided of a third aspect of the embodiments of the present disclosure.

[0169] As illustrated in FIG. 9, the heating device according to the first aspect or the second aspect further includes a holder (e.g., the heater holders 23, 23A, 23B, 23C, 23D, 23E, 23F, and 23G) that holds the heater and the thermal conductor. The holder positions the thermal conductor at a position in a longitudinal direction (e.g., the longitudinal direction X) of the thermal conductor where the thermal conductor is disposed opposite the

thermosensitive portion of the power breaker.

[0170] A description is provided of a fourth aspect of the embodiments of the present disclosure.

[0171] As illustrated in FIGS. 10 and 20, in the heating device according to the third aspect, the holder has a first thermosensitive portion through hole (e.g., the first thermosensitive portion through holes 23a2 and 23a2A). The thermal conductor has a second thermosensitive portion through hole (e.g., the second thermosensitive portion through hole 28a). The second thermosensitive portion through hole has one end that communicates with the first thermosensitive portion through hole and another end that is open to the heater. The thermosensitive portion of the power breaker contacts the heater through the first thermosensitive portion through hole of the holder and the second thermosensitive portion through hole of the thermal conductor. As illustrated in FIGS. 16 and 19, the thermal conductor includes a contact portion (e.g., the bent portions 28d and 28dA) that abuts on the second thermosensitive portion through hole of the thermal conductor. The holder further includes a wall (e.g., the wall 23f) that abuts on or defines the first thermosensitive portion through hole of the holder. The contact portion of the thermal conductor contacts the wall that positions the thermal conductor with respect to the holder.

[0172] A description is provided of a fifth aspect of the embodiments of the present disclosure.

[0173] As illustrated in FIGS. 16 and 17, in the heating device according to the fourth aspect, the thermal conductor defines a short direction (e.g., the orthogonal direction Y) that is perpendicular to a thickness direction and the longitudinal direction of the thermal conductor. The holder further includes another wall (e.g., the wall 23f) that abuts on or defines the first thermosensitive portion through hole and is arranged with the wall in the short direction.

[0174] The thermal conductor further includes another contact portion (e.g., the bent portion 28d) that abuts on or defines the second thermosensitive portion through hole of the thermal conductor and contacts the another wall of the holder.

[0175] A description is provided of a sixth aspect of the embodiments of the present disclosure.

[0176] As illustrated in FIG. 19, in the heating device according to the fourth aspect, the holder further includes another wall (e.g., the wall 23f) that abuts on or defines the first thermosensitive portion through hole and is arranged with the wall in the longitudinal direction of the thermal conductor. The thermal conductor further includes another contact portion (e.g., the bent portion 28dA) that abuts on or defines the second thermosensitive portion through hole and contacts the another wall of the holder.

[0177] A description is provided of a seventh aspect of the embodiments of the present disclosure.

[0178] As illustrated in FIG. 18, the heating device according to any one of the fourth aspect to the sixth aspect further includes a thermal insulator (e.g., the thermal in-

ulator 40) through which the power breaker is positioned with respect to the contact portion of the thermal conductor.

[0179] A description is provided of an eighth aspect of the embodiments of the present disclosure.

[0180] As illustrated in FIG. 14, in the heating device according to any one of the third aspect to the seventh aspect, one of the thermal conductor and the holder includes a projection (e.g., the bent portion 28c). Another one of the thermal conductor and the holder includes a recess (e.g., the groove 23b2) that engages the projection. The projection engaging the recess positions the thermal conductor with respect to the holder at the position in the longitudinal direction of the thermal conductor where the thermal conductor is disposed opposite the thermosensitive portion of the power breaker.

[0181] A description is provided of a ninth aspect of the embodiments of the present disclosure.

[0182] As illustrated in FIG. 20, in the heating device according to any one of the first aspect, the second aspect, the third aspect, and the eighth aspect, the holder holds the heater and the thermal conductor. The holder has the first thermosensitive portion through hole. The thermal conductor has the second thermosensitive portion through hole. The second thermosensitive portion through hole has one end that communicates with the first thermosensitive portion through hole of the holder and another end that is open to the heater. The thermosensitive portion of the power breaker contacts the heater through the first thermosensitive portion through hole of the holder and the second thermosensitive portion through hole of the thermal conductor. The power breaker engages the first thermosensitive portion through hole of the holder.

[0183] A description is provided of a tenth aspect of the embodiments of the present disclosure.

[0184] As illustrated in FIG. 9, the heating device according to any one of the first aspect to the ninth aspect includes the holder that holds the heater and the thermal conductor. The heater contacts the holder in a predetermined rotation direction (e.g., the rotation direction A2) of the rotator and is positioned by the holder.

[0185] A description is provided of an eleventh aspect of the embodiments of the present disclosure.

[0186] As illustrated in FIG. 3, in the heating device according to any one of the first aspect to the tenth aspect, the heater includes a base (e.g., the base 30) that is made of ceramics.

[0187] A description is provided of a twelfth aspect of the embodiments of the present disclosure.

[0188] As illustrated in FIG. 10, in the heating device according to any one of the first aspect to the eleventh aspect, the heater includes a heat generator (e.g., the resistive heat generators 31, 31A, 31B, and 31C) that defines a heating region (e.g., the heating region E). The thermal conductor is longer than the heating region in the longitudinal direction of the thermal conductor.

[0189] A description is provided of a thirteenth aspect

of the embodiments of the present disclosure.

[0190] As illustrated in FIG. 2, in the heating device according to any one of the first aspect to the twelfth aspect, the rotator does not include an elastic layer.

[0191] A description is provided of a fourteenth aspect of the embodiments of the present disclosure.

[0192] As illustrated in FIG. 3, in the heating device according to any one of the first aspect to the thirteenth aspect, the heater includes a plurality of heat generators (e.g., the resistive heat generators 31, 31A, 31B, and 31C) arranged in a longitudinal direction of the heater.

[0193] A description is provided of a fifteenth aspect of the embodiments of the present disclosure.

[0194] As illustrated in FIGS. 2 and 10, a heating device (e.g., the fixing devices 9, 9A, 9B, 9C, 9D, 9E, 9F, 9G, 9H, 9I, 9J, 9K, 9L, 9M, 9N, and 9P) includes a rotator (e.g., the fixing belt 20 and the heating belt 120), a laminated heater (e.g., the heaters 22, 22A, 22B, 22C, and 22D), a thermal conductor (e.g., the first thermal equalization plates 28, 28A, 28B, 28C, 28D, and 28E), a holder (e.g., the heater holders 23, 23A, 23B, 23C, 23D, 23E, 23F, and 23G), a power breaker (e.g., the thermostat 27), and a temperature detector (e.g., the thermistor 25, the lateral end thermistor 25A, and the center thermistor 25B).

[0195] The rotator rotates in a predetermined rotation direction (e.g., the rotation direction A2). The heater is laminated and disposed opposite an inner face (e.g., the inner circumferential face 20a) of the rotator. The thermal conductor is disposed opposite the heater. The holder holds the heater and the thermal conductor. As illustrated in FIG. 9, the power breaker includes a thermosensitive portion (e.g., the thermosensitive portion 271). The power breaker interrupts power supply to the heater.

[0196] As illustrated in FIG. 7, the temperature detector includes a detecting portion (e.g., the thermal element 251) that is disposed opposite the thermal conductor. The thermal conductor is interposed between the heater and the holder. As illustrated in FIG. 10, the holder has a first thermosensitive portion through hole (e.g., the first thermosensitive portion through holes 23a2 and 23a2A) and a detecting portion through hole (e.g., the detecting portion through hole 23a1). The thermal conductor has a second thermosensitive portion through hole (e.g., the second thermosensitive portion through hole 28a). The second thermosensitive portion through hole has one end that communicates with the first thermosensitive portion through hole and another end that is open to the heater. The thermosensitive portion of the power breaker contacts the heater through the first thermosensitive portion through hole of the holder and the second thermosensitive portion through hole of the thermal conductor. The detecting portion of the temperature detector is disposed opposite the thermal conductor through the detecting portion through hole of the holder.

[0197] A description is provided of a sixteenth aspect of the embodiments of the present disclosure.

[0198] As illustrated in FIG. 2, a fixing device (e.g., the

fixing devices 9, 9A, 9B, 9C, 9D, 9E, 9F, 9G, 9H, 9I, 9J, 9K, 9L, 9M, 9N, and 9P) includes the heating device according to any one of the first aspect to the fifteenth aspect. The fixing device fixes an image on a recording medium (e.g., the sheet P) under heat.

[0199] A description is provided of a seventeenth aspect of the embodiments of the present disclosure.

[0200] As illustrated in FIG. 1, an image forming apparatus (e.g., the image forming apparatuses 100 and 100A) includes the fixing device according to the sixteenth aspect.

[0201] Accordingly, the temperature detector and the power breaker are disposed inside the heating device properly.

[0202] According to the embodiments described above, the fixing belt 20 serves as a rotator. Alternatively, a fixing film, a fixing sleeve, or the like may be used as a rotator.

Claims

1. A heating device (9) comprising:

a rotator (20);
a heater (22) that is laminated and disposed opposite an inner face (20a) of the rotator (20);
a thermal conductor (28) disposed opposite the heater (22);
a temperature detector (25) contacting the thermal conductor (28); and
a power breaker (27) to interrupt power supply to the heater (22), the power breaker (27) being separated from the thermal conductor (28) and contacting the heater (22).

2. The heating device (9) according to claim 1,

wherein the power breaker (27) includes a thermosensitive portion (271) made of metal, and
wherein the thermal conductor (28) is made of metal.

3. The heating device (9) according to claim 1 or 2, further comprising a holder (23) holding the heater (22) and the thermal conductor (28),

wherein the power breaker (27) includes a thermosensitive portion (271) being separated from the thermal conductor (28) and contacting the heater (22), and
wherein the holder (23) positions the thermal conductor (28) at a position in a longitudinal direction of the thermal conductor (28) where the thermal conductor (28) is disposed opposite the thermosensitive portion (271) of the power breaker (27).

4. The heating device (9) according to claim 3,

wherein one of the thermal conductor (28) and the holder (23) includes a projection (28c) and another one of the thermal conductor (28) and the holder (23) includes a recess (23b2) to engage the projection (28c), and
wherein the projection (28c) engaging the recess (23b2) positions the thermal conductor (28) with respect to the holder (23) at the position in the longitudinal direction of the thermal conductor (28) where the thermal conductor (28) is disposed opposite the thermosensitive portion (271) of the power breaker (27).

5. The heating device (9) according to claim 3 or 4, wherein the heater (22) contacts the holder (23) in a predetermined rotation direction of the rotator (20) and is positioned by the holder (23).

6. The heating device (9) according to any one of claims 3 to 5,

wherein the holder (23) has a first thermosensitive portion through hole (23a2) and includes a wall (23f) abutting on the first thermosensitive portion through hole (23a2),
wherein the thermal conductor (28) has a second thermosensitive portion through hole (28a) having one end that communicates with the first thermosensitive portion through hole (23a2) of the holder (23) and another end that is open to the heater (22),
wherein the thermal conductor (28) includes a contact portion (28d) abutting on the second thermosensitive portion through hole (28a), the contact portion (28d) contacting the wall (23f) that positions the thermal conductor (28) with respect to the holder (23), and
wherein the thermosensitive portion (271) of the power breaker (27) contacts the heater (22) through the first thermosensitive portion through hole (23a2) of the holder (23) and the second thermosensitive portion through hole (28a) of the thermal conductor (28).

7. The heating device (9) according to claim 6,

wherein the holder (23) further includes another wall (23f) abutting on the first thermosensitive portion through hole (23a2) and being arranged with the wall (23f) in a direction that is perpendicular to a thickness direction and the longitudinal direction of the thermal conductor (28), and
wherein the thermal conductor (28) further includes another contact portion (28d) abutting on the second thermosensitive portion through hole (28a) and contacting said another wall (23f).

8. The heating device (9) according to claim 6 or 7,
 wherein the holder (23) further includes another wall (23f) abutting on the first thermosensitive portion through hole (23a2) and being arranged with the wall (23f) in the longitudinal direction of the thermal conductor (28), and
 wherein the thermal conductor (28) further includes another contact portion (28dA) abutting on the second thermosensitive portion through hole (28a) and contacting said another wall (23f). 5
9. The heating device (9) according to any one of claims 6 to 8, further comprising a thermal insulator (40) through which the power breaker (27) is positioned with respect to the contact portion (28d) of the thermal conductor (28). 10
10. The heating device (9) according to any one of claims 6 to 9,
 wherein the power breaker (27) engages the first thermosensitive portion through hole (23a2A) of the holder (23). 15
11. The heating device (9) according to any one of claims 6 to 10,
 wherein the thermal conductor (28) is interposed between the heater (22) and the holder (23),
 wherein the temperature detector (25) includes a detecting portion (251) disposed opposite the thermal conductor (28), and
 wherein the holder (23) further has a detecting portion through hole (23a1) through which the detecting portion (251) of the temperature detector (25) is disposed opposite the thermal conductor (28). 20
12. The heating device (9) according to any one of claims 1 to 11,
 wherein the heater (22) includes a base (30) made of ceramics. 25
13. The heating device (9) according to any one of claims 1 to 12,
 wherein the heater (22) includes a heat generator (31) defining a heating region (E), and
 wherein the thermal conductor (28) is longer than the heating region (E) in a longitudinal direction of the thermal conductor (28). 30
14. The heating device (9) according to any one of claims 1 to 13,
 wherein the heater (22) includes a plurality of heat generators (31) arranged in a longitudinal direction of the heater (22). 35
15. An image forming apparatus (100) comprising the heating device (9) according to any one of claims 1 to 14. 40
- 45
- 50
- 55

FIG. 1

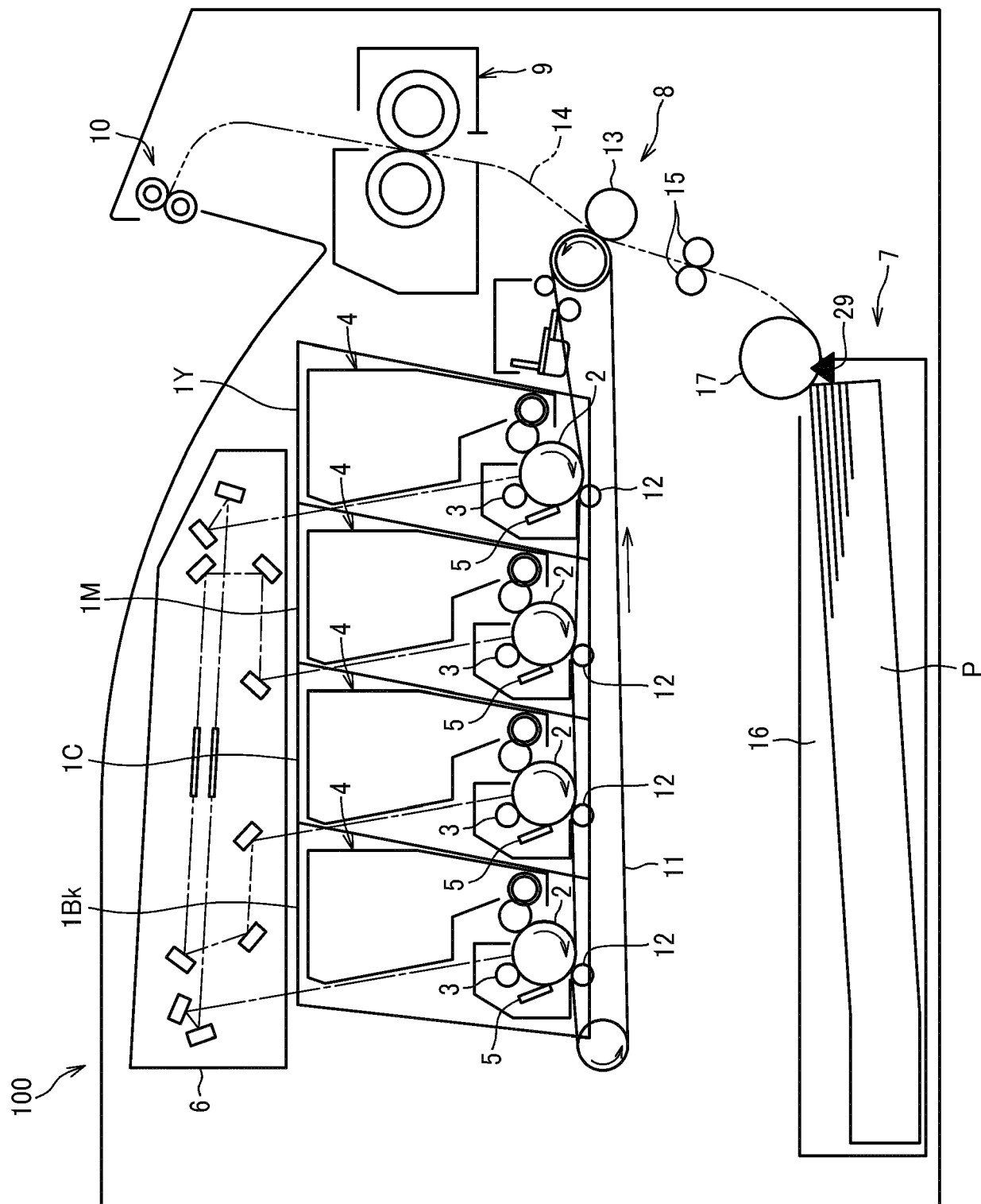


FIG. 2

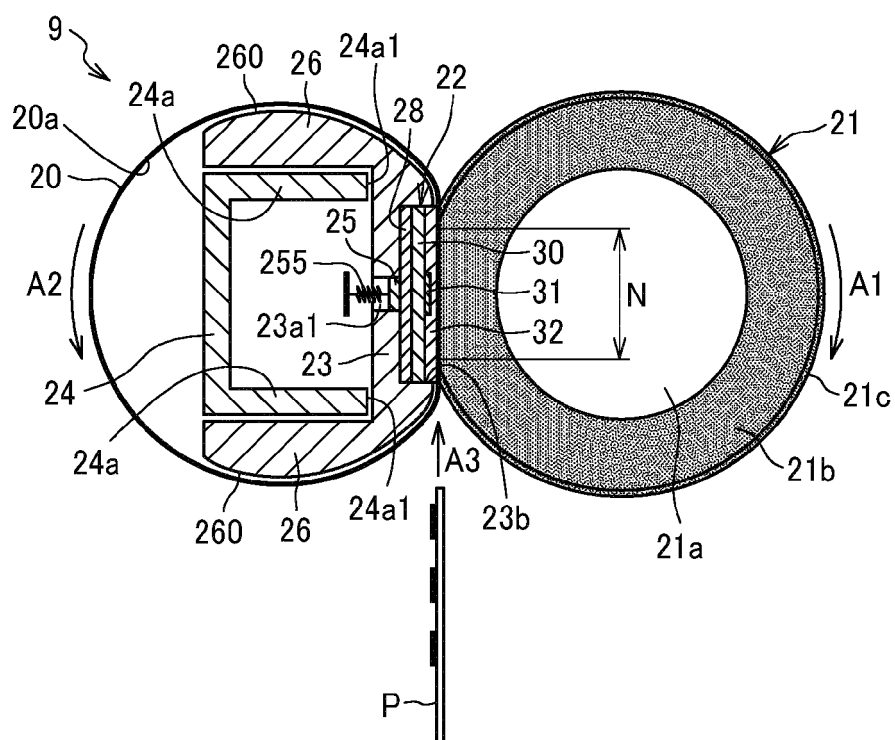


FIG. 3

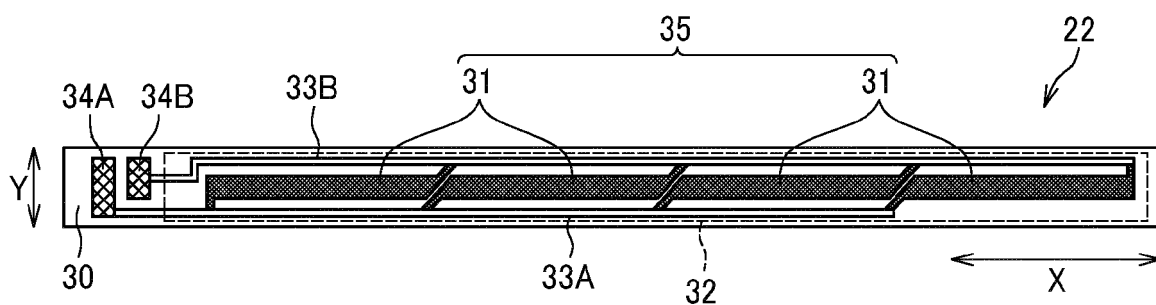


FIG. 4

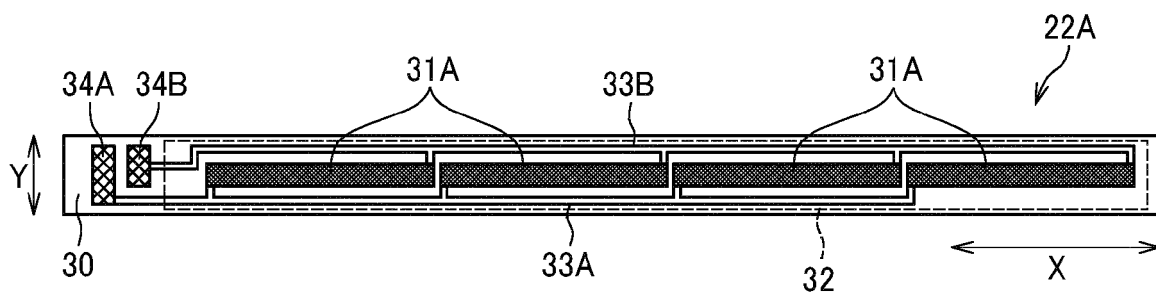


FIG. 5

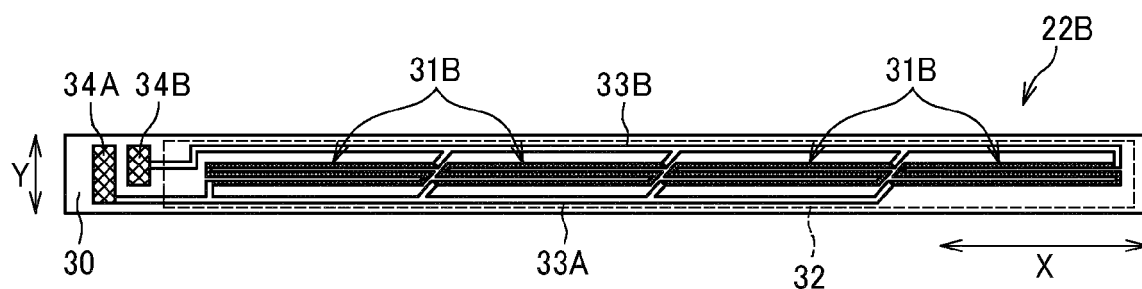


FIG. 6

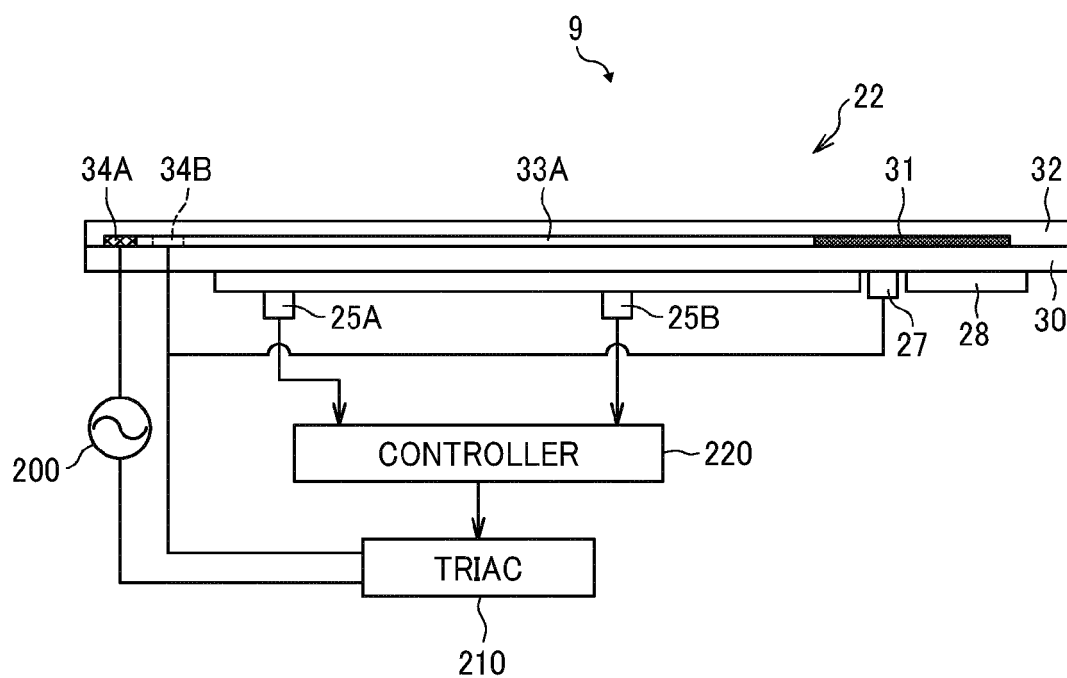


FIG. 7

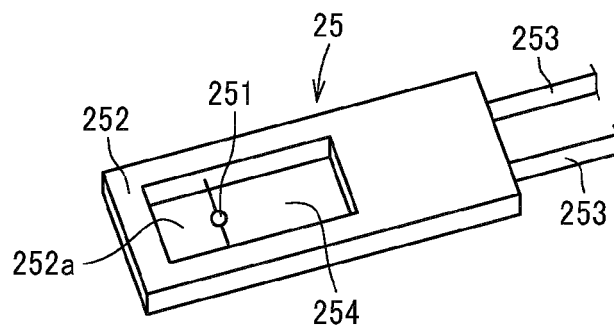


FIG. 8

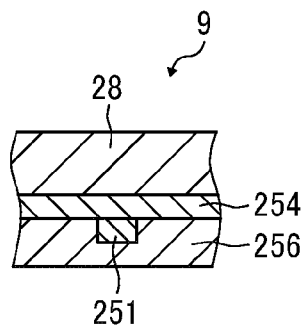


FIG. 9

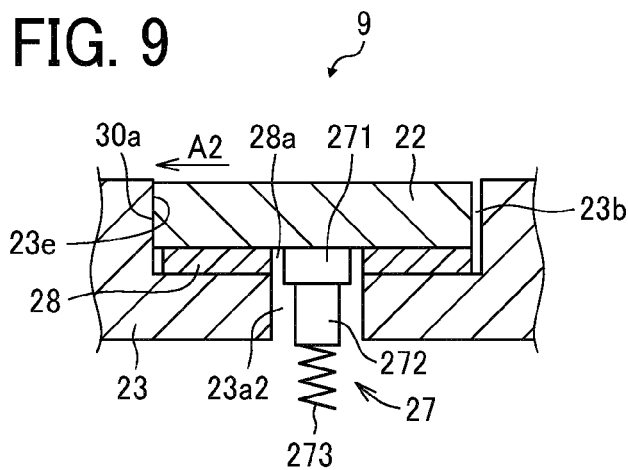


FIG. 10

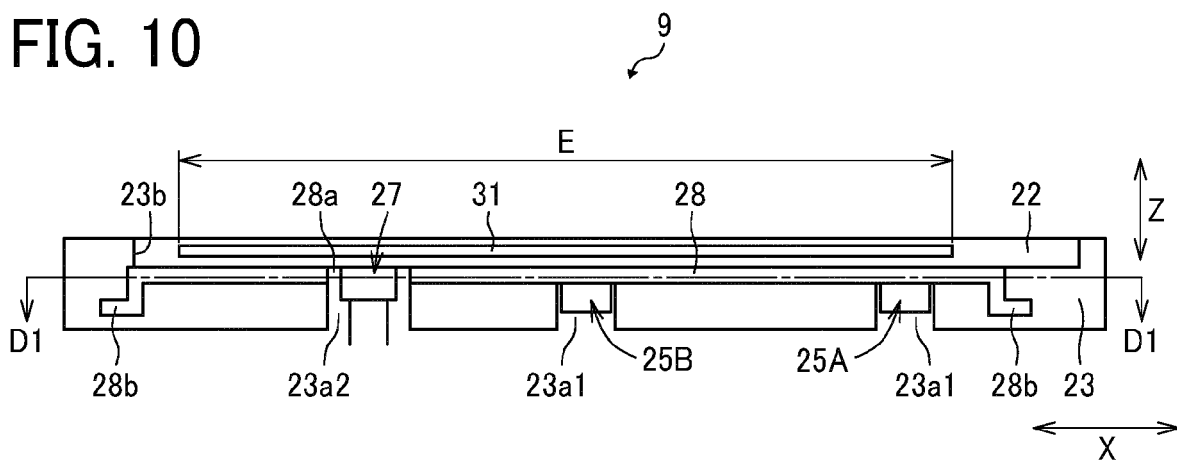


FIG. 11

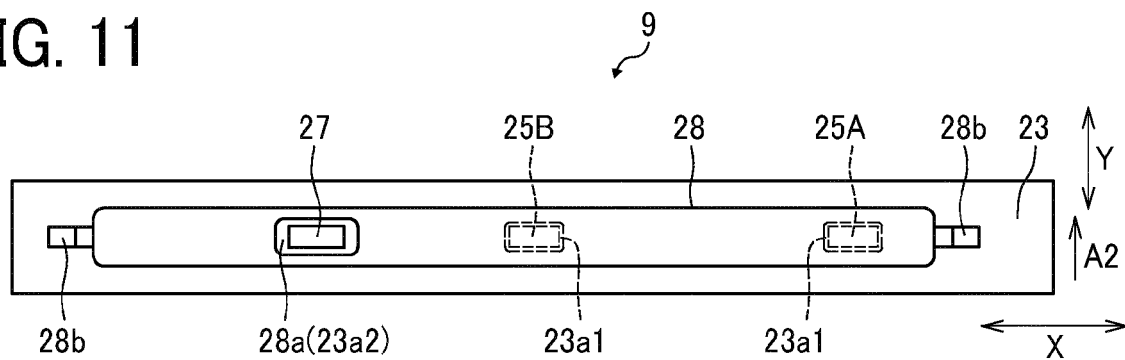


FIG. 12

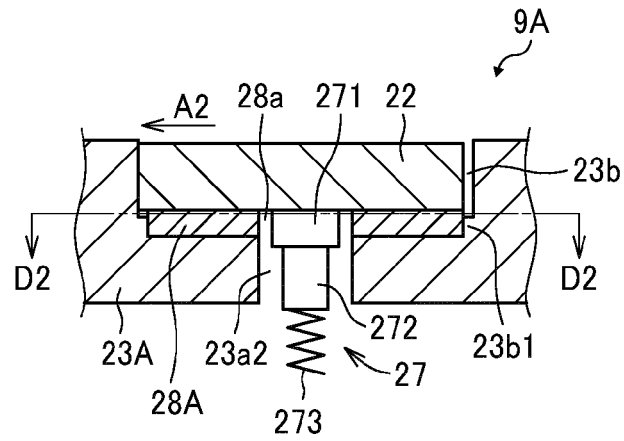


FIG. 13

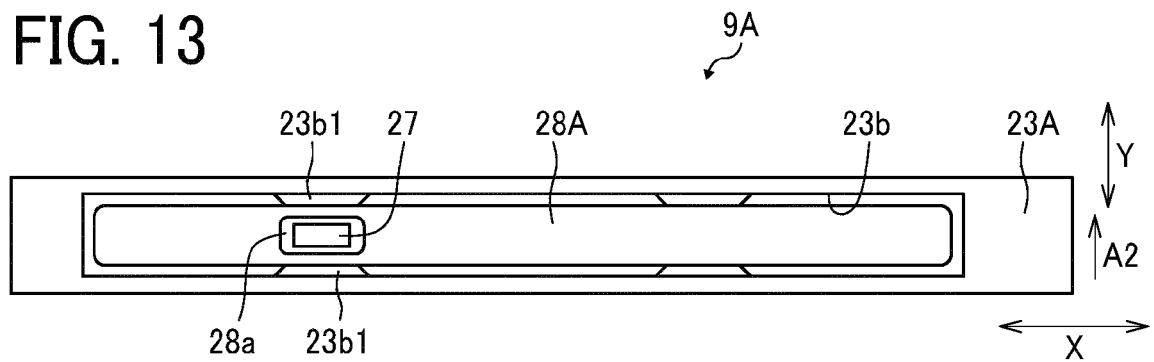


FIG. 14

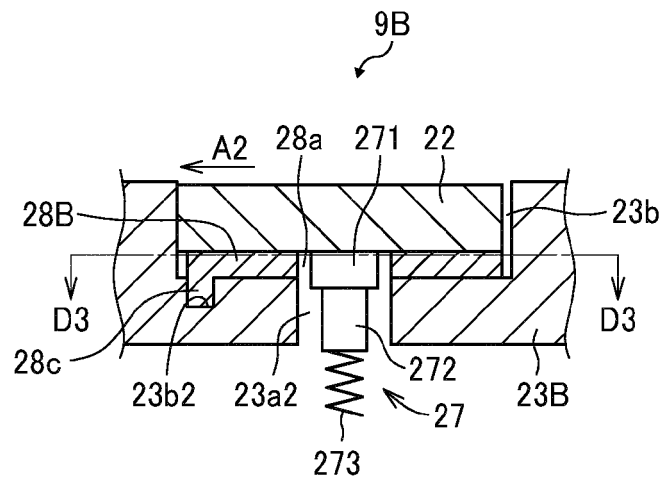


FIG. 15

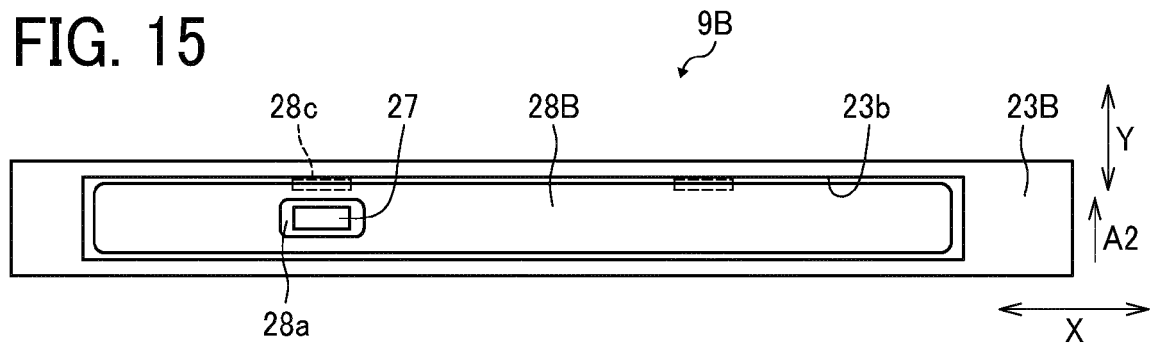


FIG. 16

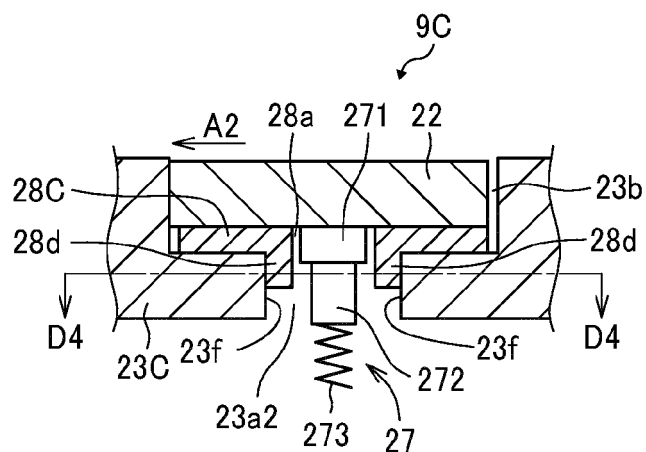


FIG. 17

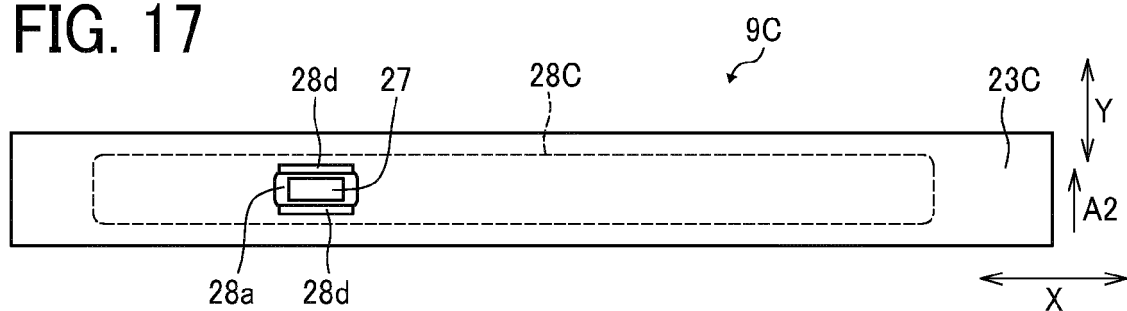


FIG. 18

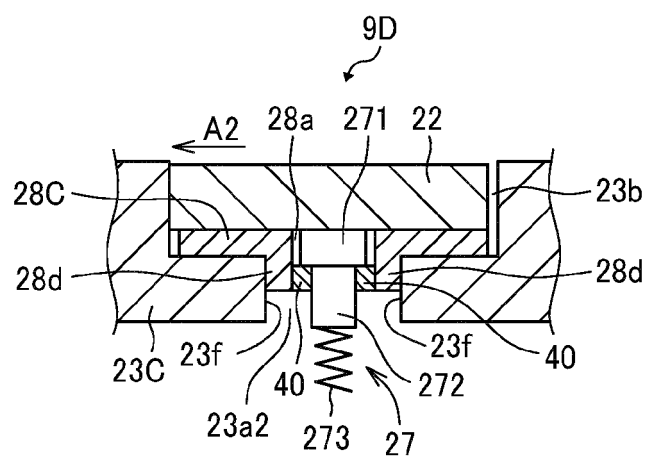


FIG. 19

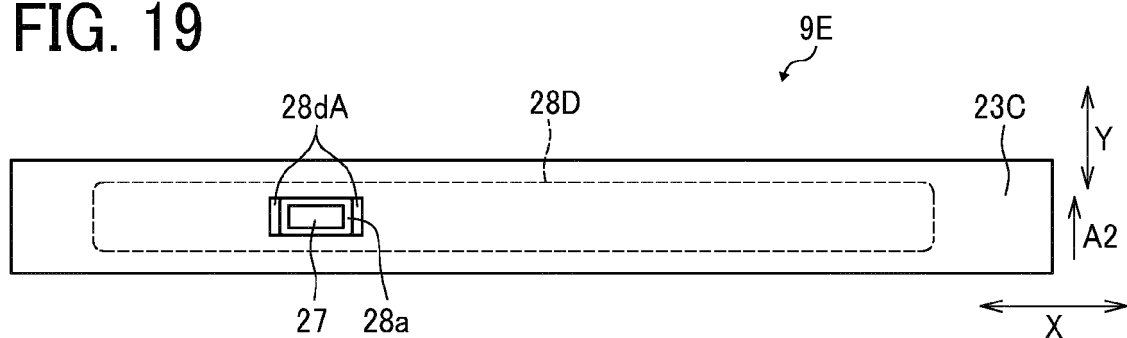


FIG. 20

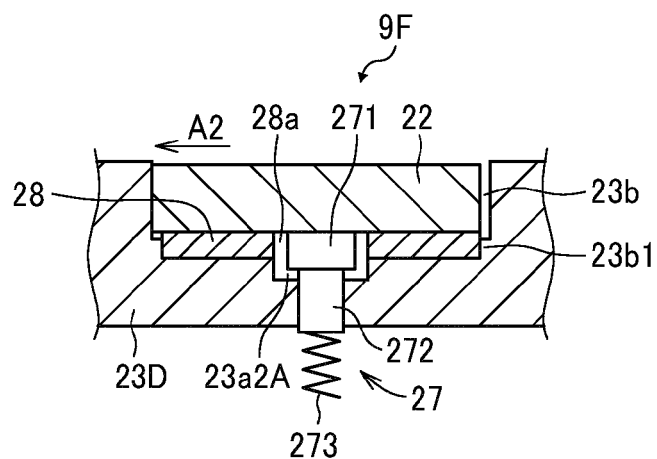


FIG. 21

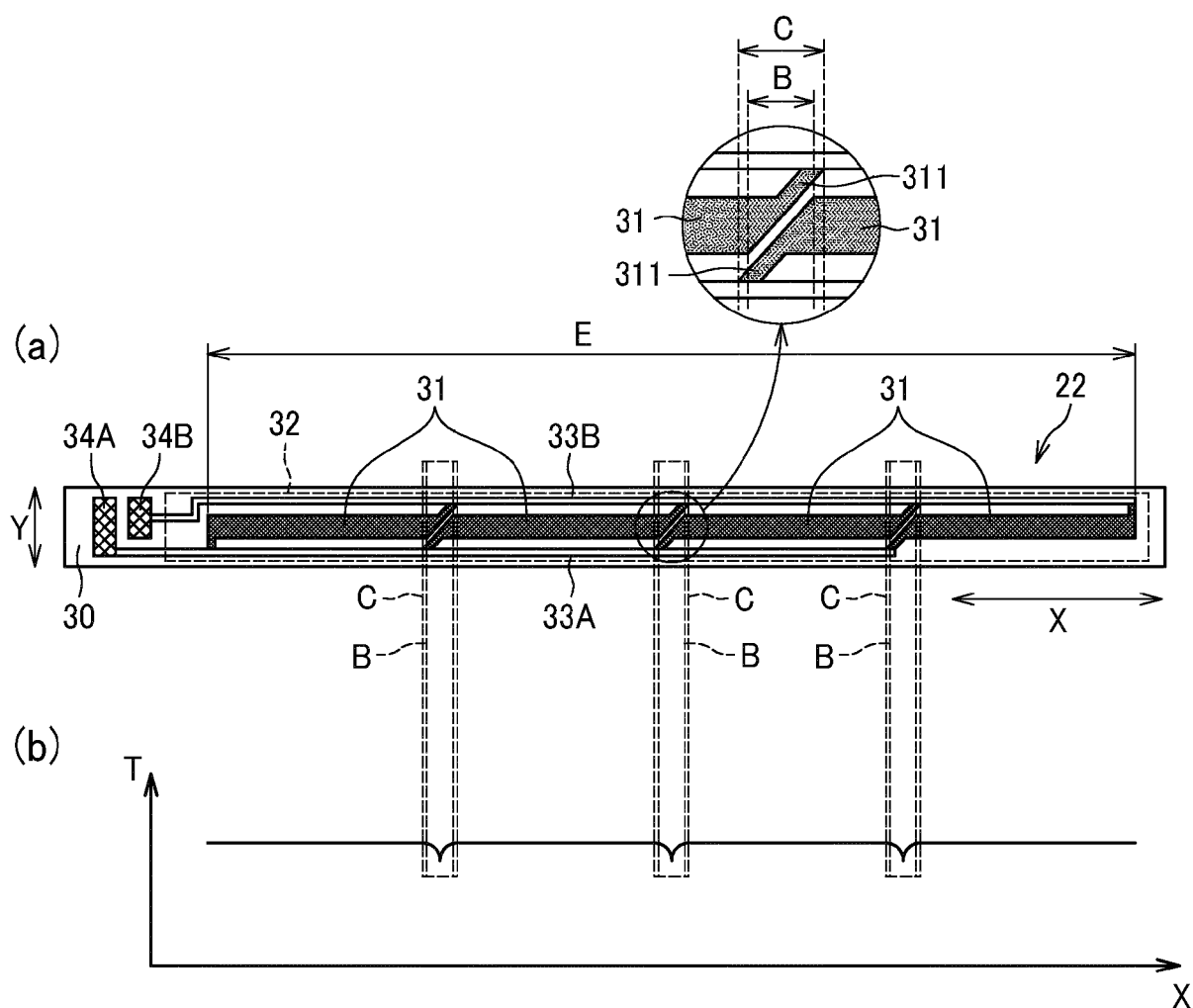


FIG. 22

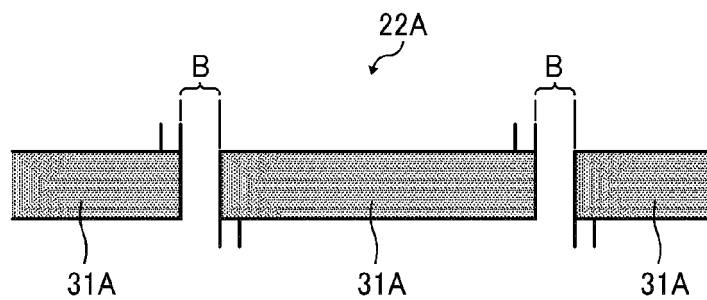


FIG. 23

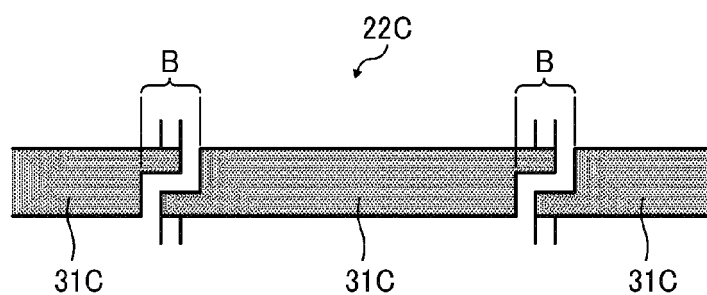


FIG. 24

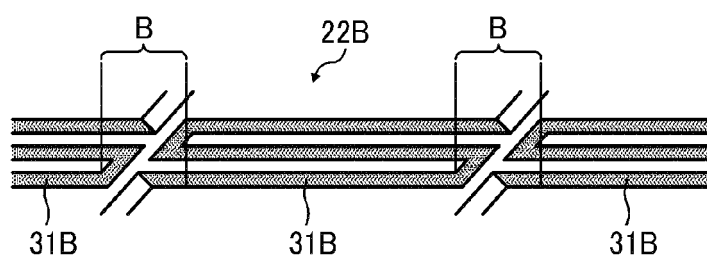


FIG. 25

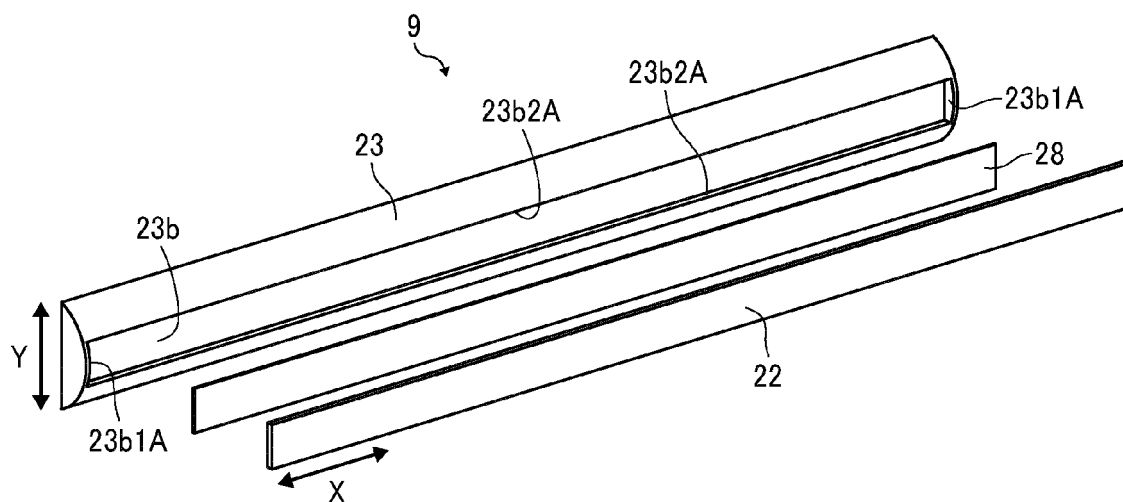


FIG. 26

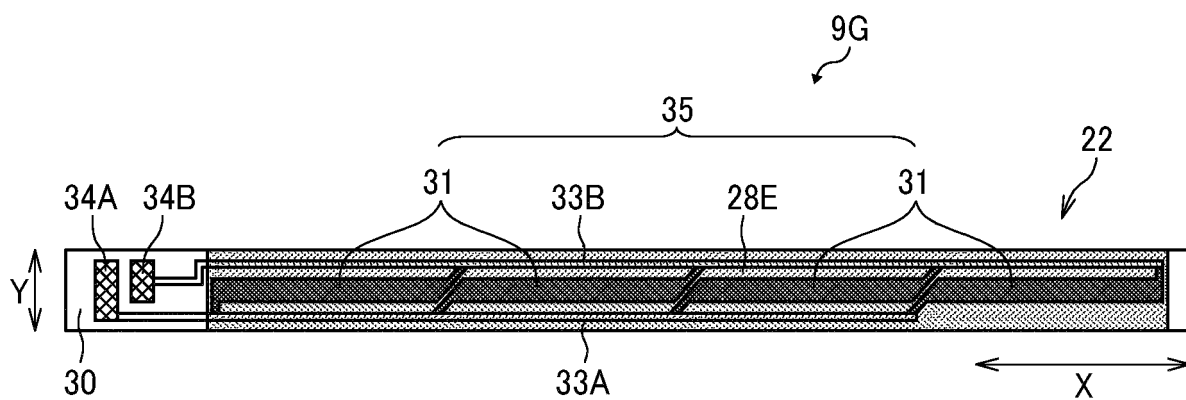


FIG. 27

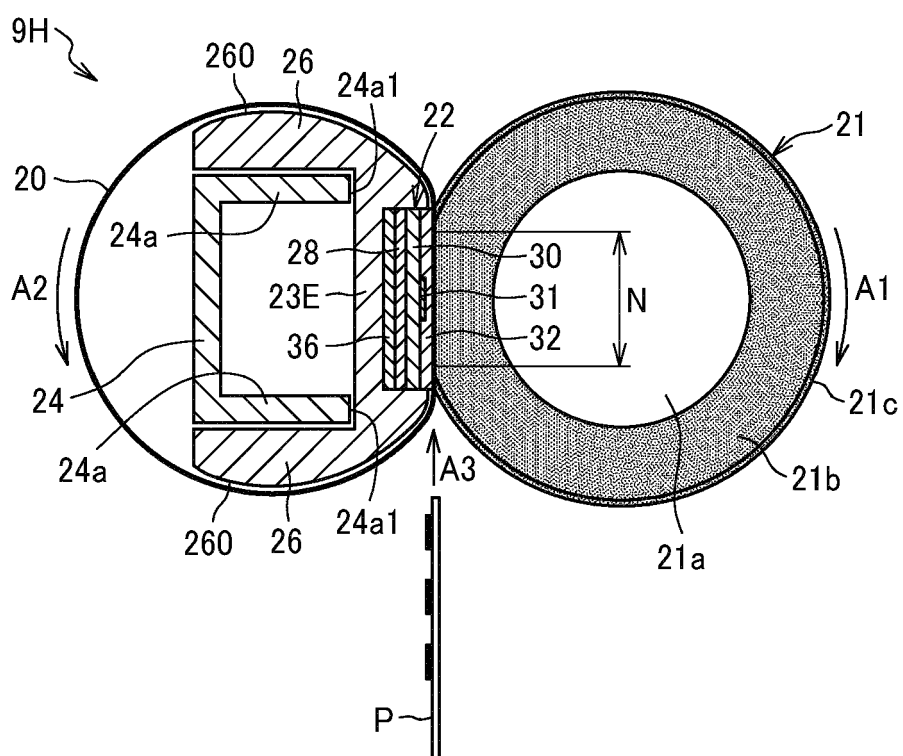


FIG. 28

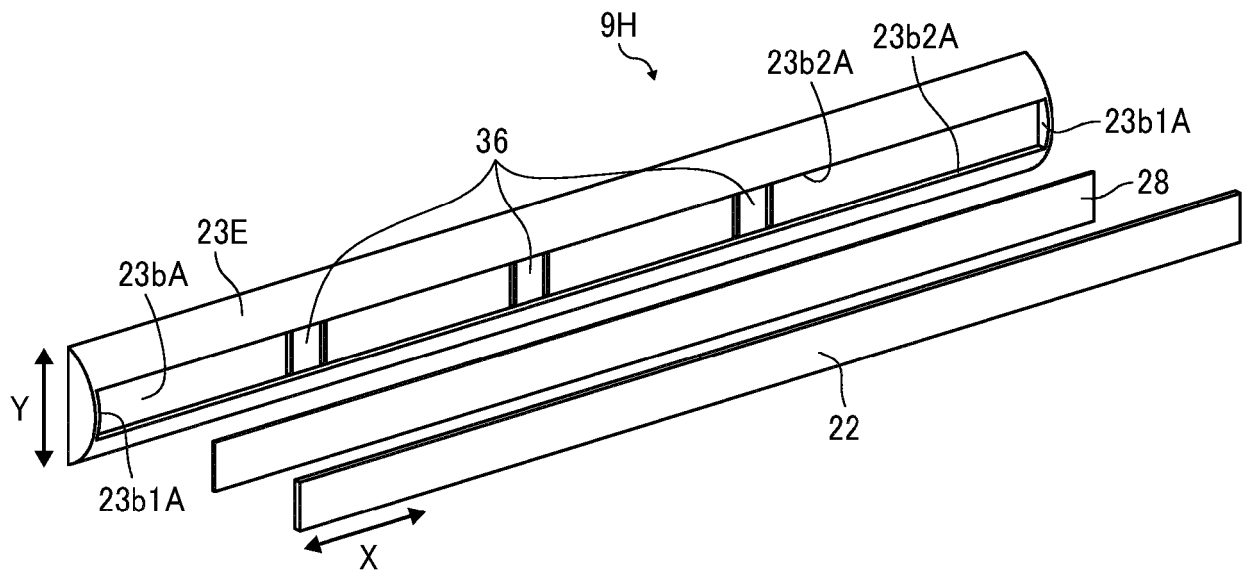


FIG. 29

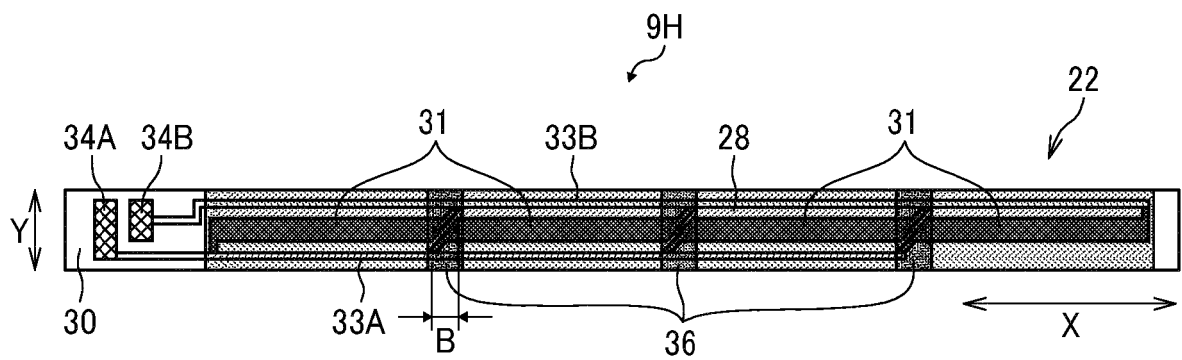


FIG. 30

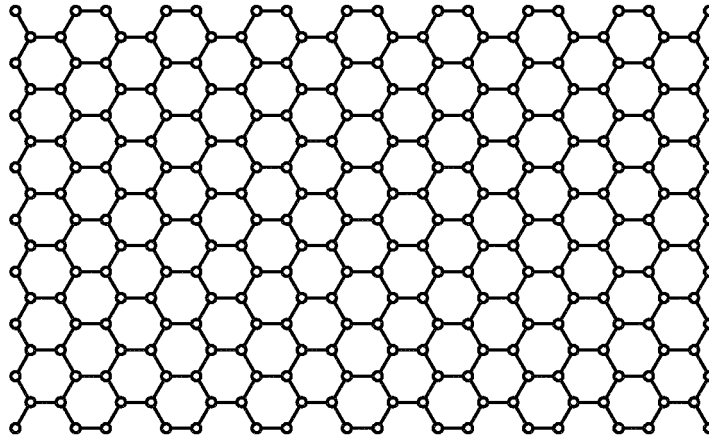


FIG. 31

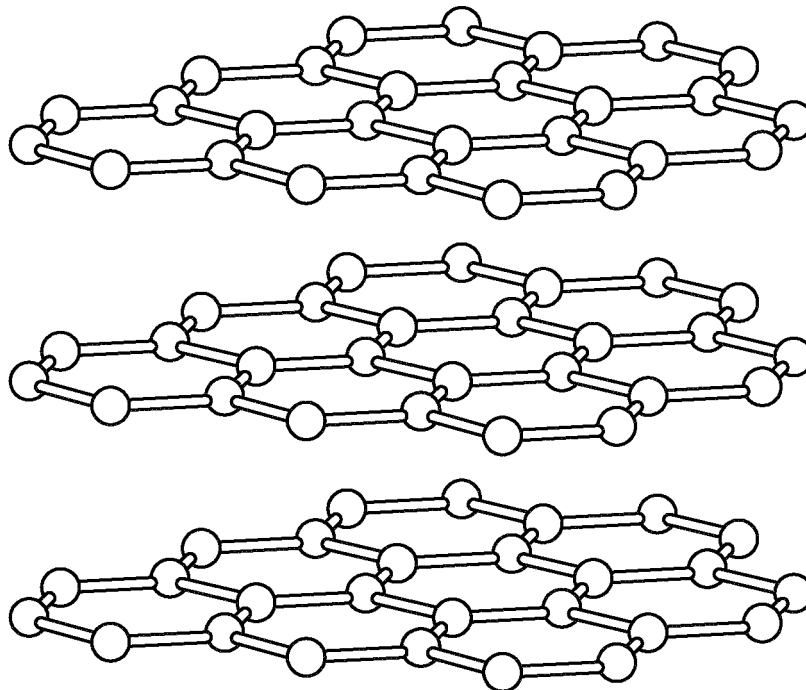


FIG. 32

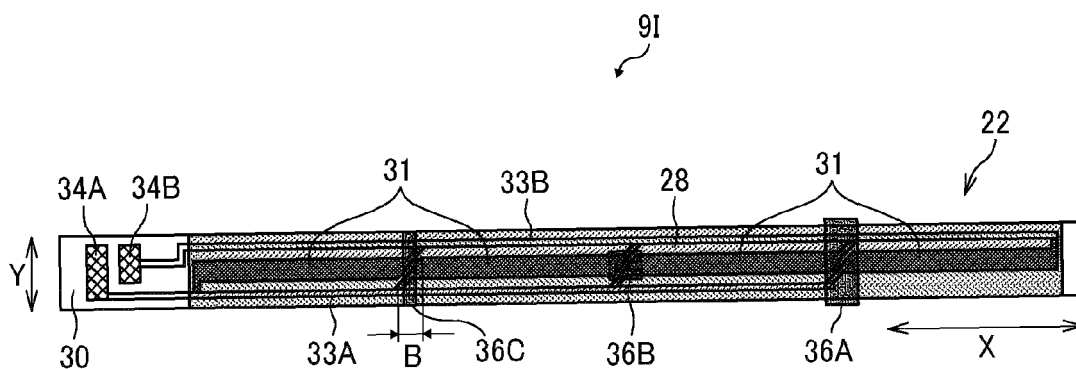


FIG. 33

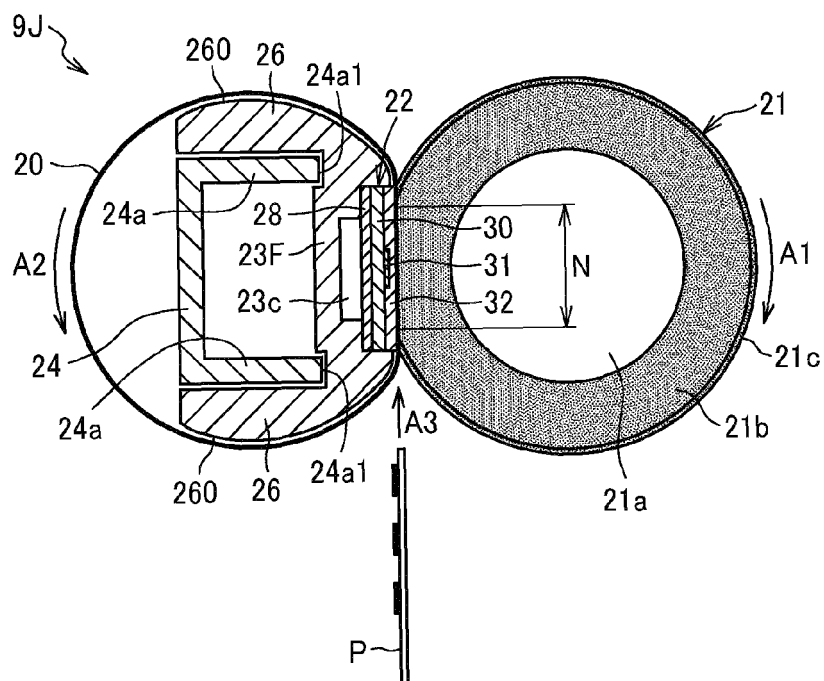


FIG. 34

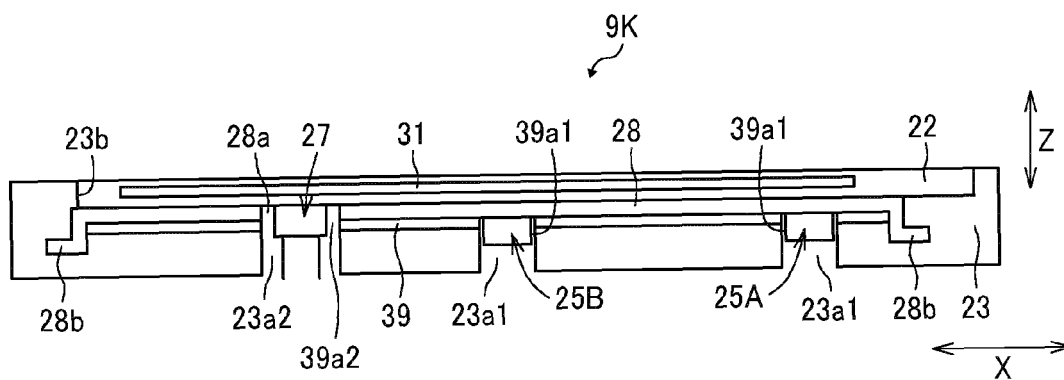


FIG. 35

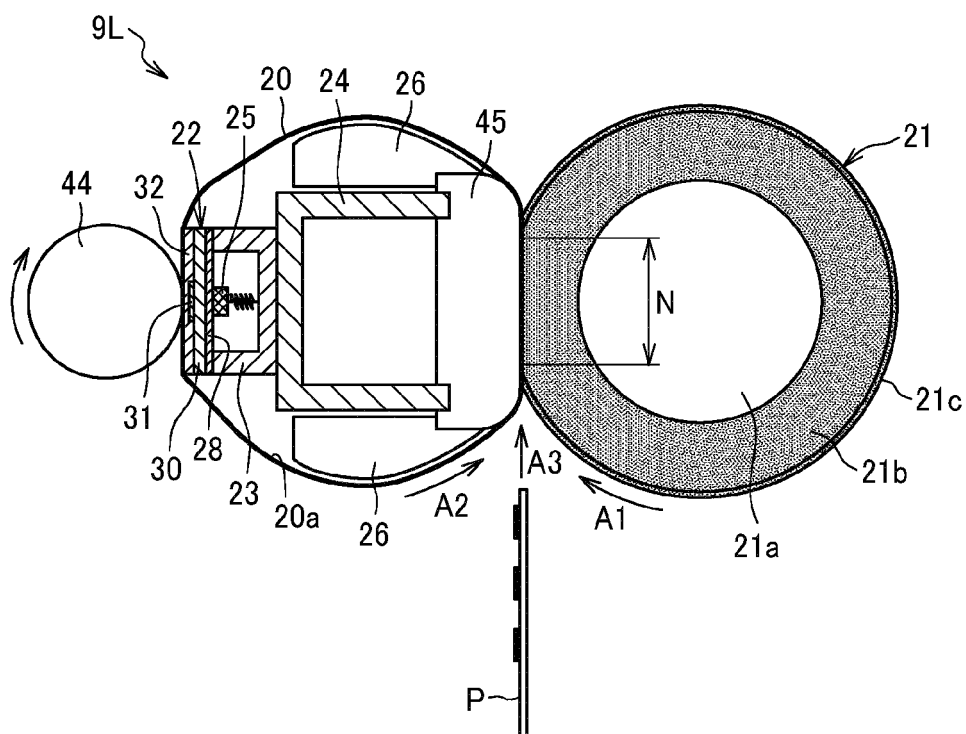


FIG. 36

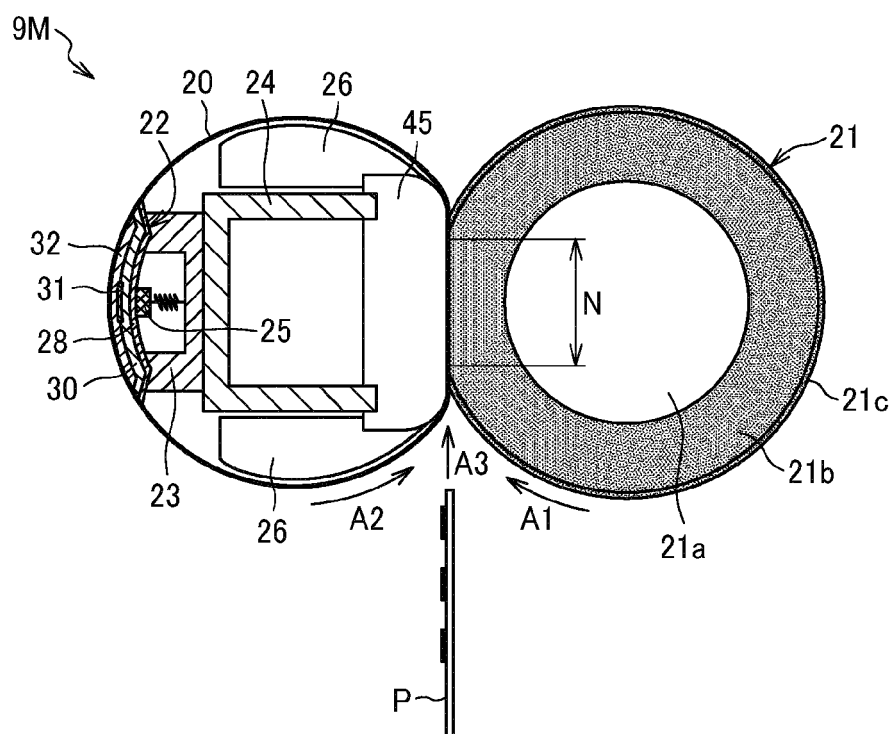


FIG. 37

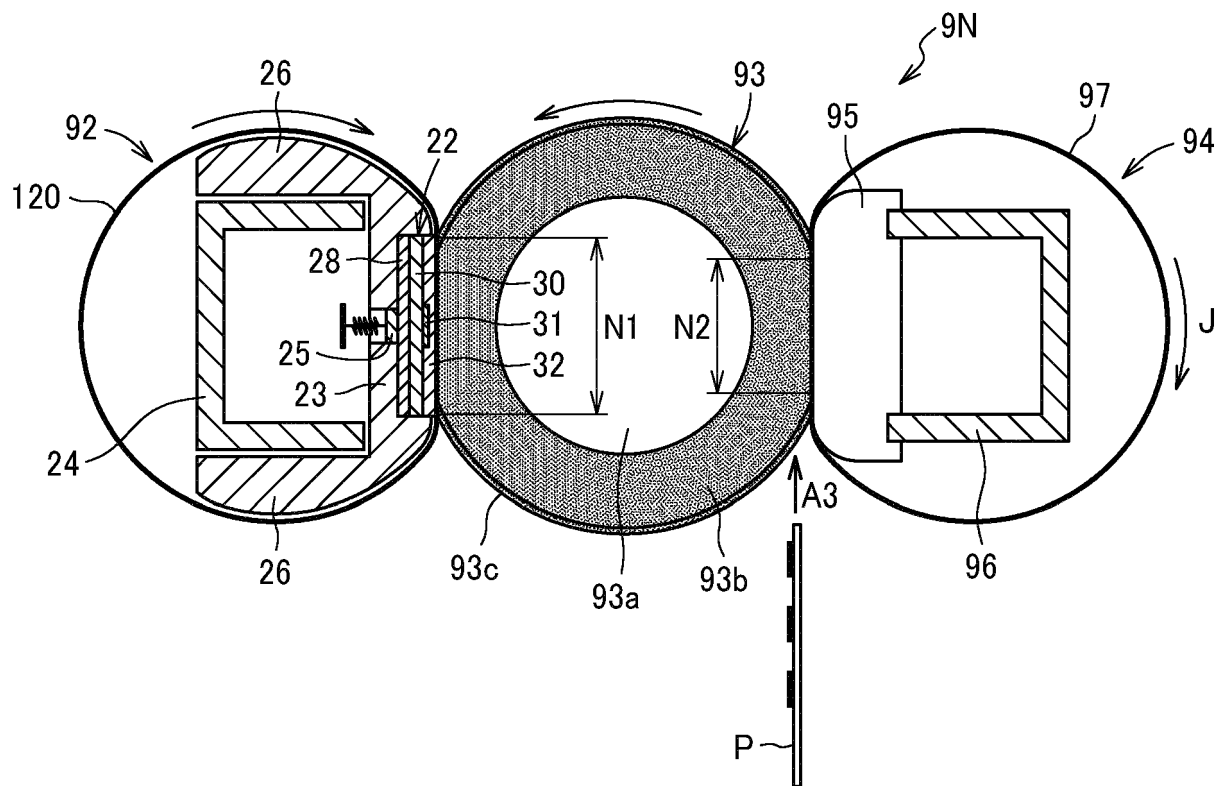


FIG. 38

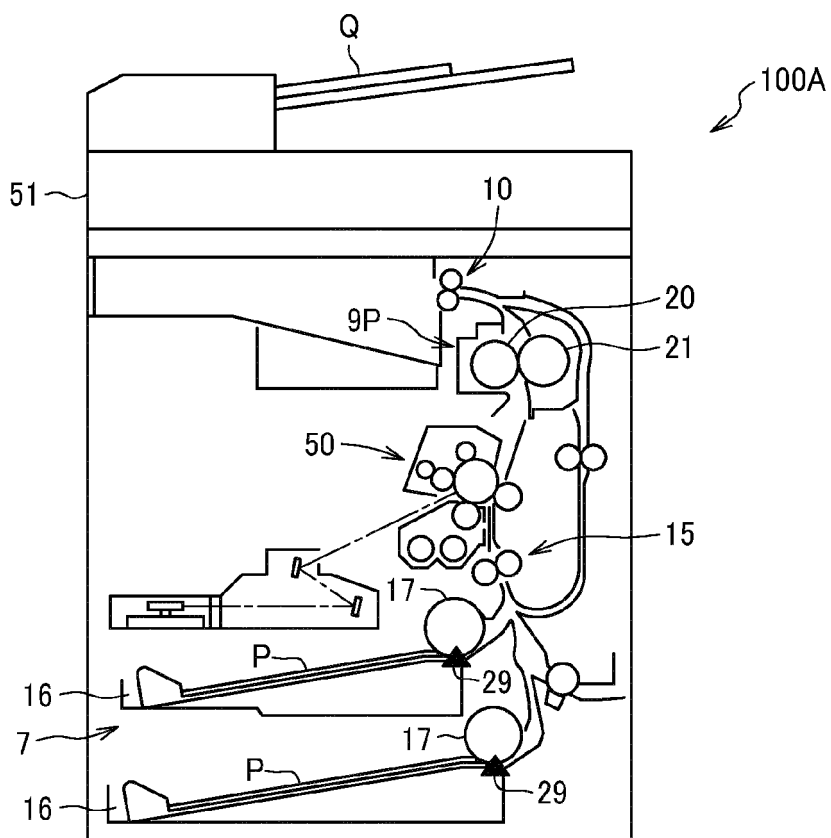


FIG. 39

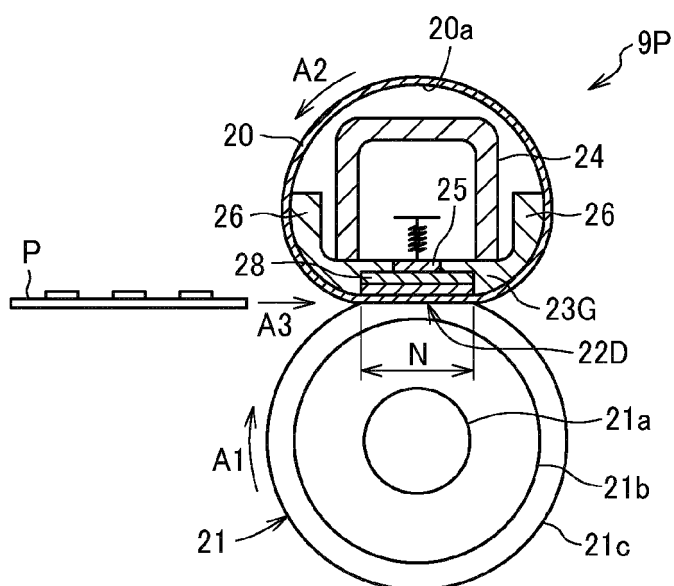


FIG. 40

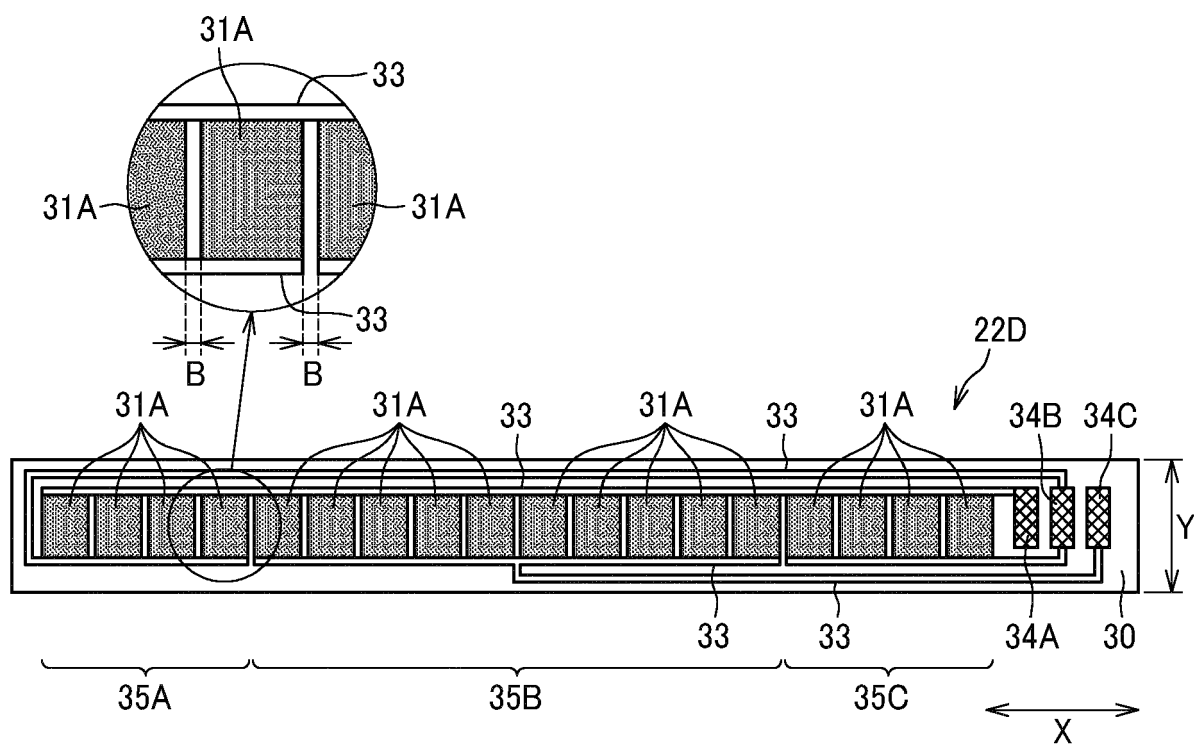


FIG. 41

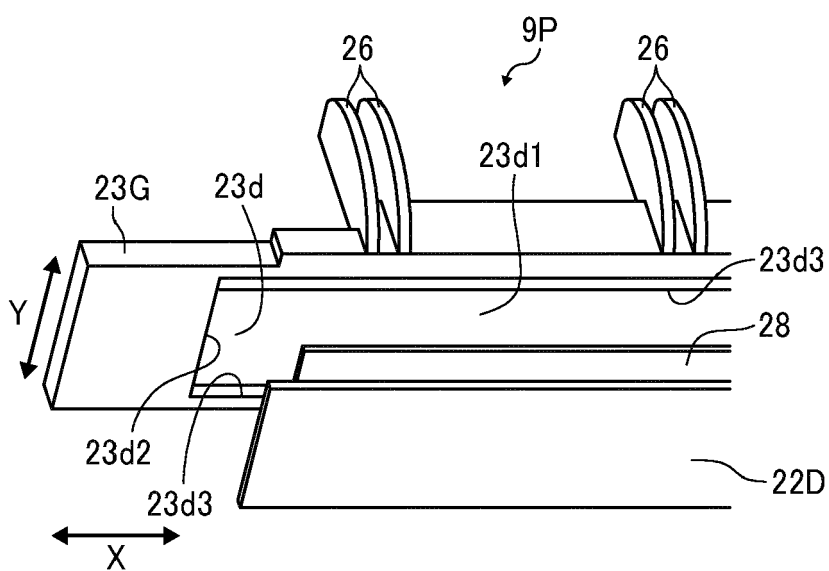


FIG. 42

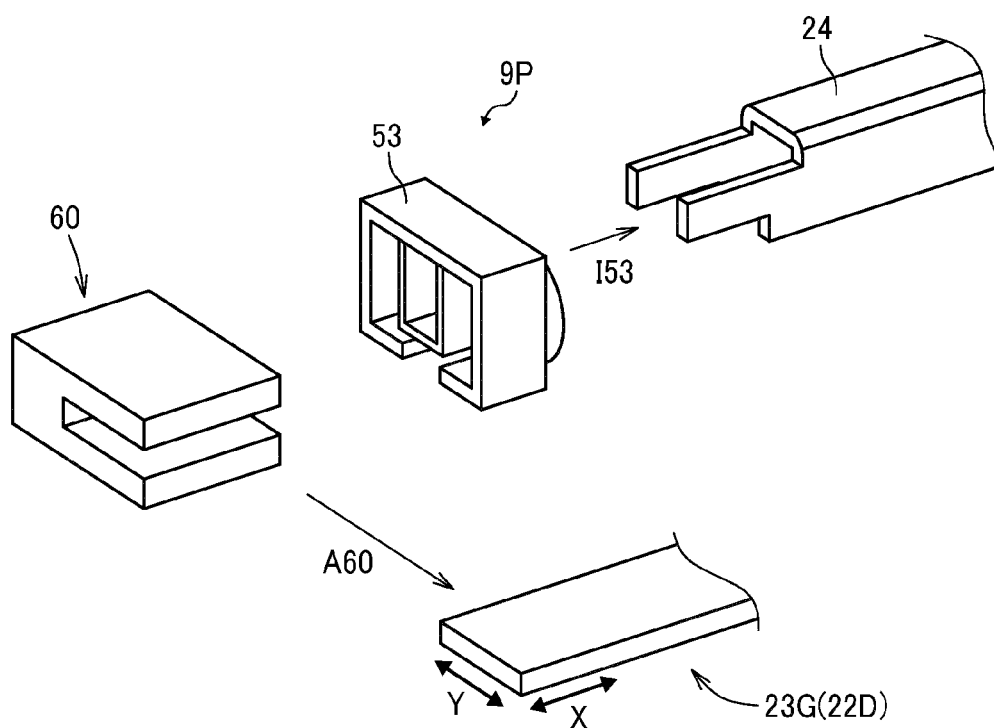


FIG. 43

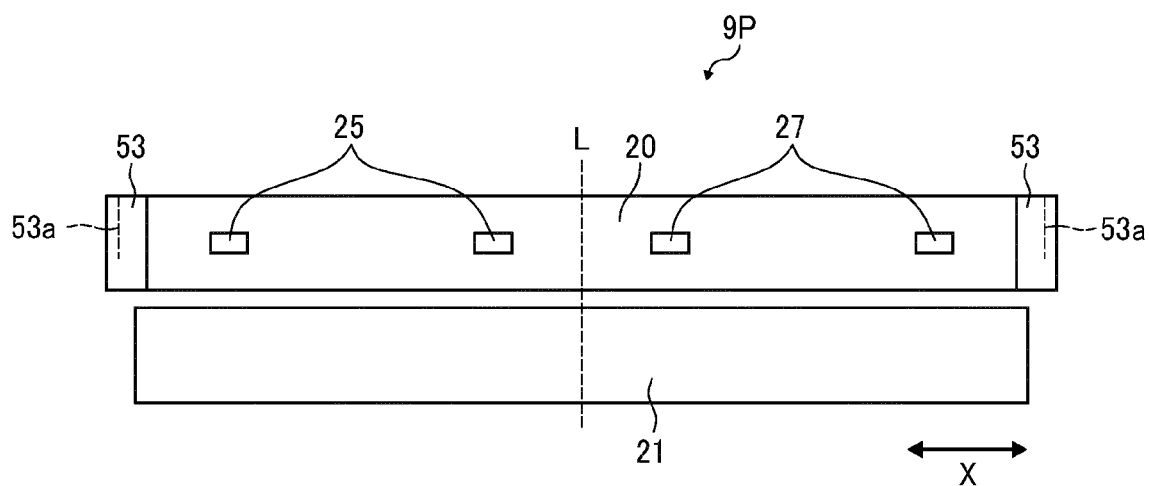
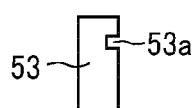


FIG. 44





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EP 24 17 1881

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Place of search Munich		Date of completion of the search 14 October 2024	Examiner Rubio Sierra, F
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