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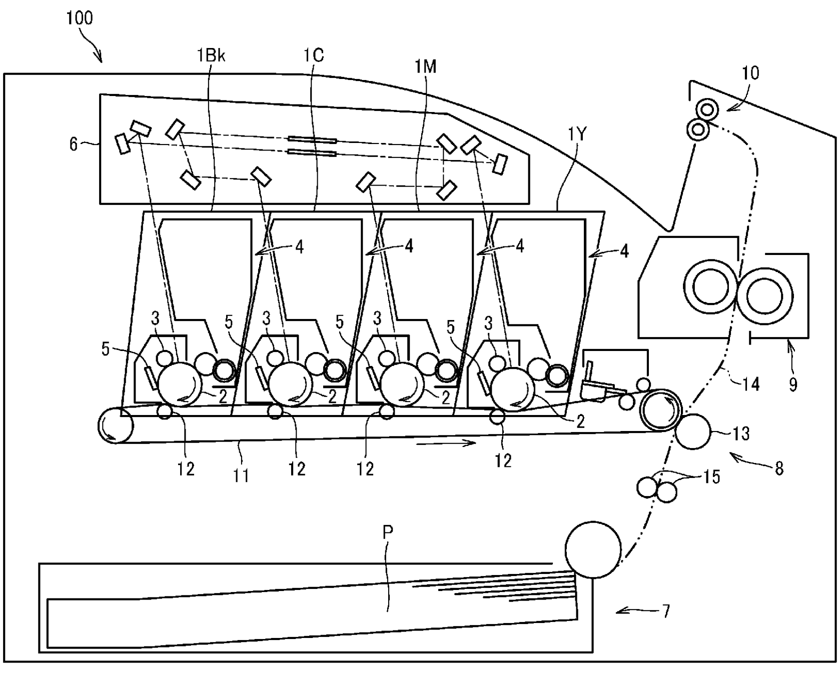
(54) **HEATING DEVICE, FIXING DEVICE, DRYING DEVICE, AND IMAGE FORMING APPARATUS**

(57) A heating device (200) includes a tube (20), a heater (22), and a flange (53). The tube (20) is rotatable and extends in a longitudinal direction of the tube (20). The heater (22) heats the tube (20). The flange (53) holds the heater (22) and an end of the tube (20) in the longitudinal direction. The flange (53) has a recess (53d) in which the heater (22) is held and a bridging portion (53h) bridging the recess (53d). The heater (22) has a protrusion (22p) on at least one end of both ends of the heater (22) in the longitudinal direction, and the protrusion (22p) protrudes outside the bridging portion (22p) in the longitudinal direction.

FIG. 1



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Description

BACKGROUND

Technical Field

[0001] Embodiments of the present disclosure relate to a heating device, a fixing device, a drying device, and an image forming apparatus.

Related Art

[0002] One type of fixing device in an image forming apparatus such as a copier or a printer typically known in the art includes a heating device using a planar heater (a resistive heat generator) to heat a fixing belt. On an end of the planar heater in a rotation axis direction of the fixing belt, an identification symbol is typically disposed. A worker sees and checks the identification symbol to confirm whether the heater assembled to the fixing device has a desired specification with respect to a power source voltage.

[0003] For example, Japanese Unexamined Patent Application Publication No. 2022-133736 discloses a planar heater that includes a base, a resister pattern, a conductor pattern, a power supply electrode, and a base pattern. The base includes a surface portion made of insulative material. The resistor pattern is on the base. The conductor pattern is on the base and electrically coupled to the resistor pattern. The power supply electrode is electrically coupled to the conductor pattern. The base pattern is on the base and made of a material different from a material of the surface portion of the base to print visible identification information.

[0004] The fixing device includes belt supports supporting both ends of the fixing belt in the rotation axis direction of the fixing belt. For example, Japanese Unexamined Patent Application Publication No. 2013-117576 discloses a heating device to heat a recording medium passing through a nip. The heating device includes an endless belt rotatably supported, a stay, a heater, a pressure applying member, and supports. The supports disposed at both ends of the belt in the rotational axis direction of the belt. The support has a first support supporting an end of the stay and a second support supporting an end of the heater. The first support and the second support form one component attachable to and detachable from both the end of the stay and the end of the heater and can relatively move in at least a pressing direction in which the pressure applying member presses.

[0005] The belt support is likely to hide the identification symbol so that the worker cannot confirm the identification symbol. The fixing device is desired to prevent the above-described disadvantage.

SUMMARY

[0006] An object of the present disclosure is to prevent the mark from becoming difficult to be visually recognized. In order to achieve this object, there is provided a heating device according to claim 1. Advantageous embodiments are defined by the dependent claims.

[0007] Advantageously, the heating device includes a tube, a heater, and a flange. The tube is rotatable and extends in a longitudinal direction of the tube. The heater heats the tube. The flange has a recess in which the heater is held and a bridging portion bridging the recess. The heater has a protrusion on at least one end of both ends of the heater in the longitudinal direction. The protrusion protrudes outside the bridging portion in the longitudinal direction.

[0008] According to one aspect of the present disclosure, the mark is prevented from becoming difficult to be visually recognized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] 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 diagram of a configuration of an image forming apparatus according to an embodiment of the present disclosure;
FIG. 2 is a schematic sectional side view of a fixing device according to an embodiment of the present disclosure;
FIG. 3 is a perspective view of a heater according to a first embodiment of the present disclosure;
FIG. 4 is a plan view of the heater of FIG. 3;
FIG. 5 is a diagram of a power supply circuit to supply power to the heater of FIG. 3;
FIG. 6 is a flowchart of a control operation of the heater of FIG. 3;
FIG. 7 is a plan view of a heater according to a second embodiment;
FIG. 8 is a perspective view of a connector as a power supply component connected to a heater;
FIG. 9 is a plan view of a heater according to a second embodiment;
FIG. 10 is a schematic diagram of the heater of FIG. 7, a pressure roller, and a maximum sheet;
FIG. 11 is a schematic diagram of the heater of FIG. 7, a pressure roller including a high-friction portion, and a maximum sheet;
FIG. 12 is a schematic diagram of a heater according to a third embodiment, a pressure roller, and a maximum sheet;
FIG. 13 is a perspective view of a flange to illustrate the shape of the flange;
FIGS. 14AA, 14AB, and 14B are diagrams illustrat-

ing a problem regarding the shape of a flange;

FIG. 15A is a side view of the flange of FIGS. 14A and 14B;

FIG. 15B is a side view of a flange including a bridging portion;

FIG. 16 is a schematic diagram illustrating a fixing device including a heater that has a characteristic part of the present disclosure;

FIG. 17A is a plan view of a heater having a characteristic part of the present disclosure;

FIG. 17B is a schematic diagram of the heater of FIG. 17A and flanges;

FIG. 18A is a graph illustrating a temperature distribution of a heater according to a comparative example;

FIG. 18B is a plan view of the heater of FIG. 18A and a maximum sheet;

FIG. 19A is a graph illustrating a temperature distribution of a heater according to the present disclosure;

FIG. 19B is a plan view of the heater of FIG. 19A and a maximum sheet;

FIG. 20A is a plan view of a heater including resistive heat generators that have a high resistance value;

FIG. 20B is a plan view of a heater including resistive heat generators that have a low resistance value;

FIG. 21A is a graph of a temperature distribution of a heater including end heat generators;

FIG. 21B is a plan view of a heater including end heat generators that change the total area of heat generators and a maximum sheet;

FIG. 21C is a plan view of a part of the heater indicated by the circle of FIG. 21B;

FIG. 22A is a graph of a temperature distribution of a heater including heat generators that have a total area different from the area of the heater of FIG. 21B;

FIG. 22B is a plan view of a heater including heat generators that have a total area different from the area of the heater of FIG. 21B;

FIGS. 23A and 23B are diagrams each illustrating a bridging portion;

FIG. 24 is a schematic sectional side view of a fixing device to illustrate a modification of the arrangement of the thermistor;

FIG. 25 is a schematic sectional side view of a fixing device different from the above;

FIG. 26 is a schematic sectional side view of a fixing device different from the above;

FIG. 27 is a schematic sectional side view of a fixing device different from the above;

FIG. 28 is a schematic diagram illustrating a configuration of an image forming apparatus different from the image forming apparatus of FIG. 1;

FIG. 29 is a schematic sectional side view of a fixing device different from the above;

FIG. 30 is a plan view of a heater according to a fourth embodiment;

FIG. 31 is a perspective view of a part of a heater and a part of a heater holder;

FIG. 32 is a perspective view to illustrate a method of attaching a connector to a heater and a method of attaching a flange to a stay;

FIG. 33 is a schematic diagram illustrating an arrangement of thermistors and thermostats;

FIG. 34 is a schematic diagram illustrating a groove of a flange;

FIG. 35 is a schematic sectional side view of a fixing device different from the above;

FIG. 36 is a perspective view of a heater, a first high thermal conductor, a second high thermal conductor, and a heater holder;

FIG. 37 is a plan view of a heater to illustrate an arrangement of a first high thermal conductor and second high thermal conductors;

FIG. 38 is a diagram illustrating another arrangement of first high thermal conductors and second high thermal conductors;

FIG. 39 is a plan view of a heater to illustrate other examples of arrangements of the second high thermal conductors;

FIG. 40 is a schematic sectional side view of a fixing device different from the above;

FIG. 41 is a diagram illustrating an atomic crystal structure of graphene; and

FIG. 42 is a diagram illustrating an atomic crystal structure of graphite.

[0010] 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

[0011] 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.

[0012] 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.

[0013] In the drawings for illustrating embodiments of the present disclosure, like elements or like components in function or shape are given like reference signs as far as distinguishable, and overlapping descriptions may be omitted.

[0014] FIG. 1 is a schematic diagram of a configuration of an image forming apparatus 100 according to an embodiment of the present disclosure.

[0015] The image forming apparatus 100 illustrated in FIG. 1 includes four image forming units 1Y, 1M, 1C, and 1Bk detachably attached to an image forming apparatus body. The image forming units 1Y, 1M, 1C, and 1Bk have the same configuration except for containing different color developers, i.e., yellow (Y), magenta (M), cyan (C), and black (Bk) toners, respectively, corresponding to decomposed color separation components of full-color images. Specifically, each of the image forming units 1Y, 1M, 1C, and 1Bk includes a photoconductor 2 that is drum-shaped and serves as an image bearer, a charging device 3 to charge a surface of the photoconductor 2, a developing device 4 to supply toner as a developer to the surface of the photoconductor 2 to form a toner image, and a cleaner 5 to clean the surface of the photoconductor 2.

[0016] The image forming apparatus 100 further includes an exposure device 6, a sheet feeder 7, a transfer device 8, a fixing device 9, and a sheet ejection device 10. The exposure device 6 exposes the surface of each of the photoconductors 2 and forms an electrostatic latent image on the surface of each of the photoconductors 2. The sheet feeder 7 supplies a sheet P serving as a recording medium to the transfer device 8. 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 the sheet P thereon. The sheet ejection device 10 ejects the sheet P to the outside of the image forming apparatus 100.

[0017] 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 stretched taut across a plurality of rollers. The four primary transfer rollers 12 serve as primary transferors that 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 serves as a secondary transferor that transfers the full-color toner image formed on the intermediate transfer belt 11 onto the sheet P. The four primary transfer rollers 12 are in contact with the respective photoconductors 2 via the intermediate transfer belt 11. Thus, the intermediate transfer belt 11 contacts each of the photoconductors 2, forming a primary transfer nip therebetween. The secondary transfer roller 13 contacts, via the intermediate transfer belt 11, one of the plurality of rollers around which the intermediate transfer belt 11 is stretched. Thus, the secondary transfer nip is formed between the secondary transfer roller 13 and the intermediate transfer belt 11.

[0018] The image forming apparatus 100 includes a sheet conveyance path 14 through which the sheet P fed from the sheet feeder 7 is conveyed. A timing roller pair 15 is disposed in the sheet conveyance path 14 at a position between the sheet feeder 7 and the secondary transfer nip defined by the secondary transfer roller 13.

[0019] Referring to FIG. 1, a description is provided of printing processes performed by the image forming apparatus 100 described above.

[0020] When the image forming apparatus 100 receives an instruction to start printing, a driver drives and rotates the photoconductor 2 clockwise in FIG. 1 in each of the image forming units 1Y, 1M, 1C, and 1Bk. The charging device 3 charges the surface of the photoconductor 2 uniformly at a high electric potential. Subsequently, the exposure device 6 exposes the surface of each of the photoconductors 2 based on image data created by a document reading device that reads an image on an original or print data instructed by a terminal, thus decreasing the electric potential of an exposed portion on the photoconductor 2 and forming an electrostatic latent image on the photoconductor 2. The developing device 4 supplies toner to the electrostatic latent image formed on the photoconductor 2, forming a toner image thereon.

[0021] The toner images formed on the photoconductors 2 reach the primary transfer nips defined by the primary transfer rollers 12 with the rotation of the photoconductors 2 and are transferred 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, forming a full-color toner image thereon. The full-color toner image on the intermediate transfer belt 11 is conveyed to the secondary transfer nip defined by the secondary transfer roller 13 as the intermediate transfer belt 11 rotates. At the secondary transfer nip, the full-color toner image is transferred onto the sheet P conveyed to the secondary transfer nip. The sheet P is supplied from the sheet feeder 7. The timing roller pair 15 temporarily halts the sheet P supplied from the sheet feeding device 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. Thus, the full-color toner image is transferred onto and borne on the sheet P. After the toner image is transferred from each of the photoconductors 2 onto the intermediate transfer belt 11, each of cleaning devices 5 removes residual toner on each of the photoconductors 2.

[0022] 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 sheet ejection device 10 ejects the sheet P onto the outside of the image forming apparatus 100, thus finishing a series of printing processes.

[0023] A description is given of the fixing device 9.

[0024] In the following description, the longitudinal direction of the heater is indicated by X as illustrated in FIG. 3. The longitudinal direction of the heater is along the surface of the base on which the resistive heat generators are provided. The longitudinal direction of the heater is also in parallel with the rotational axis direction of the fixing belt or other parts in the fixing device, the longitudinal direction of the fixing belt, or a direction in which the resistive heat generators are arranged that is referred to as an arrangement direction. A short-side direction of the heater (also referred to as a width direction of the heater) is orthogonal to the longitudinal direction and indicated by Y as illustrated in FIG. 3. A thickness direction of the heater (also referred to as a height direction) is orthogonal to the longitudinal direction and the short-side direction of the heater and is indicated by Z as illustrated in FIG. 3.

[0025] As illustrated in FIG. 2, the fixing device 9 according to the present embodiment includes an endless fixing belt 20, a pressure roller 21 as a pressure rotator that contacts an outer circumferential surface of the fixing belt 20 to form a fixing nip N, a heater 22 to heat the fixing belt 20, a heater holder 23 to hold the heater 22, a stay 24 as a support to support the heater holder 23, and thermistors 25 as temperature detectors to detect temperature of the fixing belt 20.

[0026] The fixing belt 20 includes a tubular base that is made of polyimide (PI) and has an outer diameter of 25 mm and a thickness in a range of 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 tetrafluoroethylene-perfluoroalkylvinylether copolymer (PFA) or polytetrafluoroethylene (PTFE) and has a thickness in a range of 5 μm to 50 μm to enhance the durability of the fixing belt 20 and facilitate separation of the sheet P and a foreign substance from the fixing belt 20. An elastic layer made of rubber having a thickness of from 50 to 500 μm may be interposed between the base and the release layer. The base of the fixing belt 20 may be made of heat-resistant resin such as polyetheretherketone (PEEK) or metal such as nickel (Ni) and steel use stainless (SUS), instead of polyimide. The inner circumferential surface of the fixing belt 20 may be coated with PI or PTFE as a slide layer.

[0027] The pressure roller 21 having, for example, an outer diameter of 25 mm, includes a solid iron core 21a, an elastic layer 21b formed on the surface of the core 21a, and a release layer 21c formed on the outside of the elastic layer 21b. The elastic layer 21b is made of silicone rubber and has a thickness of 3.5 mm, for example. Preferably, the release layer 21c is formed by a fluororesin layer having, for example, a thickness of approximately 40 μm on the surface of the elastic layer 21b to enhance releasability.

[0028] The pressure roller 21 is biased toward the fixing belt 20 by a biasing member and pressed against the heater 22 via the fixing belt 20. Thus, the fixing nip N is formed between the fixing belt 20 and the pressure roller 21. A driver drives and rotates the pressure roller 21 in a direction indicated by an arrow in FIG. 2, and the rotation of the pressure roller 21 rotates the fixing belt 20.

[0029] The heater 22 has a planar shape extending in a width direction of the fixing belt 20 and includes a planar base 30, resistive heat generators 31 disposed on the base 30, and an insulation layer 32 covering the resistive heat generators 31. The insulation layer 32 of the heater 22 contacts the inner circumferential surface of the fixing belt 20, and the heat generated by the resistive heat generators 31 is transmitted to the fixing belt 20 through the insulation layer 32. Although the resistive heat generators 31 and the insulation layer 32 are disposed on the side of the base 30 facing the fixing belt 20 (that is, the fixing nip N) in the present embodiment, the resistive heat generators 31 and the insulation layer 32 may be disposed on the opposite side of the base 30, that is, the side facing the heater holder 23. In this case, since the heat of the resistive heat generator 31 is transmitted to the fixing belt 20 through the base 30, it is preferable that the base 30 be made of a material with high thermal conductivity such as aluminum nitride. Making the base 30 with the material having high thermal conductivity enables the fixing belt 20 to be heated sufficiently even if the resistive heat generators 31 are disposed on the side of the base 30 opposite to the side facing the fixing belt 20. The heater 22 according to the present disclosure has various aspects that may be applied, which are described below.

[0030] A detailed description is now given of the construction of the heater holder 23 and the stay 24. The heater holder 23 and the stay 24 are disposed inside a loop formed by the fixing belt 20. The stay 24 is made of a metal channel member, and both side plates of the fixing device 9 support both ends of the stay 24. Since the stay 24 supports the heater holder 23 and the heater 22 held by the heater holder 23, the heater 22 reliably receives a pressing force of the pressure roller 21 pressed against the fixing belt 20 and stably forms the fixing nip N.

[0031] Since the heater holder 23 is heated to a high temperature by heat from the heater 22, the heater holder 23 is preferably made of a heat-resistant material. The heater holder 23 made of heat-resistant resin having low thermal conduction, such as a liquid crystal polymer (LCP), reduces heat transfer from the heater 22 to the heater holder 23 and provides efficient heating of the fixing belt 20. To reduce the contact area in which the heater holder 23 contacts the heater 22 and decrease the amount of heat transferred from the heater 22 to the heater holder 23, the heater holder 23 includes projections 23a in contact with the base 30 of the heater 22. The projection 23a of the heater holder 23 in the present embodiment contacts the back side of the base 30 not facing the resistive heat generator 31, which avoids contacting the projection 23a to a portion of the base 30 in which the temperature is likely to increase. Such a configuration further reduces the amount of heat transferred to the heater holder 23 and can effectively heat the fixing belt 20.

[0032] In addition, the heater holder 23 includes guides 26 to guide the fixing belt 20. The guides 26 include upstream guides upstream from the heater 22 (that is under the heater 22 in FIG. 2) and downstream guides downstream from the heater 22 (that is over the heater 22 in FIG. 2) in a rotation direction of the fixing belt 20. As illustrated in FIG. 3, the upstream guides and the downstream guides of the guides 26 are disposed at intervals in the longitudinal direction of the heater 22 (in other words, in the width direction of the fixing belt 20). Each guide 26 is formed in a substantially fan shape and has an arc-shaped or convexly curved belt-facing surface 260 extending in a circumferential direction of the fixing belt 20 so as to face the inner circumferential surface of the fixing belt 20 (see FIG. 2). As illustrated in FIG. 3, a width β of the guides 26 arranged at both ends in the longitudinal direction of the heater 22 is larger than a width β of the other guides 26. Other than this, the guides 26 have the same length (the same circumferential length) L in the belt circumferential direction, the same width β, and the same height E.

[0033] When the fixing device 9 according to the present embodiment starts printing, the pressure roller 21 is driven to rotate, and the fixing belt 20 starts to be rotated. The belt-facing surface 260 of the guide 26 contacts and guides the inner circumferential surface of the fixing belt 20 to stably and smoothly rotate the fixing belt 20. As power is supplied to the resistive heat generators 31 of the heater 22, the heater 22 heats the fixing belt 20. The sheet P bearing the unfixed toner image is conveyed through the fixing nip N between the fixing belt 20 having the temperature that has reached a predetermined target temperature (which is referred to as a fixing temperature) and the pressure roller 21 as illustrated in FIG. 2, and applying heat and pressure to the unfixed toner image fixes the unfixed toner image onto the sheet P.

[0034] The following describes the heater according to a first embodiment of the present disclosure.

[0035] FIG. 4 is a plan view of the heater according to the first embodiment.

[0036] As illustrated in FIG. 4, the heater 22 according to the first embodiment includes multiple resistive heat generators 31 disposed at intervals in the longitudinal direction (that is the width direction of the fixing belt). In other words, the multiple resistive heat generators 31 configure a heat generation portion 35 including portions arranged in the width direction of the fixing belt 20. The resistive heat generators 31 are electrically coupled in parallel to a pair of electrodes 34 disposed on both ends of the base 30 in the longitudinal direction of the base 30 via power supply lines 33. The power supply line 33 is made of a conductor having a resistance value smaller than that of the resistive heat generator 31. A gap between neighboring resistive heat generators 31 is preferably 0.2 mm or more, and is more preferably 0.4 mm or more, from the viewpoint of maintaining the insulation between the neighboring resistive heat generators 31. In addition, the gap between the resistive heat generators 31 adjacent to each other is preferably 5 mm or less, more preferably 1 mm or less from the viewpoint of reducing temperature unevenness along the longitudinal direction because too large gap between the heat generators 31 adjacent to each other easily causes a temperature drop in the gap.

[0037] The resistive heat generator 31 is made of a material having a positive temperature coefficient (PTC) of resistance that is a characteristic that the resistance value increases (the heater output decreases) as the temperature T increases.

[0038] When the small sheets each having a width smaller than the entire width of the heat generation portion 35 pass through the fixing device 9, the temperature of a region of the resistive heat generator 31 corresponding to a region of the fixing belt 20 that is not in contact with the small sheet increases because the small sheet does not absorb heat of the fixing belt 20 in the region that is not in contact with the small sheet, in other words, the region outside a small sheet passing region of the fixing belt 20 on which the small sheet passes. Since a constant voltage is applied to the resistive heat generators 31, the increase in resistance values of the resistive heat generators 31 caused by the temperature increase in the regions outside the width of the small sheets relatively reduces outputs (heat generation amounts) of the resistive heat generators 31 in the regions, thus restraining an increase in temperature in the regions that are end portions of the fixing belt outside the small sheets. Electrically coupling the multiple resistive heat generators 31 in parallel can prevent temperature rises in non-sheet passing regions while maintaining the print speed. The heat generator that configures the heat generation portion 35 may not be the resistive heat generator having the PTC characteristic. The resistive heat generators in the heater 22 may be arranged in a plurality of rows arranged in the short-side direction.

[0039] The resistive heat generators 31 are produced, for example, as below. Silver-palladium (AgPd), glass powder, and the like are mixed to make paste. The paste is coated to the base 30 by screen printing. Thereafter, the base 30 is subject to firing. Then, the resistive heat generators 31 are produced. The resistive heat generators 31 each have a resistance value of 80 Ω at room temperature, in the present embodiment. The material of the resistive heat generators 31 may contain a resistance material, such as silver alloy (AgPt) or ruthenium oxide (RuO_2), other than the above material. Silver (Ag) or silver palladium (AgPd) may be used as a material of the power supply lines 33 and the electrodes 34. Screen-printing such a material forms the power supply lines 33 and the electrodes 34.

[0040] The material of the base 30 is preferably a nonmetallic material having excellent thermal resistance and insulating properties, such as glass, mica, or ceramic such as alumina or aluminum nitride. The base 30 according to the present embodiment uses an aluminum base having a shorter-side width of 8 mm, a longitudinal width of 270 mm, and a thickness of 1.0 mm. The base 30 may be made by layering the insulation material on conductive material such as metal. Low-cost aluminum or stainless steel is favorable as the metal material of the base 30. To enhance the thermal uniformity of the heater 22 and image quality, the base 30 may be made of a material having high thermal conductivity, such as copper, graphite, or graphene.

[0041] The insulation layer 32 may be, for example, a heat-resistant glass layer having a thickness of 75 μm. The insulation layer 32 covers the resistive heat generators 31 and the power supply lines 33 to insulate and protect the resistive heat generators 31 and the power supply lines 33 and maintain sliding performance with the fixing belt 20.

[0042] FIG. 5 is a diagram of a power supply circuit to supply power to the heater according to the first embodiment.

[0043] As illustrated in FIG. 5, an AC power supply 400 is electrically connected to the electrodes 34 of the heater 22 to configure the power supply circuit in the first embodiment that supplies power to the resistive heat generators 31. The power supply circuit includes a triac 401 that controls the amount of supplied power. A controller 402 controls the amount of power supplied to the resistive heat generators 31 via the triac 401 based on temperatures detected by the thermistors 25 as temperature detectors. The controller 402 includes a microcomputer including, for example, a central processing unit (CPU), a read-only memory (ROM), a random-access memory (RAM), and an input and output (I/O) interface.

[0044] In the present embodiment, one of the pair of thermistors 25 as temperature detectors is disposed in the central region of the heater 22 in the longitudinal direction, which is in the smallest span within which sheets are conveyed, and the other one of the pair of thermistors 25 is disposed in one end portion of the heater 22 in the longitudinal direction. A thermostat 27 as a power cut-off device is disposed at one end of the heater 22 in the longitudinal direction and cuts off the power supply to the resistive heat generators 31 when the temperature of the resistive heat generator 31 becomes a predetermined temperature or higher. The thermistors 25 and the thermostat 27 are in contact with a back side of the base 30 (that is a side opposite to a side on which the resistive heat generators 31 are disposed) to detect the temperatures of the resistive heat generators 31.

[0045] The control operation of the heater according to the present embodiment is described below with reference to the flowchart of FIG. 6.

[0046] The image forming apparatus starts a printing operation in step S1 in FIG. 6, and a controller 402 controls an alternating-current power supply 400 to start supplying power to each of the resistive heat generators 31 of the heater 22 in step S2 in FIG. 6. As a result, each resistive heat generator 31 starts to generate heat, and the heat heats the fixing belt 20. At this time, the thermistor 25 disposed in the central region of the heater 22 in the longitudinal direction of the heater 22 (that is a central thermistor) detects a temperature T4 of the resistive heat generator 31 positioned in the central region of the heater 22 in step S3 in FIG. 6. Based on the temperature T4 obtained from the central thermistor 25, the controller 402 controls the amount of power supplied to each resistive heat generator 31 by the triac 401 so that the temperature of each resistive heat generator 31 reaches a predetermined temperature in step S4 in FIG. 6.

[0047] At the same time, the thermistor 25 disposed on one end of the heater 22 in the longitudinal direction (that is an end thermistor) also detects a temperature T8 of the resistive heat generator 31 in step S5 in FIG. 6. Then, the controller 402 determines whether the temperature T8 detected by the thermistor 25 at one end of the heater 22 is equal to or higher than a predetermined temperature TN ($T8 \geq TN$) in step S6 in FIG. 6. If the temperature T8 is lower than the predetermined temperature TN, the controller 402 determines that the temperature is abnormally low due to breakage or disconnection and controls the power supply 400 to cut off the power supplied to the heater 22 in step S7 in FIG. 6. In addition, if the temperature T8 is lower than the predetermined temperature TN, the controller 402 controls an operation panel of the image forming apparatus to display an error message in step S8 in FIG. 6. On the other hand, if the detected temperature T8 is equal to or higher than the predetermined temperature TN, the controller 402 determines that the temperature is not abnormally low and starts the printing operation in step S9 in FIG. 6.

[0048] Further, if breakage or disconnection of the resistive heat generator 31 causes out-of-control in the temperature control based on the detection by the thermistor 25 at the central region, the other resistive heat generators 31 including the resistive heat generator 31 at one end in the longitudinal direction may have an abnormally high temperature. In this case, in response to reaching the temperature of the resistive heat generator 31 to a predetermined temperature or higher, the thermostat 27 operates to cut off the power supply to the resistive heat generator 31, thereby avoiding the resistive heat generator 31 from reaching an abnormally high temperature.

[0049] The fixing device 9 according to the present embodiment includes the thin fixing belt 20, the thin fixing belt 20 has a small thermal capacity. As a result, the surface temperature of the fixing belt 20 is easily affected by the heat generation amount distribution of the heater 22. Since the fixing device 9 according to the present embodiment has the heat generation portion 35 including portions arranged in the width direction of the fixing belt 20, the temperature of the fixing belt 20 tends to be low at a position corresponding to a gap between the portions of the heat generation portion 35.

[0050] The heater according to a second embodiment is described below.

[0051] Differences from the above-described embodiment are described below, and descriptions of other parts similar to the above-described embodiment are omitted below as appropriate. The heater according to the second embodiment may be referred to as a series type heater for convenience in the present specification.

[0052] FIG. 7 is a plan view of the heater according to the second embodiment.

[0053] As illustrated in FIG. 7, the heater 22 according to the present embodiment includes a base 55 having a planar shape extending in a direction indicated by an arrow X in FIG. 7.

[0054] The base 55 is disposed so that a longitudinal direction X of the base 55 is in parallel with the longitudinal direction of the fixing belt 20 or an axial direction of the pressure roller 21. On the surface of the base 55, two resistive heat generators 56 extend in the longitudinal direction X of the base 55 and are arranged side by side in a short-side direction Y of the base 55.

[0055] As illustrated in FIG. 7, a pair of electrodes 58 are disposed on one end of the base 55 in the longitudinal direction X. The pair of electrodes 58 are coupled to ends of the two resistive heat generators 56 via a pair of power supply lines 59.

[0056] The other ends of the resistive heat generators 56, which are not coupled to the pair of electrodes 58, are coupled to each other via another power supply line 59. An insulation layer 57 covers the resistive heat generators 56 and power supply lines 59 to insulate the resistive heat generators 56 and power supply lines 59 from other parts. On the other hand, electrodes 58 are not covered with the insulation layer 57 and are exposed so that a connector as a power supply terminal to be described later can be coupled.

[0057] The base 55 is made of a material having excellent heat resistance and insulating properties, such as polyimide, glass, mica, or ceramic such as alumina or aluminum nitride. Alternatively, the base 55 may include a metal plate made of metal (that is a conductive material) such as steel use stainless (SUS), iron, or aluminum and an insulation layer formed on the metal plate. In particular, the base 55 made of a high thermal conductive material such as aluminum, copper, silver, graphite, or graphene enhances the thermal uniformity of the heater 22 and image quality. The insulation layer 57 is made of a material having excellent heat resistance and insulating properties, such as polyimide, glass, mica, or ceramic such as alumina or aluminum nitride. The resistive heat generator 56 is, for example, produced as below. Silver-palladium (AgPd), glass powder, and the like are mixed to make paste. The paste is screen-printed on the surface of the base 55. Thereafter, the base 55 is subject to firing. Thus, the resistive heat generator 56 is produced.

[0058] The material of the resistive heat generator 56 may contain a resistance material, such as silver alloy (e.g., AgPt) or ruthenium oxide (RuO_2). The electrodes 58 and the power supply lines 59 are formed by screen-printing silver (Ag) or silver-palladium (AgPd).

[0059] FIG. 8 is a perspective view of a connector 40 as a power supply member coupled to the heater 22.

[0060] As illustrated in FIG. 8, the connector 40 includes a housing 41 made of resin, multiple contact terminals 42 disposed in the housing 41, and a harness 43 including wires each coupled each contact terminal 42 to supply power. Each contact terminal 42 is configured by an elastically deformable member such as a flat spring.

[0061] As illustrated in FIG. 8, the connector 40 is attached to the heater 22 and the heater holder 23 such that the connector 40 sandwiches the heater 22 and the heater holder 23 together. Thus, the connector 40 holds the heater 22 and the heater holder 23 together. In the above-described state, contact portions 42a disposed at ends of the contact terminals 42 in the connector 40 elastically contact and press against the electrodes 58 corresponding to the contact terminals 42 to electrically couple to the electrodes 58 and contact terminals 42, respectively. As a result, power can be supplied from a power supply disposed in the image forming apparatus to the heater 22 (that is, the resistive heat generators 56) via the connector 40.

[0062] As illustrated in FIG. 9, the heater 22 according to the present embodiment includes the electrodes 58 disposed on one end of the base 55 in the longitudinal direction X and no electrode disposed on the other end of the base 55 in the longitudinal direction. The above-described configuration needs a space to dispose the electrodes 58 on one end of the base 55. The space to dispose the electrodes 58 increases a length of a part including one end of the base 55. In other words, since the heater 22 according to the present embodiment includes the electrodes 58 on one end of the base and no electrode on the other end of the base, a length La between one edge 55a of the base 55 adjacent to the electrodes 58 and one edge 60a of a heat generation area 60 being adjacent to the electrodes 58 and including the resistive heat generators 56 is longer than a length Lb between the other edge 55b of the base 55 and the other edge 60b of the heat generation area 60 as illustrated in FIG. 9. The other edge 55b is an edge of the other end of the base 55 that is farther from the electrodes 58 than one end of the base 55. Hereinafter, the other end of the base 55 is referred to as a non-electrode portion of the base 55. Similarly, the other edge 60b of the heat generation area 60 is an edge of the other end of the heat generation area 60 that is farther from the electrodes 58 than one end of the heat generation area 60. Hereinafter, the other end of the heat generation area 60 is referred to as a non-electrode portion of the heat generation area 60. The heat generation area in the above is not an area in which one resistive heat generator 56 is disposed. The heat generation area in the above description and the following description is an area including ends to the other ends of resistive heat generators 56 on the base 55.

[0063] In the above-described heater 22 including the base 55 having one end longer than the other end in the longitudinal direction X, when the heater 22 generates the heat, the amount of heat transferred to the one end of the base 55 is larger than the amount of heat transferred to the other end of the base 55. In other words, the amount of heat transferred to one end of the base 55 including the electrodes 58 is larger than the amount of heat transferred to the other end of the base 55 including the non-electrode portion of the base 55. As a result, a temperature in a part of the heater, the part near the electrode is relatively lower than a temperature in a part of the heater, the part near the non-electrode portion. In particular, the temperature in the part of the heater near the electrode does not easily rise at the beginning of a start-up operation of the fixing device after the image forming apparatus is powered on because the temperature of the fixing device is low. As a result, a nonuniform temperature distribution in the fixing belt occurs and may cause difficulty in uniformly heating the sheet passing through the fixing nip. In the present embodiment, the following measures are taken in order to reduce a temperature difference in the fixing device.

[0064] FIG. 10 is a schematic diagram of the heater according to the second embodiment, the pressure roller, and a maximum sheet. FIG. 10 illustrates the heater 22 and the pressure roller 21 that are included in the fixing device, and a maximum sheet-passing region W through which a sheet P having a maximum width passes. In FIG. 10, the fixing belt and other parts are omitted. The fixing device including the heater according to the second embodiment is referred to as a fixing device 9A below.

[0065] As illustrated in FIG. 10, the heat generation area 60 of the heater 22 is designed to be a region equal to or larger than the maximum sheet-passing region W and laterally symmetric with respect to the center m of the maximum sheet-passing region W in the width direction of the maximum sheet-passing region W so that the heat generation area 60 can uniformly heat any size of the sheet in the width direction that is a direction orthogonal to a sheet passing direction and the direction along the surface of the sheet. In other words, a length Ea and a length Eb in FIG. 10 are designed to be the same length (Ea = Eb). The length Ea is the length from the center m of the maximum sheet-passing region W in the width direction to the edge 60a of the heat generation area 60 adjacent to the electrodes 58. The length Eb is a length from the center m of the maximum sheet-passing region W in the width direction to the other edge 60b of the non-electrode portion of the heat generation area 60. The image forming apparatus in the present embodiment is configured by a so-called center conveyance reference system in which sheets having various sizes are conveyed so that the center positions of the sheets in the width direction pass through the same position in the image forming apparatus. Accordingly, the center m of the maximum sheet-passing region W in the width direction is also each of the centers of sheet-passing regions of the sheets other than the sheet having the maximum width in the width direction.

[0066] On the other hand, the base 55 is designed asymmetrically with respect to the center m of the maximum sheet-passing region W in the width direction because the base 55 of the heater 22 has the longer one end adjacent to the electrodes 58 than the other end. In other words, a length Da is designed to be longer than a length Db in FIG. 10 (Da > Db). The length Da is a lateral length from the center m of the maximum sheet-passing region W in the width direction to the edge 55a adjacent to the electrodes 58 on the base 55. The length Db is a lateral length from the center m of the maximum sheet-passing region W in the width direction to the other edge 55b of the non-electrode portion of the base 55. As a result, the amount of heat transferred from the heat generation area 60 to one end of the base 55 adjacent to the electrodes is larger than the amount of heat transferred to the non-electrode portion of the base 55.

[0067] A part of the heat generated in the heat generation area 60 transfers to the base 55 and also transfers to the pressure roller 21 via the fixing belt 20. The amount of heat transferred to the pressure roller 21 affects the temperature distribution of the heater 22 and the temperature distribution of the fixing belt 20. This means that adjusting the amount of heat transferred to one end of the pressure roller 21 adjacent to the electrode and the amount of heat transferred to the other end of the pressure roller 21 adjacent to the non-electrode portion of the base 55 enables adjusting the temperature distribution of the heater 22 and the temperature distribution of the fixing belt 20. Based on the above, the pressure roller 21 in the present embodiment is designed to have one end shorter than the other end adjacent to the non-electrode portion of the base 55.

[0068] As illustrated in FIG. 10, a length Fa is designed to be shorter than a length Fb (Fa < Fb). The length Fa is a lateral length from the center m of the maximum sheet-passing region W in the width direction to an edge 21d of the pressure roller 21 adjacent to the electrodes 58. The length Fb is a lateral length from the center m of the maximum sheet-passing region W in the width direction to the other edge 21e of the pressure roller 21 adjacent to the non-electrode portion of the base 55. In the above description, the edge of the pressure roller 21 is not an edge of a shaft (that is, the core 21a) of the pressure roller 21 supported by bearings. The edge of the pressure roller 21 means an edge of a roller body 21g including the elastic layer.

[0069] Since the pressure roller 21 according to the present embodiment has one end shorter than the other end, that is, the end adjacent to the electrodes 58 as described above, a length Ga between the one edge 60a of the heat generation area 60 adjacent to the electrodes 58 and the one edge 21d of the pressure roller 21 adjacent to the electrodes 58 is shorter than a length Gb between the other edge 60b of the non-electrode portion of the heat generation area 60 and the other edge 21e of the pressure roller 21 adjacent to the non-electrode portion of the base 55 as illustrated in FIG. 10. In the above-described configuration, the amount of heat transferred from the heater 22 to one end of the pressure roller 21 adjacent to the electrodes 58 is smaller than the amount of heat transferred from the heater 22 to the other end of the pressure roller 21 adjacent to the non-electrode portion of the base 55, which prevents the temperature in the part of the heater near the electrodes 58 from falling. In other words, based on an increase in the amount of heat transferred to one end of the base 55 adjacent to the electrodes 58, which is caused by the longer one end of the base 55 than the other end of the base 55 (that is, La > Lb), one end of the pressure roller 21 adjacent to the electrodes 58 in the present embodiment is designed to have a reduced projection amount projecting from the heat generation area 60 (that is, Ga < Gb) to reduce the amount of heat transferred to one end of the pressure roller 21 adjacent to the electrodes 58 to balance the amount of heat transferred from one end of the heater 22 including the electrodes 58 with the amount of heat transferred from the other end of the heater 22 adjacent to the non-electrode portion of the base 55. As a result, the fixing device in the present embodiment can reduce variations in temperature in the fixing device. The fixing device can prevent the temperature drop in one end of the fixing device around the electrodes and an excessive increase in temperature around the non-electrode portion. As a result, the fixing device according to the present embodiment can enhance fixing quality.

[0070] The fixing device according to the present embodiment reduces the variations in temperature without setting the heat generation amount different between the one end and the other end in the longitudinal direction of the heater. Setting the heat generation amount different between one end and the other end in the longitudinal direction causes disadvantages such as variations in temperature when the heater generates the maximum heat amount and damage to components due to local thermal expansion. The fixing device according to the present embodiment can avoid the above-described disadvantages. As a result, the reliability of the fixing device according to the present embodiment is enhanced.

[0071] FIG. 11 is a schematic diagram of the heater according to the second embodiment, a pressure roller including a high-friction portion 21h, and a maximum sheet. The following describes another type of fixing device including the heater according to the second embodiment, which is referred to as a fixing device 9B.

[0072] In a configuration illustrated in FIG. 11, the pressure roller 21 includes the high-friction portion 21h on the other end of the pressure roller 21 adjacent to the non-electrode portion of the base 55. Since the pressure roller 21 includes the high-friction portion 21h on the other end of the pressure roller 21 adjacent to the non-electrode portion, a frictional force between the fixing belt 20 and the pressure roller 21 in a range from the center m of the maximum sheet-passing region W in the width direction to the other edge 21e of the pressure roller 21 adjacent to the non-electrode portion of the base 55 (that is, the range including the high-friction portion 21h) is larger than a frictional force between the fixing belt 20 and the pressure roller 21 in a range from the center m of the maximum sheet-passing region W in the width direction to the edge 21d of the pressure roller 21 adjacent to the electrodes 58. In other words, the frictional force between the fixing belt 20 and the pressure roller 21 in a range from the center of the fixing belt 20 (that is the same as the center m in FIG. 11) in the longitudinal direction X of the base 55 to an edge of the fixing belt 20 adjacent to the electrodes 58 is smaller than the frictional force between the fixing belt 20 and the pressure roller 21 in a range from the center of the fixing belt 20 in the longitudinal direction X of the base 55 to the other edge of the fixing belt 20 adjacent to the non-electrode portion of the base 55 (that is, the range including the high-friction portion 21h). The fixing device 9B has the same configuration as the fixing device 9A except for the above. The frictional force (F) between the fixing belt and the pressure roller is obtained by the following expression (1) using a friction coefficient (μ) between the fixing belt and the pressure roller and a contact pressure (N) of the pressure roller with respect to the fixing belt.

$$F = \mu \times N \quad (1)$$

[0073] One end of the pressure roller 21 adjacent to the electrodes 58 in the fixing device 9B according to the second embodiment is also designed to shorten one end of pressure roller 21 adjacent to the electrodes 58 based on the increase in the amount of heat transferred to the one end of the base 55, which is caused by the longer one end of the base 55 than the other end of the base 55 (that is, La > Lb), to balance the amount of heat transferred from one end of the heater 22 including the electrodes 58 with the amount of heat transferred from the other end of the heater 22 adjacent to the non-electrode portion of the base 55, which is the same as the fixing device 9A.

[0074] Shortening one end of the pressure roller 21 adjacent to the electrodes 58 reduces the contact area between one end of the pressure roller 21 and the fixing belt 20 (that is, the contact area of a contact region in the longitudinal direction), which reduces a rotation transmission force between the pressure roller 21 and the fixing belt 20. As a result, the pressure roller 21 may not smoothly rotate the fixing belt 20, and the fixing belt 20 may slip when the sheet passes through the fixing nip.

[0075] The pressure roller 21 according to the second embodiment includes the high-friction portion 21h adjacent to the non-electrode portion to generate a large frictional force between the fixing belt 20 and the pressure roller 21 to increase a grip force between the fixing belt 20 and the pressure roller 21. The above-described configuration compensates for the reduction in the rotation transmission force due to the shortening of one end of the pressure roller 21 adjacent to the electrodes 58, and the pressure roller 21 can satisfactorily rotate the fixing belt 20.

[0076] Specifically, removing the release layer 21c as a surface layer on a part of the outer circumferential surface of the elastic layer 21b in the pressure roller 21 and exposing the part of the outer circumferential surface of the elastic layer 21b form the high-friction portion

21h of the pressure roller 21 in the second embodiment. Preferably, the position of the high-friction portion 21h is outside the maximum sheet-passing region W (and near the non-electrode portion of the base 55) so that the high-friction portion 21h can come into contact with the fixing belt 20 regardless of the size of the sheet passing through the fixing device (see FIG. 11). The high-friction portion 21h is not limited to being on the surface of the pressure roller 21 and may be on a portion of the surface of the fixing belt 20.

[0077] The heater according to a third embodiment is described below.

[0078] Differences from the above-described embodiments are described below, and descriptions of other parts similar to the above-described embodiments are omitted below as appropriate. The heater according to the third embodiment may be referred to as the series type heater for convenience in the present specification.

[0079] FIG. 12 is a schematic diagram of the heater according to the third embodiment, the pressure roller, and a maximum sheet.

[0080] One end of the pressure roller 21 adjacent to the electrodes 58 in the third embodiment illustrated in FIG. 12 is also designed to shorten one end of pressure roller 21 adjacent to the electrodes 58 (Ga < Gb) based on the increase in the amount of heat transferred to the one end of the base 55, which is caused by the longer one end of the base 55 than the other end of the base 55 (that is, La > Lb), to balance the amount of heat transferred from one end of the heater 22 including the electrodes 58 with the amount of heat transferred from the other end of the heater 22 adjacent to the non-electrode portion of the base 55, which is the same as the first and second embodiments.

[0081] The heat generation area 60 according to the third embodiment has a longer one end adjacent to the electrodes 58 than the ends in the above-described embodiments to increase the temperature in the one end of the fixing device around the electrodes 58 in which the temperature tends to decrease. The heat generation area 60 is not laterally symmetric with respect to the center m of the maximum sheet-passing region W in the width direction of the maximum sheet-passing region W. In the third embodiment, the length Ea is designed to be longer than the length Eb as illustrated in FIG. 12 (Ea > Eb). The length Ea is the length from the center m of the maximum sheet-passing region W in the width direction to the edge 60a of the heat generation area 60 adjacent to the electrodes 58. The length Eb is the length from the center m of the maximum sheet-passing region W in the width direction to the other edge 60b of the non-electrode portion of the heat generation area 60. As a result, a length Ha is set to be longer than a length Hb in FIG. 12. The length Ha is the length between the edge 60a of the heat generation area 60 adjacent to the electrodes 58 and an edge Pa of the maximum sheet-passing region W adjacent to the electrodes 58. The length Hb is the length between the other edge 60b of the heat generation area 60 adjacent to the non-electrode portion of the base 55 and an edge Pb of the maximum sheet-passing region W adjacent to the non-electrode portion of the base 55. In the above, the relationship between the lengths of one end and the other end of the heat generation area 60 in the lateral direction is described with reference to the maximum sheet-passing region W. However, since the image forming apparatus in the third embodiment is configured by the center conveyance reference system, the relationship between the lengths of one end and the other end of the heat generation area 60 with reference to the maximum sheet-passing region W is the same as the relationship between the lengths of one end and the other end of the heat generation area 60 with reference to any one of sheet-passing regions having various widths other than the maximum sheet width.

[0082] The heat generation area 60 in the third embodiment having a longer end adjacent to the electrodes 58 than the ends in the above-described other embodiments can effectively prevent the temperature drop around the electrodes 58 in the fixing device 9. Adding the above-described configuration to the configuration in the above-described embodiment including the shorter one end of the pressure roller 21 adjacent to the electrodes than the other end of the pressure roller 21 can more effectively prevent the temperature drop around the electrodes 58 in the fixing device 9. In other words, lengthening one end of the heat generation area 60 adjacent to the electrodes 58 (Ha > Hb) in addition to shortening one end of the pressure roller 21 adjacent to the electrodes 58 (Ga < Gb) can more effectively prevent the temperature drop around the electrodes 58 in the fixing device 9.

[0083] With reference to the drawings, a description is given below of some features of embodiments of the present disclosure.

[0084] Before the description of the features, problems are described below.

[0085] Problems regarding the shape of flange are described below.

[0086] For example, Japanese Unexamined Patent Application Publication No. 2020-052347 discloses a fixing device including a pair of flanges inserted into both ends of the loop of the fixing belt to support the fixing belt.

[0087] A stay, a heater, and a heater holder are assembled into a pair of flanges to form one unit including the fixing belt. The frame of the fixing device supports the unit and a pressure roller. The pressure roller is pressed against the fixing belt.

[0088] The structure of the flange is described below. As illustrated in FIG. 13, a flange 53 includes a belt support 53b, a belt restrictor 53c, and a supporting recess 53d as a recess.

[0089] The belt support 53b is C-shaped and inserted into the loop formed by the fixing belt 20, thus contacting the inner circumferential surface of the fixing belt 20 to support the fixing belt 20. The belt restrictor 53c contacts an edge face of the fixing belt 20 to restrict motion (e.g., skew) of the fixing belt 20 in the rotational axis direction of the fixing belt 20 that is the longitudinal direction of the fixing belt 20. The supporting recess 53d is inserted with a lateral end of each of the heater holder 23 and the stay 24 in the longitudinal direction thereof, thus supporting the heater holder 23 and the stay 24. The flange 53 has a guide groove 53a formed by a guide groove forming portion 53f and a belt restrictor 53c. The flange 53 is assembled to the frame of the fixing device by sliding an edge of an insertion opening of the frame along the guide groove 53a.

[0090] FIGS. 14A and 14B are diagrams illustrating the problem regarding the shape of the flange. With reference to FIGS. 14A and 14B, the problem caused by the shape of the flange is described below.

[0091] The flange is often made of resin and often has a substantially C-shape when viewed from the rotational axis direction of the fixing belt (see FIG. 14AA). In the above-described structure, contraction during molding or a pressing force received from the pressure roller may deform the flange so that the tips of the C-shape (in other words, edges of the opening of the C-shape) are closed (see FIG. 14AB).

[0092] In the fixing device, the heater is positioned to the heater holder, the heater holder is positioned by the stay supporting the heater holder, the stay is positioned by the flanges, and the flange is positioned by the frame (see the left drawing of FIG. 14B). Due to the rotation of the pressure roller, the heater receives a force directed downstream in the rotation direction of the pressure roller. As a result, the flange is pushed against the downstream side of the frame in the rotation direction of the pressure roller. If the flange is deformed, the pushed flange displaces the heater from a predetermined position (see the right drawing of FIG. 14B). The heater displaced from the predetermined position does not sufficiently transmit the heat to the fixing belt, which may cause a fixing failure. In addition, the temperature of a part of the heater displaced from the predetermined position may excessively rise, and such an excessive temperature rise generates thermal stress that may damage the heater.

[0093] With reference to FIGS. 15A and 15B, a bridging portion disposed in the flange is described. To solve the above-described problem, the tips of the C-shape of the flange as illustrated in FIG. 15A are connected by the bridging portion to form a substantially square shape as illustrated in FIG. 15B. In other words, the bridging portion bridges the supporting recess 53d that holds the heater 22. As a result, the deformation of the flange can be prevented.

[0094] In the fixing device including the flange that has the bridging portion and the substantially square shape, the connector of the heater or the bridging portion hides the end of the heater. On the end of the heater, a mark such as a mark related to a characteristic value of the heater may be printed. The bridging portion hides the mark, which causes a problem that the worker cannot visually recognize the mark.

[0095] The following describes a configuration of the heater including an extension.

[0096] FIG. 16 is a schematic diagram illustrating a main part of the fixing device including the heater that has a characteristic part of the present disclosure. The characteristic part of the present disclosure relates to the configuration of the heater. The features of the present disclosure are described in detail below. The following describes the series type heater described in the second and third embodiments, but the present disclosure may be applied to the embodiments described above.

[0097] As illustrated in FIG. 16, the fixing device 9 in the present embodiment includes a heating device 200. The heating device 200 includes the fixing belt 20 as an example of a tube, which is also referred to as a heating belt, the heater 22, and the flanges 53 as an example of end holders.

[0098] The fixing belt 20 is a rotatable tube extending in the longitudinal direction of the fixing belt. In other words, the fixing belt 20 has the rotational axis direction. The heater 22 includes the multiple resistive heat generators 56 to heat the fixing belt 20. In addition to the configuration described above, the flange 53 includes a bridging portion 53h having the square sectional shape and forming an opening through which the heater 22 passes. The bridging portion 53h bridges the supporting recess 53d that holds the heater 22. The bridging portion is described in detail below.

[0099] The fixing device 9 includes the pressure roller 21 as the pressure rotator disposed to face and contact the fixing belt 20 and form the fixing nip and a frame 80 as a side plate holding the flange 53 to be relatively movable. The fixing device 9 further includes a bearing 80b attached to the frame 80 to support a core 21a serving as a rotation shaft of the pressure roller 21.

[0100] FIGS. 17A and 17B illustrate a characteristic part of the heater 22. As illustrated in FIG. 17A, at least one end of both ends of the heater 22 in the rotational axis direction of the fixing belt 20 (that is, the longitudinal direction of the fixing belt 20) protrudes outward from the bridging portion 53h (outward from the position of the resistive heat generator 56) in the rotational axis direction (in the longitudinal direction). In other words, the heater 22 has a configuration in which one end of the heater 22 protrudes outside the bridging portion 53h in the longitudinal direction of the heater 22 (see FIG. 17B). In addition, one end of the heater 22 protrudes outside the core 21a of the pressure roller 21 as illustrated in FIG. 16. As a result, the worker can visually recognize the mark, which is described below, in a direction indicated by an arrow γ illustrated in FIG. 16. This is the reason why the fixing device has the above-described configuration. In addition, since the heater 22 can be easily held, the fixing device 9 can be easily assembled. In the present embodiment, the heater 22 has a protrusion 22p as one end protruding outside the bridging portion 53h in the longitudinal direction of the fixing belt 20, and, at the other end of the heater 22 in the longitudinal direction of the heater

22, the connector 40 is disposed and coupled to the electrodes 58 of the heater 22. In other words, the heater 22 has the protrusion 22p on at least one end of both ends of the heater 22 in the longitudinal direction of the fixing belt 20, and the protrusion 22p protrudes outside the bridging portion 53h in the longitudinal direction of the fixing belt 20.

[0101] The protrusion 22p has a mark 22m to identify a characteristic value of the heater 22. The characteristic value of the heater 22 indicates, for example, a resistance value of the resistive heat generator or a power supply voltage to confirm whether the heater has appropriate specifications. The mark 22m is on a part protruding outside the bridging portion 53h and outside the end of the fixing belt 20 in the rotational axis direction. Examples of the mark 22m include a mark, a seal, a carved mark, a character, a sticker, or a mark written with a magic marker.

[0102] The size (width) of the protrusion 22p in the longitudinal direction X of the heater 22 is larger than the size (width) of the heater 22 in the short-side direction Y of the heater 22 that is the direction orthogonal to the rotational axis direction of the fixing belt 20. In other words, the length of the protrusion 22p in the longitudinal direction of the fixing belt 20 is larger than the width of the heater 22 in a direction orthogonal to the longitudinal direction. For example, in the case where the mark 22m includes characters, arranging the characters in the longitudinal direction of the heater 22 in the above-described structure can prevent the size of the heater 22 in the short-side direction from increasing.

[0103] The temperature distribution of the heater is described in detail below. The temperature distribution of a heater according to a comparative example is described below.

[0104] FIG. 18A is a graph illustrating the temperature distribution of the heater according to the comparative example. FIG. 18B is a plan view of the heater according to the comparative example and the maximum sheet. The graph of FIG. 18A illustrates the relationship between the distances (mm) from the edge 55b in the longitudinal direction (X direction) of the heater and the temperatures (°C), and FIG. 18B illustrates the relationship between the configuration of the heater and the graph illustrated in FIG. 18A. The sheet P is illustrated in FIG. 18B to illustrate the relationship between the heater and a region in which the sheet P is conveyed. With reference to FIGS. 18A and 18B, the temperature distribution of the heater in the comparative example is described below.

[0105] In FIG. 18B, a centerline passes through the center of the resistive heat generator 56 extending in the longitudinal direction X of the heater 22. As illustrated in FIG. 18B, a portion of the heater 22 from the center line to the edge 55a adjacent to the electrode 58 is typically longer in the longitudinal direction of the heater 22 than the other portion of the heater 22 from the centerline to the other edge 55b of the non-electrode portion of the base 55 to fit with the connector 40. The difference of lengths of the above portions is 20 to 30 mm. The heat generated by the resistive heat generator 56 is thermally conducted to the base 55 of the heater 22, which reduces the temperature of the heater 22. Since the length from the resistive heat generator to the edge 55a adjacent to the electrode 58 is longer than the length from the resistive heat generator to the other edge 55b, the temperature of a portion of the heater around the electrode 58 is lower than the temperature of a portion of the heater close to the other edge 55b. As a result, as in the temperature distribution illustrated in FIG. 18A, a large temperature difference occurs between both ends of the heater 22 in the longitudinal direction.

[0106] Subsequently, the temperature distribution of the heater according to the present disclosure is described below.

[0107] FIG. 19A is a graph illustrating the temperature distribution of the heater according to the present disclosure. FIG. 19B is a plan view of the heater according to the present disclosure and the maximum sheet. The graph of FIG. 19A illustrates the relationship between the distances (mm) from the edge 55b in the longitudinal direction (X direction) of the heater and the temperatures (°C), and FIG. 19B illustrates the relationship between the configuration of the heater and the graph illustrated in FIG. 19A. The sheet P is illustrated in FIG. 19B to illustrate the relationship between the heater and the region in which the sheet P is conveyed. With reference to FIGS. 19A and 19B, the temperature distribution of the heater in the present disclosure is described below.

[0108] The heater 22 often has the temperature difference between both ends in the longitudinal direction X. The heater 22 has the longer portion from the centerline of the resistive heat generator to the edge 55a adjacent to the electrodes 58 than the other portion from the centerline to the other edge 55b, and the temperature in the longer portion decreases. As a result, the large temperature difference occurs between both ends of the heater 22 in the longitudinal direction X. The reason why the temperature difference occurs is that only one side of the heater 22 in the longitudinal direction X is elongated.

[0109] To reduce the above-described temperature difference, the protrusion 22p of the heater 22 is configured by protruding the other edge 55b that is opposite the edge 55a adjacent to the electrode 58 and connector 40 as illustrated in FIG. 19B. In other words, the protrusion 22p is formed by extending the other portion including the other edge 55b that is opposite the edge 55a adjacent to the electrodes 58. As a result, the heater 22 extends toward both sides in the longitudinal direction X. As a result, the heater 22 has the temperature distribution as illustrated in FIG. 19A that reduces the temperature difference between both ends of the heater 22 in the longitudinal direction X.

[0110] The protrusion width (the protrusion amount) of the protrusion 22p from the edge of the flange 53 is 5 mm and preferably equal to or longer than 10 mm. Since the temperature distribution is bilaterally symmetrical, more preferably, the distances from the centerline of the resistive heat generator 56 of the heater 22 to both edges of the heater 22 are designed to be equal (both edges are bilaterally symmetrical with respect to the centerline of the resistive heat generator 56).

[0111] The resistance value of the resistive heat generator affects the temperature distribution in the longitudinal direction of the heater. In order to reduce the temperature difference between both ends of the heater 22 in the longitudinal direction, which portion of the heater in the longitudinal direction X should be made longer is described with reference to FIGS. 20A and 20B.

[0112] In the following description, the protrusion of the heater 22 protruding from the bridging portion to the edge 55a adjacent to the connector 40 (electrodes 58) is referred to as an electrode-side protrusion 22q.

[0113] In the heater 22 including the resistive heat generator 56 having a high resistance value (a low thermal conductivity), the temperature in the portion of the heater adjacent to the connector 40 (the electrodes 58) is higher than the temperature of the other portion of the heater 22 as illustrated in FIG. 20A. Accordingly, the electrode-side protrusion 22q is designed to be longer than the protrusion 22p. In contrast, in the heater 22 including the resistive heat generator 56 having a low resistance value (a high thermal conductivity), the temperature in the portion of the heater adjacent to the connector 40 (the electrodes 58) is lower than the temperature of the other portion of the heater 22 as illustrated in FIG. 20B. Accordingly, the protrusion 22p is designed to be longer than the electrode-side protrusion 22q. Designing as described above can reduce the temperature difference between both ends of the heater 22 in the longitudinal direction.

[0114] The temperature at each of both ends of the heater in the longitudinal direction tends to be lower than the temperature at the center of the heater in the longitudinal direction X, which may cause a so-called temperature drop at the end of the fixing belt that may cause a fixing failure at the end of the sheet. With reference to FIGS. 21A to 21C, the following describes an embodiment to prevent the temperature drop at the end of the fixing belt.

[0115] As illustrated in FIG. 21B, the resistive heat generator 56 of the heater 22 in the present embodiment includes end heaters 56t at both ends of the resistive heat generator 56. FIG. 21C is a plan view of a part of the heater surrounded by a broken line circle in FIG. 21B to describe the end heater 56t. The sheet P is illustrated in FIG. 21B to illustrate the relationship between the heater and the region in which the sheet P is conveyed. As illustrated in FIG. 21C, the size (width) β of the end heater 56t in the short-side direction Y that is orthogonal to the rotational axis direction of the fixing belt 20 (in other words, the longitudinal direction of the fixing belt 20) is larger than the size (width) α of the resistive heat generator 56 in the short-side direction Y at the center of the heater 22. The above-described structure can increase the heat generation amount generated at each of both ends of the heater to be larger than the heat generation amount generated at the center of the heater. As a result, the temperature distribution of the heater in the longitudinal direction becomes uniform as illustrated in FIG. 21A, and thus, the above-described structure can prevent the temperature drop at the end of the fixing belt.

[0116] The size of the end heater 56t can be changed in accordance with the length of the heater in the longitudinal direction, which is described below with reference to FIGS. 22A and 22B. The sheet P is illustrated in FIG. 22B to illustrate the relationship between the heater and the region in which the sheet P is conveyed.

[0117] As illustrated in FIG. 22B, the length of the protrusion 22p in the longitudinal direction is longer than the length of the protrusion 22p of FIG. 21B in the longitudinal direction X of the heater. As a result, the temperature of the protrusion 22p in FIG 22B reduces. To prevent the temperature of the protrusion 22p from reducing, the resistive heat generator 56 of the heater 22 in the present embodiment includes the end heater 56t close to the electrodes 58 and an end heater 56p on the protrusion 22p, and the end heater 56p has the area larger than the area of the end heater 56t.

[0118] As illustrated in FIG. 22B, the size (width) of the end heater 56p having the larger area in the short-side direction Y of the end heater 56t that is orthogonal to the rotational axis direction of the fixing belt 20 (in other words, the longitudinal direction of the fixing belt 20) is larger than the size (width) of the resistive heat generator 56 in the short-side direction Y at the center of the heater 22. In addition, the size of the end heater 56p in the longitudinal direction X of the end heater 56t is larger than the size of the end heater 56t in the longitudinal direction X.

[0119] The above-described structure can increase the heat generation amount generated at each of both ends of the heater to be larger than the heat generation amount generated at the center of the heater. In addition, since the end heater 56p can increase the amount of heat generated in a portion of the heater adjacent to the protrusion 22p, the above-described structure can prevent the temperature of the protrusion 22P from reducing. As a result, the temperature distribution of the heater in the longitudinal direction becomes uniform as illustrated in FIG. 22A, and thus, the above-described structure can prevent the temperature drop at the end of the fixing belt.

[0120] In the above-described embodiment, the heater 22 has the protrusion 22p longer than the protrusion 22q including the electrodes 58, but the present embodiment may be applied to the heater having the protrusion 22q longer than the protrusion 22p. In this case, the area of the end heater 56t adjacent to the protrusion 22q including the electrodes 58 is designed to be larger than the area of the end heater 56p adjacent to the protrusion 22p.

[0121] Subsequently, the bridging portion of the flange is described below in detail.

[0122] The flanges are disposed on both ends of the fixing belt but have the same structure. The following describes the structure of one flange.

[0123] The flange 53 is made of resin. The contraction during molding resin may deform the flange, but the bridging portion prevents the deformation of the flange 53. The flange 53 made of resin prevents the heat generated by the resistive heat generators 56 of the heater 22 from transferring to other parts via the flange 53.

[0124] With reference to FIGS. 23A and 23B, the bridging portion of the flange is described below. As illustrated in FIG. 23A, the flange includes the bridging portion 53h forming the opening through which the heater 22 passes. The bridging portion 53h bridges the supporting recess 53d that holds the heater 22. The width of the bridging portion 53h of the flange 53 that is the size of the bridging portion 53h in the longitudinal direction X of the heater (the direction from the front side to the back side of the paper surface in FIG. 23A) is larger than the thickness of the frame 80. The above-described structure can prevent the flange from deforming. In the present embodiment, the width of the bridging portion 53h is in a range from 3 to 4 mm.

[0125] The thickness of the bridging portion 53h of the flange 53 is larger than the thickness of the heater 22. The above-described structure can prevent the flange from deforming. In the present embodiment, the thickness of the bridging portion 53h ranges from 1.5 to 2 mm. The above-described thickness of the bridging portion 53h means the size of the bridging portion in the thickness direction Z of the heater.

[0126] Alternatively, the bridging portion 53h may have a facing portion 53t facing the pressure roller 21 as illustrated in FIG. 23B. The facing portion 53t has a thickness smaller than the portion of the bridging portion 53h other than the facing portion 53t. Thus, the interference with the core of the pressure roller can be avoided, and the size can be reduced. The facing portion 53t in the present embodiment has a thickness of 0.5 mm.

[0127] The bridging portion 53h is positioned so as to overlap the frame 80, which is the side plate, in a direction orthogonal to the rotational axis direction of the fixing belt 20 (in other words, the longitudinal direction of the fixing belt 20). This can prevent the deformation of a fitting portion of the frame 80 and enhance the positional accuracy.

[0128] The present disclosure is also applicable to the embodiments described below.

[0129] The present disclosure may be applied to the fixing device including the thermistor arranged as illustrated in FIG. 24.

[0130] In FIG. 24, the thermistor 25 is disposed upstream from the center NA of the fixing nip N in the rotation direction of the fixing belt 20, in other words, at an entrance portion in the fixing nip N. Since the sheet P easily takes the heat from the heater at the entrance portion of the fixing nip N, the thermistor 25 detects the temperature of this portion, which enables the fixing device 9 to enhance the fixing property and effectively prevent the occurrence of fixing offset.

[0131] The embodiments of the present disclosure are also applicable to the fixing devices as illustrated in FIGS. 25 to 27 other than the fixing devices described above.

[0132] Referring now to FIGS. 25 to 27, a description is given of some modifications of the fixing device 9.

[0133] The fixing device 9 illustrated in FIG. 25 includes a pressurization roller 44 opposite the pressure roller 21 with respect to the fixing belt 20. The pressurization roller 44 is an opposed rotator that rotates and is opposite the fixing belt 20 as the rotator. The fixing belt 20 is sandwiched by the pressurization roller 44 and the heater 22 and heated by the heater 22. On the other hand, a nip formation pad 45 is disposed inside the loop formed by the fixing belt 20 and disposed opposite the pressure roller 21. The nip formation pad 45 is supported by the stay 24. The nip formation pad 45 sandwiches the fixing belt 20 together with the pressure roller 21, thereby forming the fixing nip N.

[0134] A description is provided of the construction of the fixing device 9 as illustrated in FIG. 26. The fixing device 9 does not include the pressurization roller 44 described above with reference to FIG. 25. In order to attain a contact length for which the heater 22 contacts the fixing belt 20 in the circumferential direction thereof, the heater 22 is curved into an arc in cross section that corresponds to a curvature of the fixing belt 20. Other parts of the fixing device 9 illustrated in FIG. 26 are the same as the fixing device 9 illustrated in FIG. 25.

[0135] Finally, the fixing device 9 illustrated in FIG. 27 is described. The fixing device 9 includes a heating assembly 92, a fixing roller 93 that is a fixing member, and a pressure assembly 94 that is a facing member. The heating assembly 92 includes the heaters 22, the heater holder 23, the stay 24, and the heating belt 120 as an example of a rotator, as described in the above-described embodiment. The fixing roller 93 is an opposed rotator that rotates and faces the heating belt 120 as the rotator. The fixing roller 93 includes a core 93a, an elastic layer 93b, and a release layer 93c. The core 93a is a solid core made of iron. The elastic layer 93b coats the circumferential surface of the core 93a. The release layer 93c coats an outer circumferential surface of the elastic layer 93b. The pressure assembly 94 is opposite to the heating assembly 92 with respect to the fixing roller 93. The pressure assembly 94 includes a nip formation pad 95 and a stay 96 inside the loop of a pressure belt 97, and the pressure belt 97 is rotatably arranged to wrap around the nip formation pad 95 and the stay 96. The sheet P passes through the fixing nip N2 between the pressure belt 97 and the fixing roller 93 to be heated and pressed to fix the image onto the sheet P.

[0136] The image forming apparatus according to the present embodiments of the present disclosure is applicable not only to the color image forming apparatus illustrated in FIG. 1 but also to a monochrome image forming apparatus, a copier, a printer, a facsimile machine, or a multifunction peripheral including at least two functions of the copier, printer, and facsimile machine.

[0137] For example, as illustrated in FIG. 28, the image forming apparatus 100 according to the present embodiment includes an image forming device 50 including a photoconductor drum, the sheet conveyer including the timing roller pair 15, the sheet feeder 7, the fixing device 9, the sheet ejection device 10, and a reading device 51. The sheet feeder 7 includes the plurality of sheet feeding trays, and the sheet feeding trays store sheets of different sizes.

[0138] The reading device 51 reads an image of a document Q. The reading device 51 generates image data from the read image. The sheet feeder 7 stores the plurality of sheets P and feeds the sheet P to the conveyance path. The timing roller pair 15 conveys the sheet P on the conveyance path to the image forming device 50.

[0139] The image forming device 50 forms a toner image on the sheet P. Specifically, the image forming device 50 includes the photoconductor drum, a charging roller, the exposure device, the developing device, a supply device, a transfer roller, the cleaning device, and a discharging device. The toner image is, for example, an image of the document Q.

[0140] The fixing device 9 heats and presses the toner image to fix the toner image on the sheet P. Conveyance rollers convey the sheet P on which the toner image has been fixed to the sheet ejection device 10. The sheet ejection device 10 ejects the sheet P to the outside of the image forming apparatus 100.

[0141] The following describes modifications of the fixing device.

[0142] Description of configurations common to those of the fixing devices of the above-described embodiments is omitted as appropriate.

[0143] As illustrated in FIG. 29, the fixing device 9 includes the fixing belt 20, the pressure roller 21, the heater 22, the heater holder 23, the stay 24, and the thermistor 25.

[0144] The fixing nip N is formed between the fixing belt 20 and the pressure roller 21. The nip width of the fixing nip N is 10 mm, and the linear velocity of the fixing device 9 is 240 mm / s.

[0145] The fixing belt 20 includes a polyimide base and the release layer and does not include the elastic layer. The release layer is made of a heat-resistant film material made of, for example, fluororesin. The outer loop diameter of the fixing belt 20 is about 24 mm.

[0146] The pressure roller 21 includes the core 21a, the elastic layer 21b, and the release layer 21c. The pressure roller 21 has an outer diameter of 24 to 30 mm, and the elastic layer 21b has a thickness of 3 to 4 mm.

[0147] The heater 22 includes the base, a thermal insulation layer, a conductor layer including the resistive heat generator, and the insulation layer and is formed to have a thickness of 1 mm as a whole. A width Y of the heater 22 in the short-side direction of the heater 22 (that is also referred to as a direction intersecting an arrangement direction) is 13 mm.

[0148] FIG. 30 is a plan view of a heater according to a fourth embodiment. In FIG. 30, multiple resistive heat generators 31 are arranged in the longitudinal direction of the heater. In the following description, a direction in which the multiple resistive heat generators arranged is referred to as an arrangement direction, and an area between neighboring resistive heat generators is referred to as a separation area. As illustrated in FIG. 30, the conductor layer of the heater 22 includes the multiple resistive heat generators 31, power supply lines 33, and electrodes 34A to 34C. As illustrated in the enlarged view of FIG. 30, the separation area B is formed between neighboring resistive heat generators of the multiple resistive heat generators 31 arranged in the arrangement direction. The enlarged view of FIG. 30 illustrates two separation areas B, but the separation area B is formed between the neighboring resistive heat generators of all the multiple resistive heat generators 31. The resistive heat generators 31 configure three heat generation portions 35A to 35C. When a current flows between the electrodes 34A and 34B, the heat generation portions 35A and 35C generate heat. When a current flows between the electrodes 34A and 34C, the heat generation portion 35B generates heat. When the fixing device 9 fixes the toner image onto the small sheet, the heat generation portion 35B generates heat. When the fixing device 9 fixes the toner image onto the large sheet, all the heat generation portions 35A to 35C generate heat.

[0149] As illustrated in FIG. 31, the heater holder 23 holds the heater 22 in a recessed portion 23b of the heater holder 23.

[0150] The recessed portion 23b is formed on the side of the heater holder 23 facing the heater 22. The recessed portion 23b has a bottom surface 23b1 and walls 23b2 and 23b3. The bottom surface 23b1 is substantially parallel to the base 30 and the surface recessed from the side of the heater holder 23 toward the stay 24. The walls 23b2 are both side surfaces of the recessed portion 23b in the arrangement direction. The recessed portion 23b may have one wall 23b2. The walls 23b3 are both side surfaces of the recessed portion 23b in the direction intersecting the arrangement direction. The heater holder 23 has guides 26. The heater holder 23 is made of LCP.

[0151] As illustrated in FIG. 32, a connector 70 includes a housing made of resin such as LCP and a plurality of contact terminals fixed to the housing.

[0152] The connector 70 is attached to the heater 22 and the heater holder 23 such that a front side of the heater 22 and the heater holder 23 and a back side of the heater 22 and the heater holder 23 are sandwiched by the connector 70. In this state, the contact terminals contact and press against the electrodes of the heater 22, respectively and the heat generation portions 35 are electrically coupled to the power supply provided in the image forming apparatus via the connector 70. The above-described configuration enables the power supply to supply power to the heat generation portions 35. Note that at least part of each of the electrodes 34 is not coated by the insulation layer and therefore exposed to secure connection with the connector 70.

[0153] A flange 53 contacts the inner circumferential surface of the fixing belt 20 at each of both ends of the fixing belt 20 in the arrangement direction to hold the fixing belt 20. The flange 53 is fixed to the housing of the fixing device 9. The flange 53 is inserted into each of both ends of the stay 24 (see an arrow direction from the flange 53 in FIG. 32).

[0154] To attach to the heater 22 and the heater holder 23, the connector 70 is moved in the direction intersecting the arrangement direction (see a direction indicated by arrow from the connector 70 in FIG. 32). The connector 70 and the heater holder 23 may have a convex portion and a recessed portion to attach the connector 70 to the heater holder 23. The convex portion disposed on one of the connector 70 and the heater holder 23 is engaged with the recessed portion disposed on the other one of the connector 70 and the heater holder 23 and relatively move in the recessed portions to attach the connector 70 to the heater holder 23. The connector 70 is attached to one end of the heater 22 and one end of the heater holder 23 in the arrangement direction. These ends of the heater 22 and the heater holder 23 are farther from a portion in which the pressure roller 21 receives a driving force from a drive motor than the other end of the heater 22 and the other end of the heater holder 23, respectively.

[0155] As illustrated in FIG. 33, one thermistor 25 faces a center portion of the inner circumferential surface of the fixing belt 20 in the arrangement direction, and another thermistor 25 faces an end portion of the inner circumferential surface of the fixing belt 20 in the arrangement direction. The heater 22 is controlled based on the temperature of the center portion of the fixing belt 20 and the temperature of the end portion of the fixing belt 20 in the arrangement direction that are detected by the thermistors 25. Any one of the thermistors 25 is disposed corresponding to the separation area between the neighboring resistive heat generators of the heater 22.

[0156] As illustrated in FIG. 33, one thermostat 27 faces a center portion of the inner circumferential surface of the fixing belt 20 in the arrangement direction, and another thermostat 27 faces an end portion of the inner circumferential surface of the fixing belt 20 in the arrangement direction. Each of the thermostats 27 shuts off a current to the heater 22 in response to a detection of a temperature of the fixing belt 20 higher than a predetermined threshold value.

[0157] The flanges 53 are disposed at both ends of the fixing belt 20 in the arrangement direction and hold both ends of the fixing belt 20, respectively. The flange 53 is made of LCP.

[0158] As illustrated in FIG. 34, the flange 53 has a slide groove 53e. The slide groove 53e extends in a direction in which the fixing belt 20 moves toward and away from the pressure roller 21. An engaging portion of the housing of the fixing device 9 is engaged with the slide groove 53e. The relative movement of the engaging portion in the slide groove 53e enables the fixing belt 20 to move toward and away from the pressure roller 21.

[0159] The following describes other types of fixing devices each including high thermal conductors.

[0160] For convenience of explanation, reference numerals different from the reference numerals in the above description are given.

[0161] A fixing device 160 illustrated in FIG. 35 includes a heater holder 164, a first high thermal conductor 89, and second high thermal conductors 90 between the heater holder 164 and the first high thermal conductor 89. The second high thermal conductor 90 is disposed at a position different from the position of the first high thermal conductor 89 in the left-to-right direction in FIG. 35 that is a direction in which the heater holder 164, a stay 165, and the first high thermal conductor 89 are layered. Specifically, the second high thermal conductor 90 is disposed so as to overlap the first high thermal conductor 89.

[0162] The fixing device in the present embodiment includes a temperature sensor (that is, the thermistor 25), which is the same as the fixing device in the above-described embodiments. FIG. 35 illustrates a cross section in which the temperature sensor is not disposed.

[0163] The second high thermal conductor 90 is made of a material having thermal conductivity higher than the thermal conductivity of a base 155, for example, graphene or graphite. In the present embodiment, the second high thermal conductor 90 is made of a graphite sheet having a thickness of 1 mm. Alternatively, the second high thermal conductor 90 may be a plate made of aluminum, copper, or silver.

[0164] As illustrated in FIG. 36, multiple second high thermal conductors 90 are arranged on a recessed portion 164b of the heater holder 164 at intervals in the longitudinal direction. The recessed portion 164b of the heater holder 164 has a plurality of holes in which the second high thermal conductors 90 are disposed. Clearances are formed between the heater holder 164 and both sides of the second high thermal conductor 90 in the longitudinal direction. The clearance prevents heat transfer from the second high thermal conductor 90 to the heater holder 164, and a heater 163 efficiently heats a fixing belt 161.

[0165] The heater illustrated in FIG. 37 includes multiple resistive heat generators arranged in the longitudinal direction of the heater. As illustrated in FIG. 37, each of the second high thermal conductor 90 (see the hatched portions) is disposed at a position corresponding to the separation area B1 in the longitudinal direction indicated by the arrow X and faces at least a part of each of neighboring resistive heat generators 156 in the longitudinal direction. In particular, each of the second high thermal conductors 90 in the present embodiment faces the entire separation area B1. Although FIG. 37 (and FIG. 39 described later) illustrates the case where the first high thermal conductor 89 is disposed over the entirety in the longitudinal direction of the region where all the resistive heat generators 156 are disposed, the arrangement range of the first high thermal conductor 89 is not limited thereto.

[0166] The fixing device according to the present embodiment includes the second high thermal conductor 90 disposed at the position corresponding to the separation area B1 in the longitudinal direction and the position at which at least a part of each of the neighboring resistive heat generators 156 faces the second high thermal conductor 90 in addition to the first high thermal conductor 89. The above-described structure further enhances the heat transfer efficiency in the separation area B1 in the longitudinal direction and more efficiently reduces the temperature unevenness of the heater 163 in the longitudinal direction. As illustrated in FIG. 38, the first high thermal conductors 89 and the second high thermal conductors 90 may be disposed opposite the entire gap area between the resistive heat generators 156. The above-described structure enhances the heat transfer efficiency of the part of the heater 163 corresponding to the gap area to be higher than the heat transfer efficiency of the other part of the heater 163. In FIG. 38, for the sake of convenience, the resistive heat generators 156, the first high thermal conductors 89, and the second high thermal conductors 90 are shifted in the vertical direction of FIG. 38 but are disposed at substantially the same position in the direction intersecting the longitudinal direction indicated by the arrow Y However, the present disclosure is not limited to the above. The first high thermal conductor 89 and the second high thermal conductor 90 may be disposed opposite a part of the resistive heat generators 156 in the direction intersecting the longitudinal direction or may be disposed so as to cover the entire resistive heat generators 156 in the direction intersecting the longitudinal direction.

[0167] Both the first high thermal conductor 89 and the second high thermal conductor 90 may be made of a graphene sheet. The first high thermal conductor 89 and the second high thermal conductor 90 made of the graphene sheet have high thermal conductivity in a predetermined direction along the plane of the graphene, that is, not in the thickness direction but in the longitudinal direction. Accordingly, the above-described structure can be effectively reduce the temperature unevenness of the fixing belt 161 in the longitudinal direction and the temperature unevenness of the heater 163 in the longitudinal direction.

[0168] Graphene is a flaky powder. Graphene has a planar hexagonal lattice structure of carbon atoms, as illustrated in FIG. 41. The graphene sheet is typically a single layer. The graphene sheet may contain impurities in a single layer of carbon or may have a fullerene structure. The fullerene structures are generally recognized as compounds including an even number of carbon atoms, which form a cage-like fused ring polycyclic system with five and six membered rings, including, for example, C60, C70, and C80 fullerenes or other closed cage structures having three-coordinate carbon atoms.

[0169] Graphene sheets are artificially made by, for example, a chemical vapor deposition (CVD) method.

[0170] The graphene sheet is commercially available. The size and thickness of the graphene sheet or the number of layers of the graphite sheet described below are measured by, for example, a transmission electron microscope (TEM).

[0171] Graphite obtained by multilayering graphene has a large thermal conduction anisotropy. As illustrated in FIG. 42, the graphite has a crystal structure formed by layering a number of layers each having a condensed six membered ring layer plane of carbon atoms extending in a planar shape. Among carbon atoms in this crystal structure, adjacent carbon atoms in the layer are coupled by a covalent bond, and carbon atoms between layers are coupled by a van der Waals bond. The covalent bond has a larger bonding force than a van der Waals bond. Therefore, there is a large anisotropy between the bond between carbon atoms in a layer and the bond between carbon atoms in different layers. That is, the first high thermal conductor 89 and the second high thermal conductor 90 that are made of graphite each have the heat transfer efficiency in the longitudinal direction larger than the heat transfer efficiency in the thickness direction of the first high thermal conductor 89 and the second high thermal conductor 90 (that is, the stacking direction of these members), reducing the heat transferred to the heater holder 164. Accordingly, the above-described structure can efficiently decrease the temperature unevenness of the heater 163 in the longitudinal direction and can minimize the heat transferred to the heater holder 164. Since the first high thermal conductor 89 and the second high thermal conductor 90 that are made of graphite are not oxidized at about 700 degrees or lower, the first high thermal conductor 89 and the second high thermal conductor 90 each have an excellent heat resistance.

[0172] The physical properties and dimensions of the graphite sheet may be appropriately changed according to the function required for the first high thermal conductor 89 or the second high thermal conductor 90. For example, the anisotropy of the thermal conduction can be increased by using high-purity graphite or single-crystal graphite or increasing the thickness of the graphite sheet. Using a thin graphite sheet can reduce the thermal capacity of the fixing device so that the fixing device can perform high-speed printing. A width of the first high thermal conductor 89 or a width of the second high thermal conductor 90 in the direction intersecting the longitudinal direction may be increased in response to a large width of the nip N or a large width of the heater 163.

[0173] From the viewpoint of increasing mechanical strength, the number of layers of the graphite sheet is preferably 11 or more. The graphite sheet may partially include a single layer portion and a multilayer portion.

[0174] As long as the second high thermal conductor

90 faces a part of each of neighboring resistive heat generators 156 and at least a part of the gap area between the neighboring resistive heat generators 156 in the longitudinal direction, the configuration of the second high thermal conductor 90 is not limited to the configuration illustrated in FIG. 37. For example, as illustrated in FIG. 39, a second high thermal conductor 90A is longer than the base 155 in the direction intersecting the longitudinal direction indicated by the arrow Y (the short-side direction), and both ends of the second high thermal conductor 90A in the direction intersecting the longitudinal direction are outside the base 155 in FIG. 39. A second high thermal conductor 90B faces a range in which the resistive heat generators 156 are disposed in the direction intersecting the longitudinal direction. A second high thermal conductor 90C faces a part of the gap area and a part of each of neighboring resistive heat generators 156.

[0175] The fixing device according to an embodiment illustrated in FIG. 40 has a gap between the first high thermal conductor 89 and the heater holder 164 in the thickness direction that is the lateral direction in FIG. 40. In other words, the fixing device has a gap 164c serving as a thermal insulation layer in a part of a region of the recessed portion 164b (see FIG. 36) of the heater holder 164 in which the heater 163, the first high thermal conductor 89, and the second high thermal conductor 90 are disposed. The gap 164c is in the part of the region of the recessed portion 164b in the longitudinal direction, and the second high thermal conductor 90 is not in the part. Therefore, FIG. 40 does not include the second high thermal conductor 90. The gap 164c has a depth deeper than the depth of the recessed portion 164b of the heater holder 164. Thus, the area of contact between the heater holder 164 and the first high thermal conductor 89 can be kept to a minimum, so that the heat transfer from the first high thermal conductor 89 to the heater holder 164 is reduced, thus allowing the fixing belt 161 to be effectively heated by the heater 163. In the cross section of the fixing device in which the second high thermal conductor 90 is set, the second high thermal conductor 90 is in contact with the heater holder 164 as illustrated in FIG. 35 of the above-described embodiment.

[0176] The gap 164c in the present embodiment is in an entire area in which the resistive heat generators 156 are disposed in the direction intersecting the longitudinal direction that is the vertical direction in FIG. 40. The above-described configuration efficiently prevents heat transfer from the first high thermal conductor 89 to the heater holder 164, and the heater 163 efficiently heats the fixing belt 161. The fixing device may include a thermal insulation layer made of thermal insulator having a lower thermal conductivity than the thermal conductivity of the heater holder 164 instead of a space like the gap 164c serving as the thermal insulation layer.

[0177] In the present embodiment, the second high thermal conductor 90 is a member different from the first high thermal conductor 89, but the present embodiment is not limited to this. For example, the first high thermal conductor 89 may have a thicker portion than the other portion so that the thicker portion faces the separation area B1 and functions as the second high thermal conductor 90.

[0178] As described above, the heating device in the present embodiment includes the tube such as the fixing belt 20, the heater 22, and the flange 53. The tube is rotatable and extends in the longitudinal direction of the tube. In other words, the tube has the rotational axis direction. The heater 22 heats the tube. The flange 53 holds the heater and an end of the tube in the longitudinal direction. The flange 53 has the recess 53d in which the heater 22 is held and the bridging portion 53h bridging the recess 53d. The heater 22 has the protrusion 22p on at least one end of both ends of the heater 22 in the longitudinal direction. The protrusion 22p protrudes outside the bridging portion 53h in the longitudinal direction.

[0179] The above-described structure prevents the mark from becoming difficult to be visually recognized.

[0180] As described above, the heating device in the present embodiment includes the protrusion 22p protruding outside the bridging portion 53h in the longitudinal direction of the tube and the mark 22m to identify the characteristic value of the heater 22 is on the protrusion 22p.

[0181] The above-described structure can enhance the visibility of the mark. In addition, the working efficiency at the time of assembly is enhanced.

[0182] The length of the protrusion 22p in the longitudinal direction X of the heater 22 is larger than the width of the heater 22 in the direction orthogonal to the longitudinal direction of the fixing belt 20.

[0183] The above-described structure can prevent the size of the heater in the short-side direction of the heater from increasing.

[0184] As described above, the heating device 200 in the present embodiment includes the connector 40 coupled to the electrodes 58 of the heater 22. The heater 22 has the protrusion 22p as one end protruding from the flange and the protrusion 22q as the other end protruding from the flange. The connector 40 is disposed on the other end.

[0185] The above-described structure can prevent the size of the heater in the longitudinal direction of the heater from increasing and reduce the temperature difference between both ends of the heater 22 in the longitudinal direction.

[0186] As described above, the flange 53 in the present embodiment is made of resin.

[0187] The flange 53 made of resin prevents the heat generated by the heater from transferring to the outside of the heater.

[0188] As described above, the fixing device 9 in the present embodiment includes the pressure rotator such as the pressure roller 21 including the core 21a, and the protrusion 22p extends outward from the core 21a in the longitudinal direction.

[0189] The above-described structure can enhance the visibility of the mark.

[0190] As described above, the bridging portion 53h in the present embodiment has the facing portion 53t facing the pressure rotator such as the pressure roller 21, and the facing portion 53t is thinner than the other portion of the bridging portion 53h.

[0191] The above-described structure can avoid the interference with the core of the pressure roller and reduce the size of the fixing device.

[0192] As described above, the fixing device 9 in the present embodiment includes the heater holder 23 that holds the heater 22 and the stay 24 that supports the heater holder 23, and the flange 53 and the stay 24 are in contact with each other.

[0193] The above-described structure can prevent deformation due to a load.

[0194] As described above, the fixing device 9 in the present embodiment includes the heating device 200 and the side plate such as the frame 80 that holds the flange 53 so as to be relatively movable, and the bridging portion 53h is positioned so as to overlap the frame 80 in the direction orthogonal to the longitudinal direction.

[0195] The above-described structure can prevent the deformation of the fitting portion of the side plate and enhance the positional accuracy.

[0196] As described above, the fixing device 9 in the present embodiment includes the heating device 200 and the side plate such as the frame 80 that holds the flange 53 so as to be relatively movable, and the width of the bridging portion 53h is larger than the thickness of the side plate such as the frame 80.

[0197] The above-described structure can prevent deformation of the flange.

[0198] As described above, the fixing device 9 in the present embodiment includes the heating device 200 and the side plate such as the frame 80 that holds the flange 53 so as to be relatively movable, and the width of the bridging portion 53h is larger than the thickness of the heater 22.

[0199] The above-described structure can prevent deformation of the flange.

[0200] The heating device according to the present disclosure may be applied to, for example, a dryer for an inkjet type image forming apparatus.

[0201] The heating device according to the present disclosure may be applied to a laminating device.

[0202] The above-described embodiments are illustrative and do not limit this disclosure. It is therefore to be understood that within the scope of the appended claims, numerous additional modifications and variations are possible to this disclosure otherwise than as specifically described herein.

[0203] The above-described embodiments and modification are examples. Embodiments of the present disclosure can provide, for example, some advantages in the following aspects.

[First Aspect]

[0204] In a first aspect, a heating device includes a tube such as the fixing belt 20, a heater such as the heater 22, and a flange such as the flange 53. The tube is rotatable and extends in a longitudinal direction of the tube. The heater heats the tube. The flange has a recess such as the recess 53d in which the heater is held and a bridging portion such as the bridging portion 53h bridging the recess. The heater has a protrusion such as the protrusion 22p on at least one end of both ends of the heater in the longitudinal direction. The protrusion protrudes outside the bridging portion in the longitudinal direction.

[Second Aspect]

[0205] In a second aspect, the protrusion in the heating device according to the first aspect has a mark such as the mark 22m to identify a characteristic value of the heater.

[Third Aspect]

[0206] In a third aspect, the heating device according to the first aspect or the second aspect includes the protrusion having a length in the longitudinal direction that is larger than the width of the heater in a direction orthogonal to the longitudinal direction.

[Fourth Aspect]

[0207] In a fourth aspect, the heating device according to any one of the first to third aspects further includes a connector coupled to the electrodes of the heater. The connector is disposed at the other end of both ends of the heater in the longitudinal direction, and the protrusion is disposed at the one end of both ends of the heater in the longitudinal direction.

[Fifth Aspect]

[0208] In a fifth aspect, the flange in the heating device according to any one of the first to fourth aspects is made of resin.

[Sixth Aspect]

[0209] In a sixth aspect, a fixing device includes the heating device according to any one of the first to fifth aspects and a pressure rotator such as the pressure roller 21 contacting the tube to form a nip.

[Seventh Aspect]

[0210] In a seventh aspect, the pressure roller in the fixing device according to the sixth aspect includes a core, and the protrusion protrudes outside the core in the longitudinal direction.

[Eighth Aspect]

[0211] In an eighth aspect, the bridging portion in the fixing device according to the sixth aspect or the seventh aspect has a facing portion facing the pressure rotator, and the facing portion is thinner than another portion of the bridging portion other than the facing portion.

[Ninth Aspect]

[0212] In a ninth aspect, the fixing device according to any one of the sixth to eighth aspects further includes a heater holder such as the heater holder 23 holding the heater and a stay such as the stay 24 supporting the heater holder and contacting the flange.

[Tenth Aspect]

[0213] In a tenth aspect, a fixing device includes the heating device according to any one of the first to fifth aspects and a side plate such as the frame movably holding the flange, and the bridging portion 53h overlaps the side plate in a direction orthogonal to the longitudinal direction.

[Eleventh Aspect]

[0214] In an eleventh aspect, a fixing device includes the heating device according to any one of the first to fifth aspects and a side plate movably holding the flange, and a size of the bridging portion in a longitudinal direction of the heater is larger than a thickness of the side plate.

[Twelfth Aspect]

[0215] In a twelfth aspect, a fixing device includes the heating device according to any one of the first to fifth aspects and a side plate movably holding the flange, and a size of the bridging portion in a longitudinal direction of the heater is larger than a thickness of the heater.

[Thirteenth Aspect]

[0216] In a thirteenth aspect, an electrophotographic image forming apparatus includes the fixing device according to any one of the sixth to twelfth aspects.

[Fourteenth Aspect]

[0217] In a fourteenth aspect, a dryer includes the heating device according to any one of the first to fifth aspects.

[Fifteenth Aspect]

[0218] In a fifteenth aspect, an inkjet image forming apparatus includes the dryer according to the fourteenth aspect.

Claims

1. A heating device (200) comprising:

   a tube (20) being rotatable and extending in a longitudinal direction of the tube (20);
   a heater (22) to heat the tube (20); and
   a flange (53) to hold the heater (22) and an end of the tube (20) in the longitudinal direction, the flange (53) having:

      a recess (53d) in which the heater (22) is held; and
      a bridging portion (53h) bridging the recess (53d),

   wherein the heater (22) has a protrusion (22p) on at least one end of both ends of the heater (22) in the longitudinal direction, and
   the protrusion (22p) protrudes outside the bridging portion (22p) in the longitudinal direction.

2. The heating device (200) according to claim 1, wherein the protrusion (22p) has a mark (22m) to identify a characteristic value of the heater (22).

3. The heating device (200) according to claim 1 or 2, wherein a length of the protrusion (22p) in the longitudinal direction is larger than a width of the heater (22) in a direction orthogonal to the longitudinal direction.

4. The heating device (200) according to any one of claims 1 to 3, further comprising

   a connector (40) coupled to electrodes (58) of the heater (22), the connector (40) disposed at the other end of both ends of the heater (22) in the longitudinal direction,
   wherein the protrusion (22p) is disposed at the one end of both ends of the heater (22) in the longitudinal direction.

5. The heating device (200) according to any one of claims 1 to 4,
wherein the flange (53) is made of resin.

6. A fixing device (9) comprising:

   the heating device (200) according to any one of claims 1 to 5; and
   a pressure rotator (21) contacting the tube (20) to form a nip.

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

   wherein the pressure rotator (21) includes a core (21a), and the protrusion (22p) protrudes outside the core (21a) in the longitudinal direction.

8. The fixing device (9) according to claim 6 or 7, wherein the bridging portion (53h) has a facing portion (53t) facing the pressure rotator (21), and the facing portion (53t) is thinner than another portion of the bridging portion 53h other than the facing portion (53t).

9. The fixing device (9) according to any one of claims 6 to 8, further comprising:

a heater holder (23) holding the heater (22); and
a stay (24) supporting the heater holder (23) and contacting the flange (53).

10. A fixing device (9) comprising:

the heating device (200) according to any one of claims 1 to 5; and
a side plate (80) movably holding the flange (53), wherein the bridging portion (53h) overlaps the side plate (80) in a direction orthogonal to the longitudinal direction.

11. A fixing device (9) comprising:

the heating device (200) according to any one of claims 1 to 5; and
a side plate (80) movably holding the flange (53), wherein a size of the bridging portion (53h) in a longitudinal direction of the heater (22) is larger than a thickness of the side plate (80).

12. A fixing device (9) comprising:

the heating device (200) according to any one of claims 1 to 5; and
a side plate (80) movably holding the flange (53), wherein a size of the bridging portion (53h) in a longitudinal direction of the heater (22) is larger than a thickness of the heater (22).

13. An electrophotographic image forming apparatus (100) comprising the fixing device (9) according to any one of claims 6 to 12.

14. A drying device comprising
the heating device (200) according to any one of claims 1 to 5.

15. An inkjet image forming apparatus comprising the dryer according to claim 14.

FIG. 1

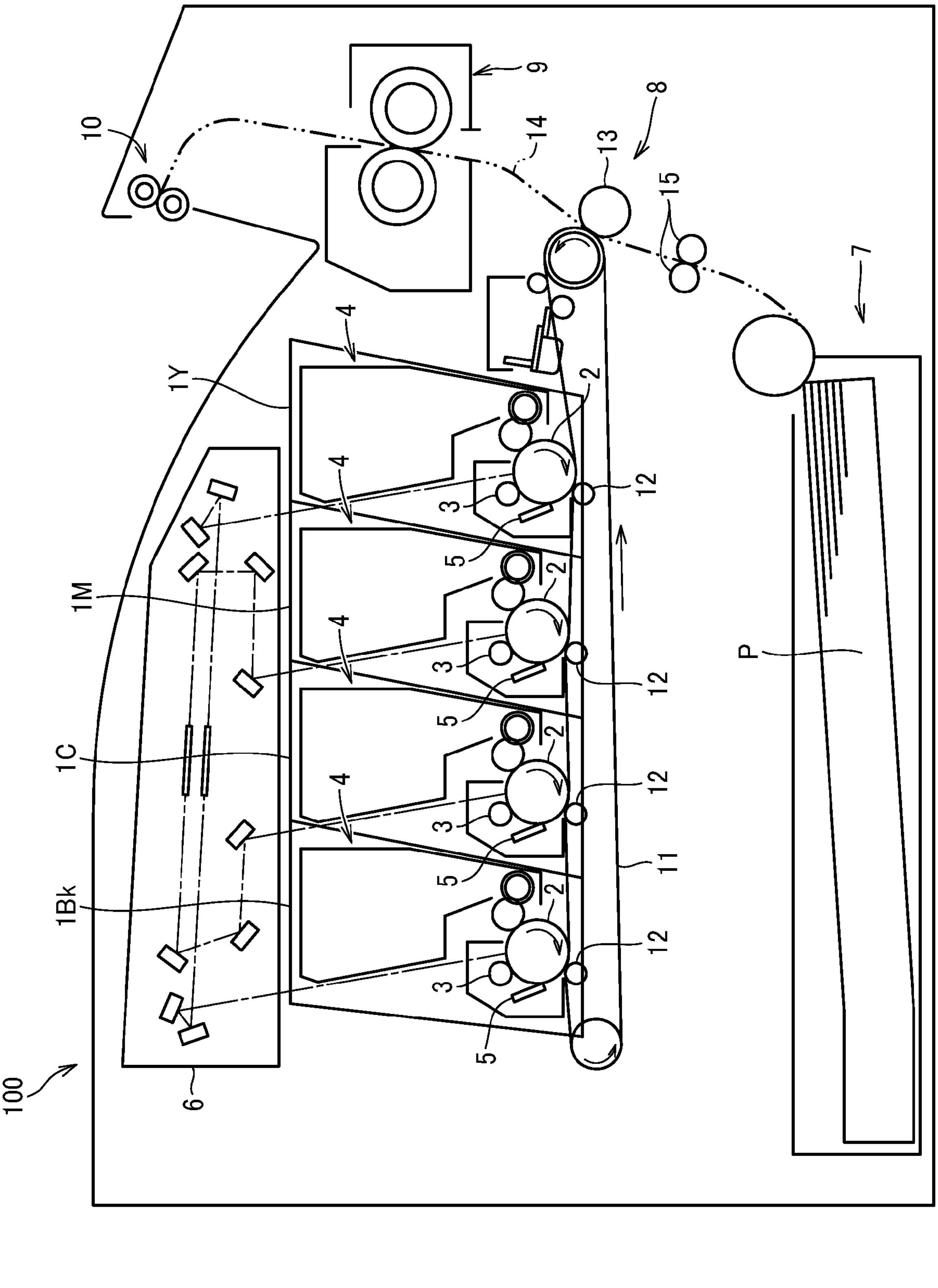


FIG. 2

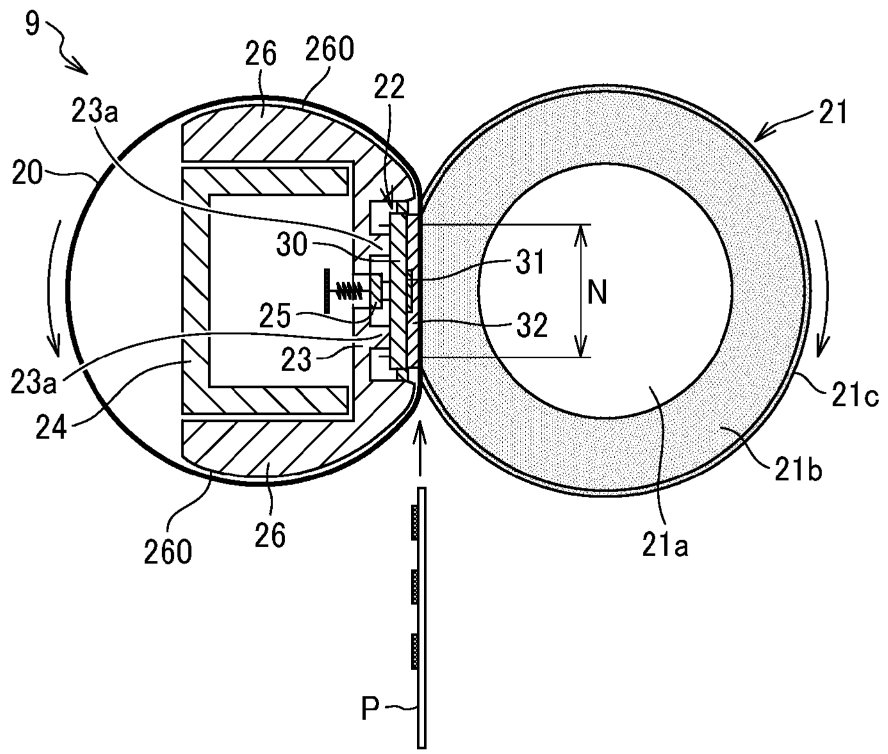

9
26
260
22
21
23a
20
30
31
N
25
32
23
23a
21c
24
21b
260
26
21a
P

FIG. 3

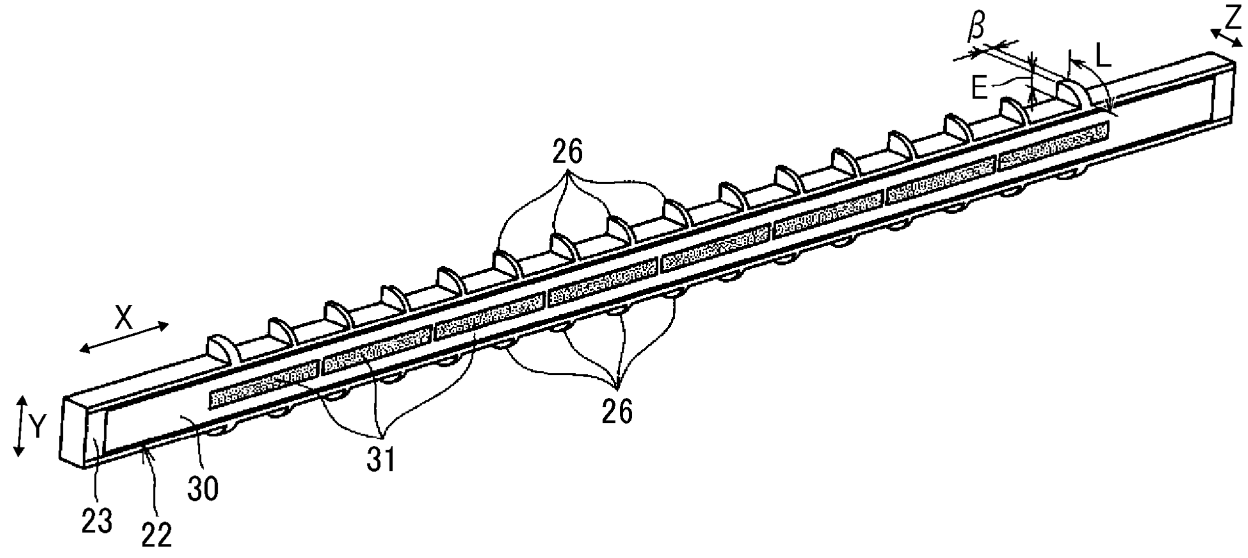
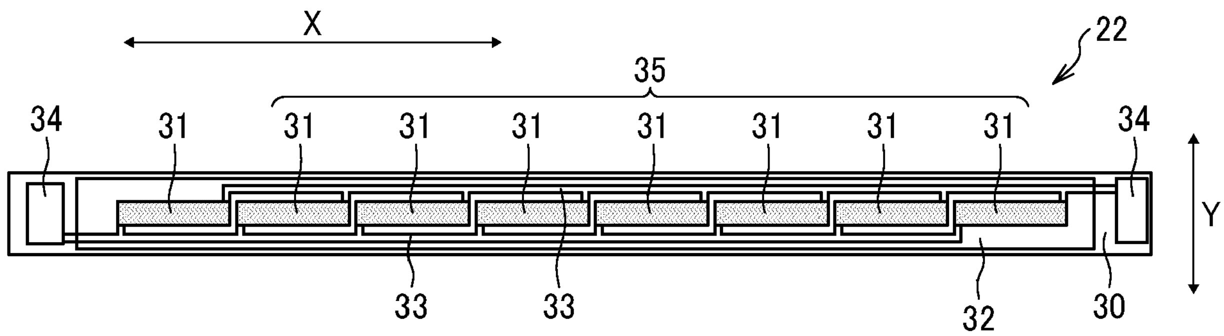
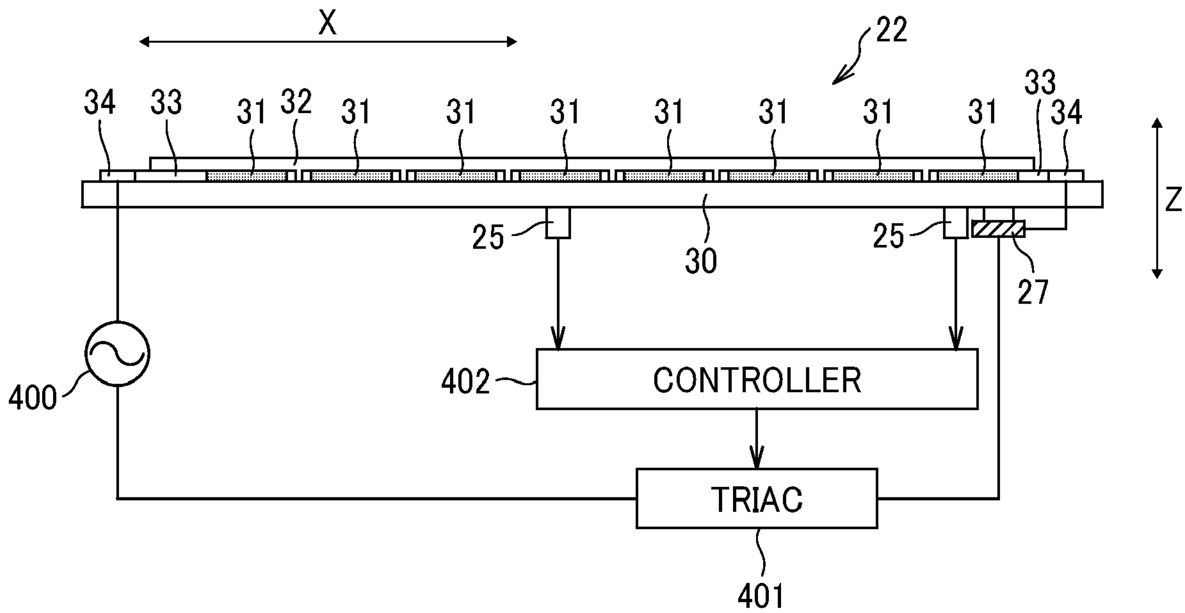

β
Z
L
E
26
X
Y
31
26
30
23
22

FIG. 4



X
22
35
34
31
31
31
31
31
31
31
31
34
Y
33
33
32
30

FIG. 5



X
22
33
34
33
31
32
31
31
31
31
31
31
31
34
Z
25
30
25
27
400
402
CONTROLLER
TRIAC
401

FIG. 6

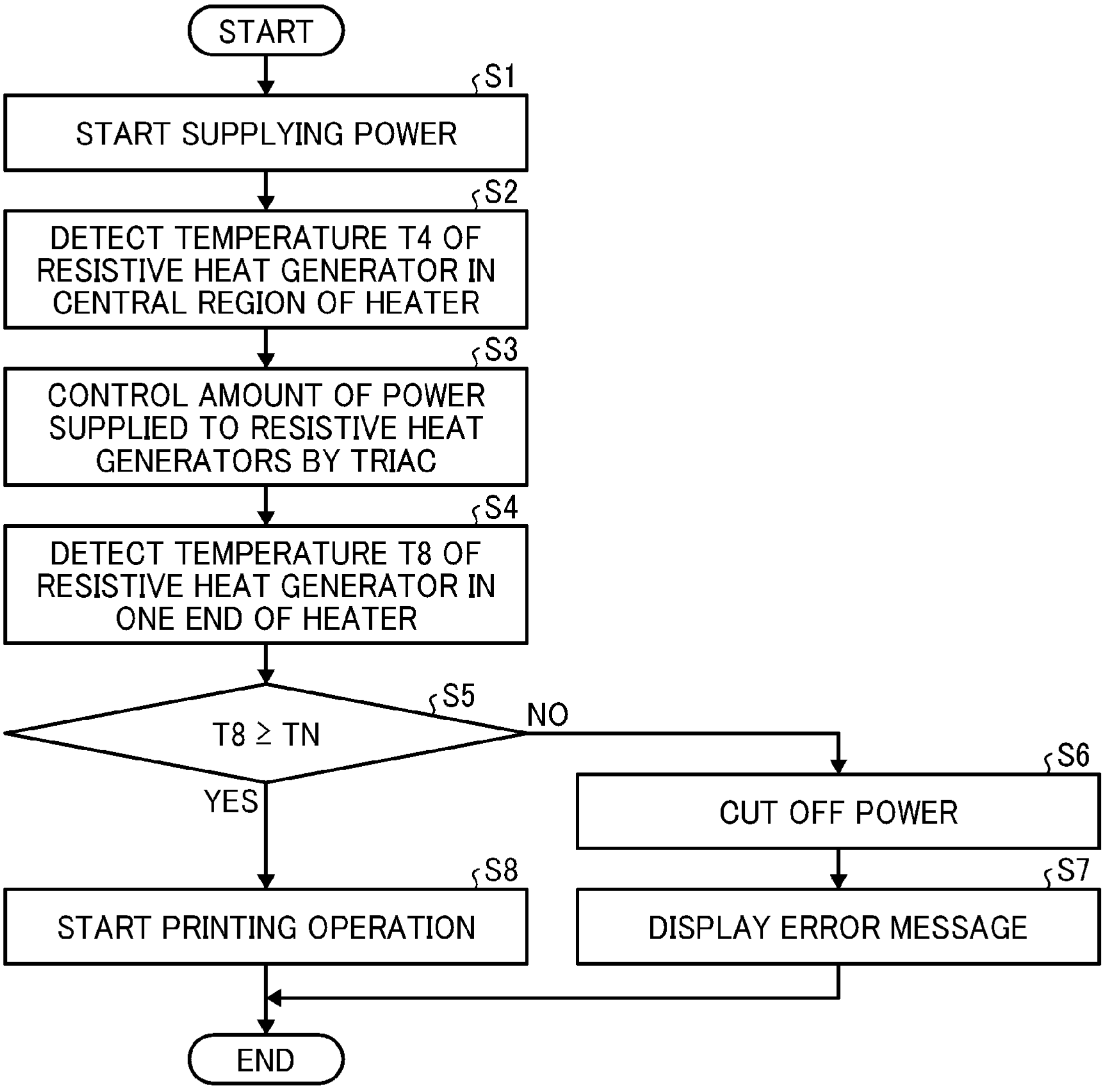

START
S1
START SUPPLYING POWER
S2
DETECT TEMPERATURE T4 OF RESISTIVE HEAT GENERATOR IN CENTRAL REGION OF HEATER
S3
CONTROL AMOUNT OF POWER SUPPLIED TO RESISTIVE HEAT GENERATORS BY TRIAC
S4
DETECT TEMPERATURE T8 OF RESISTIVE HEAT GENERATOR IN ONE END OF HEATER
S5
T8 ≥ TN
NO
YES
S6
CUT OFF POWER
S7
DISPLAY ERROR MESSAGE
S8
START PRINTING OPERATION
END

FIG. 7

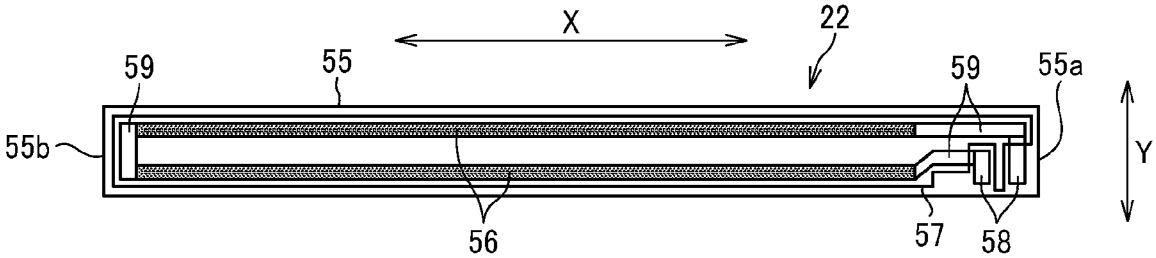

X
22
59
55
59
55a
55b
Y
56
57
58

FIG. 8

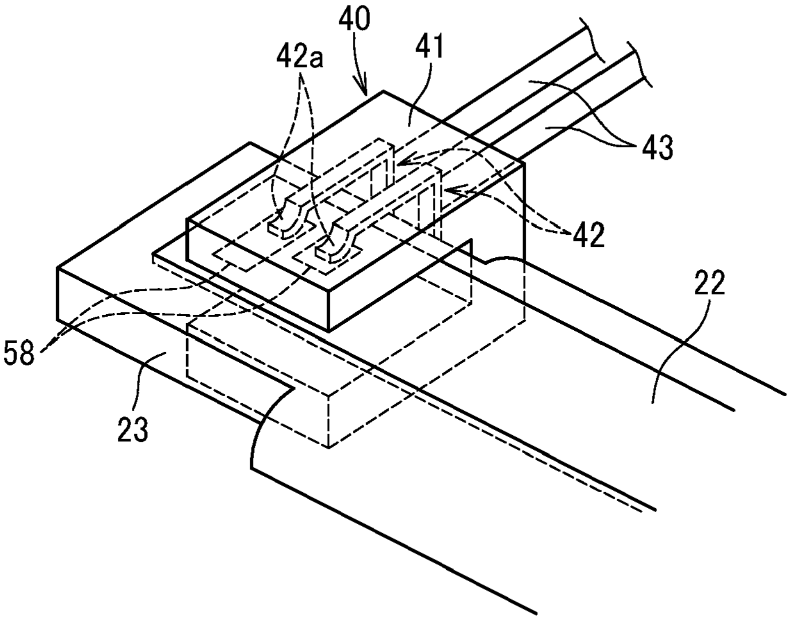
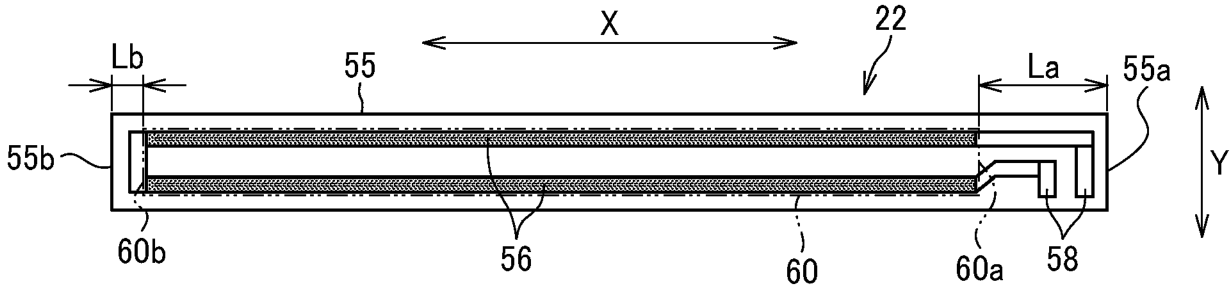


FIG. 9



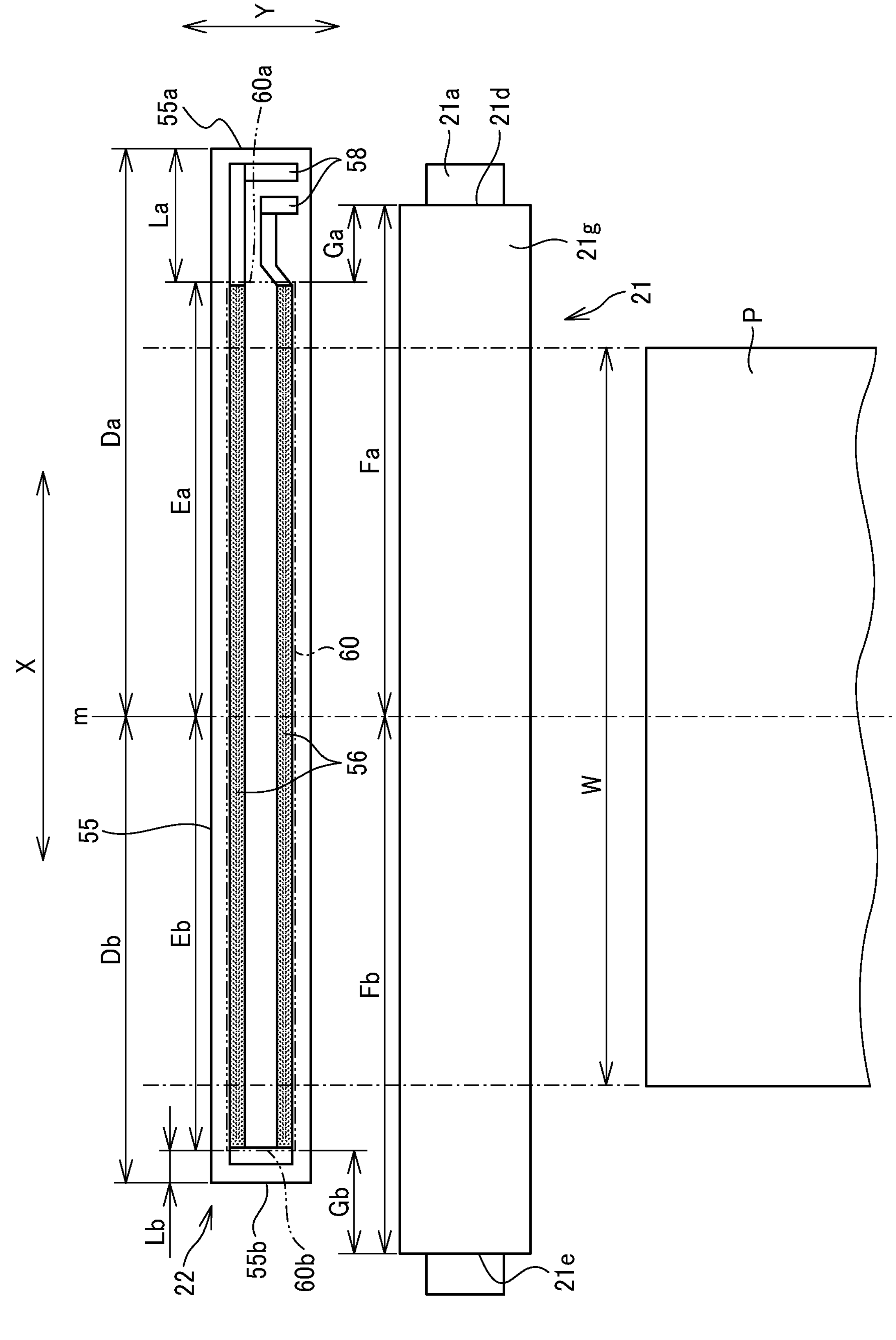

Y
X
55a
60a
58
La
Da
Ea
60
m
56
55
Db
Eb
Lb
22
55b
60b
21a
21d
Ga
21g
21
Fa
Fb
Gb
21e
P
W

FIG. 10

FIG. 11

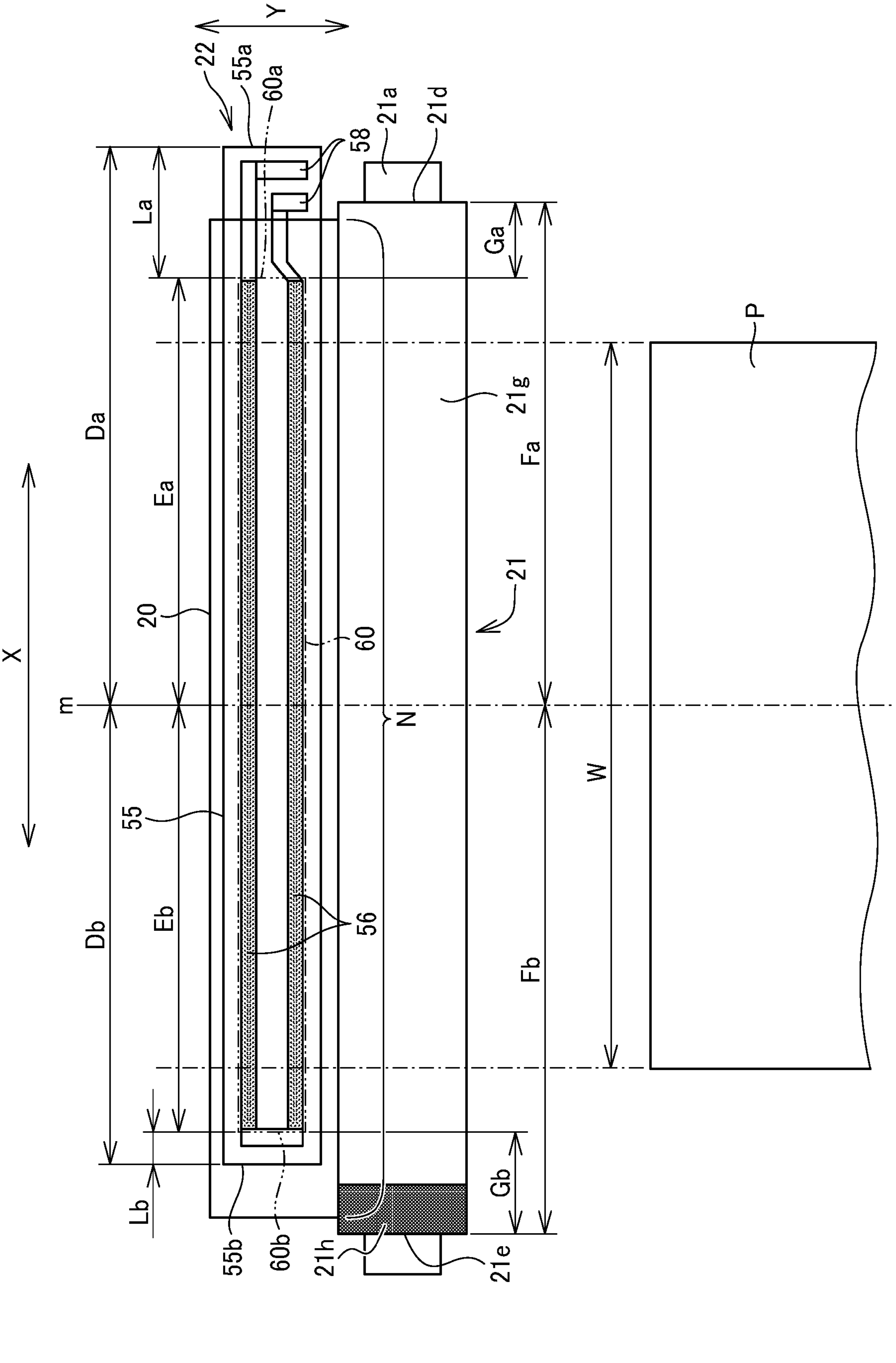

X
Y
22
55a
60a
58
21a
21d
La
Ga
P
21g
Da
Ea
Fa
21
20
60
m
N
W
55
56
Db
Eb
Fb
Gb
Lb
55b
60b
21h
21e

FIG. 12

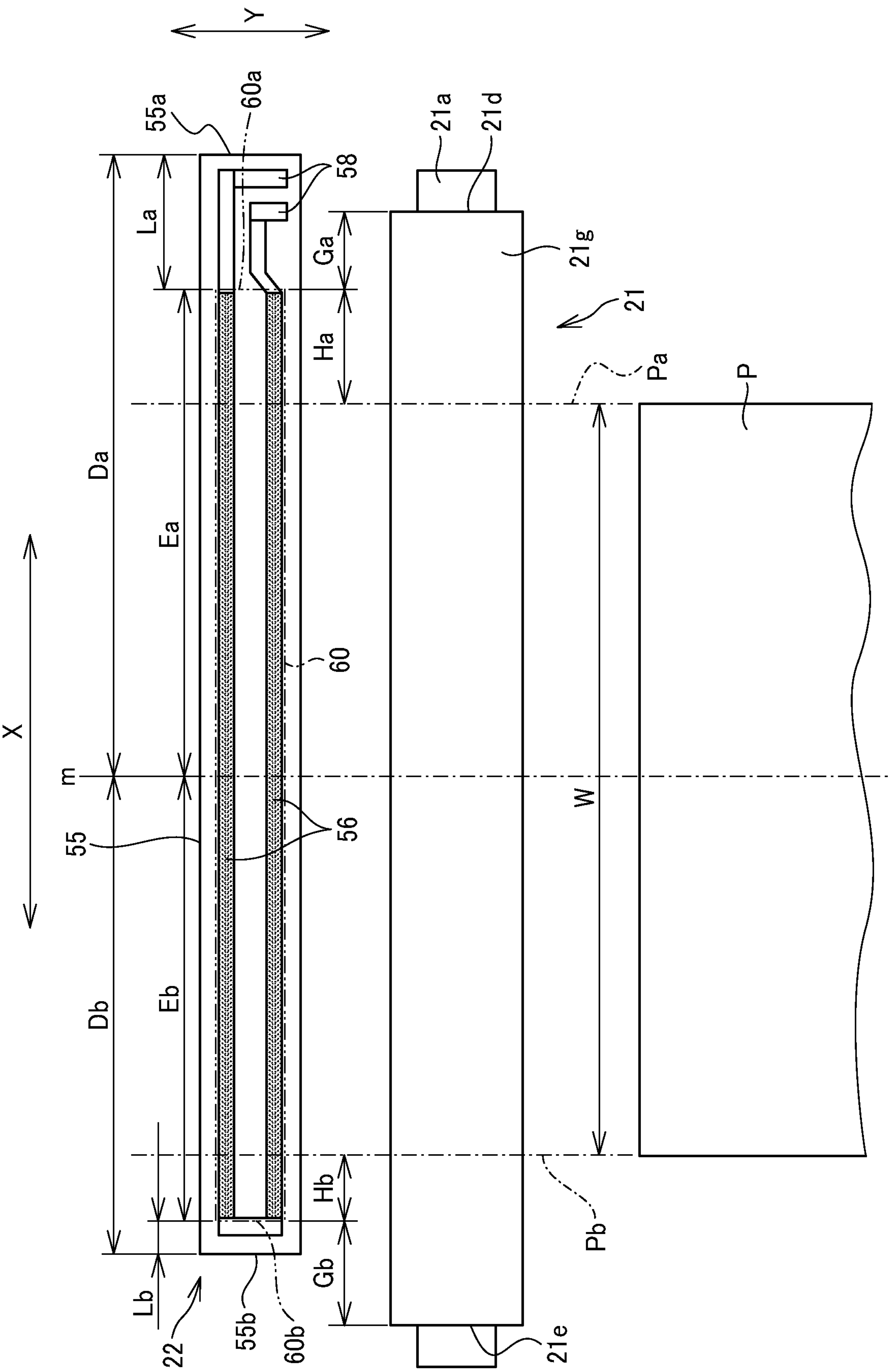

Y
X
55a
60a
21a
21d
58
La
Ga
21g
21
Ha
Pa
P
Da
Ea
60
m
W
55
56
Db
Eb
Hb
Pb
Gb
Lb
22
55b
60b
21e

FIG. 13

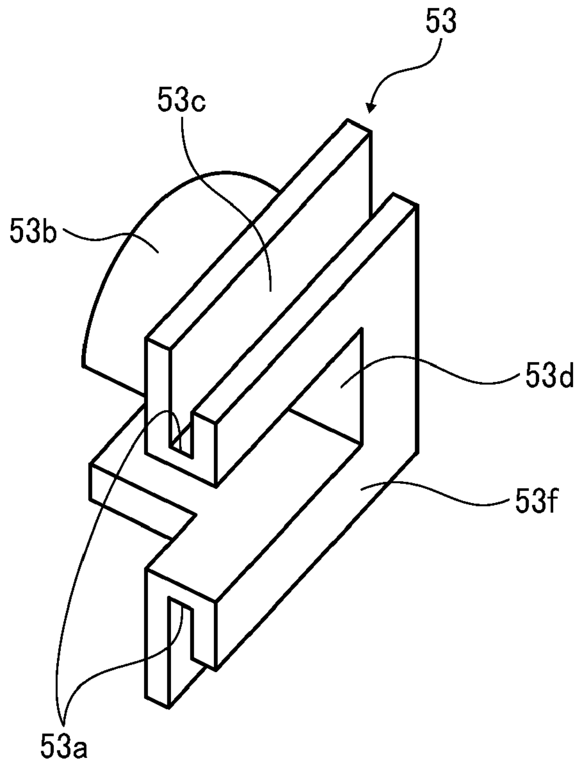


FIG. 14AA

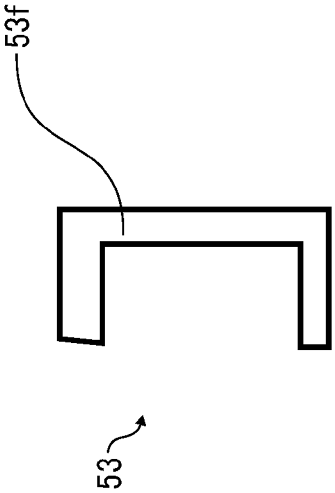


FIG. 14AB

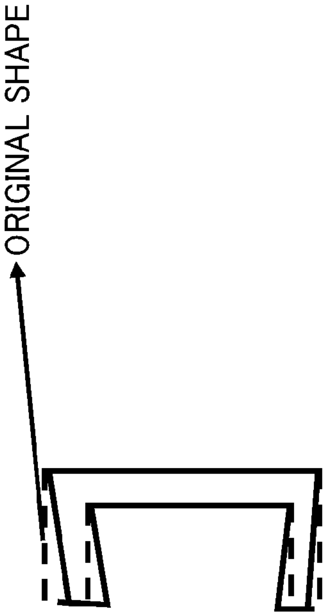


FIG. 14B

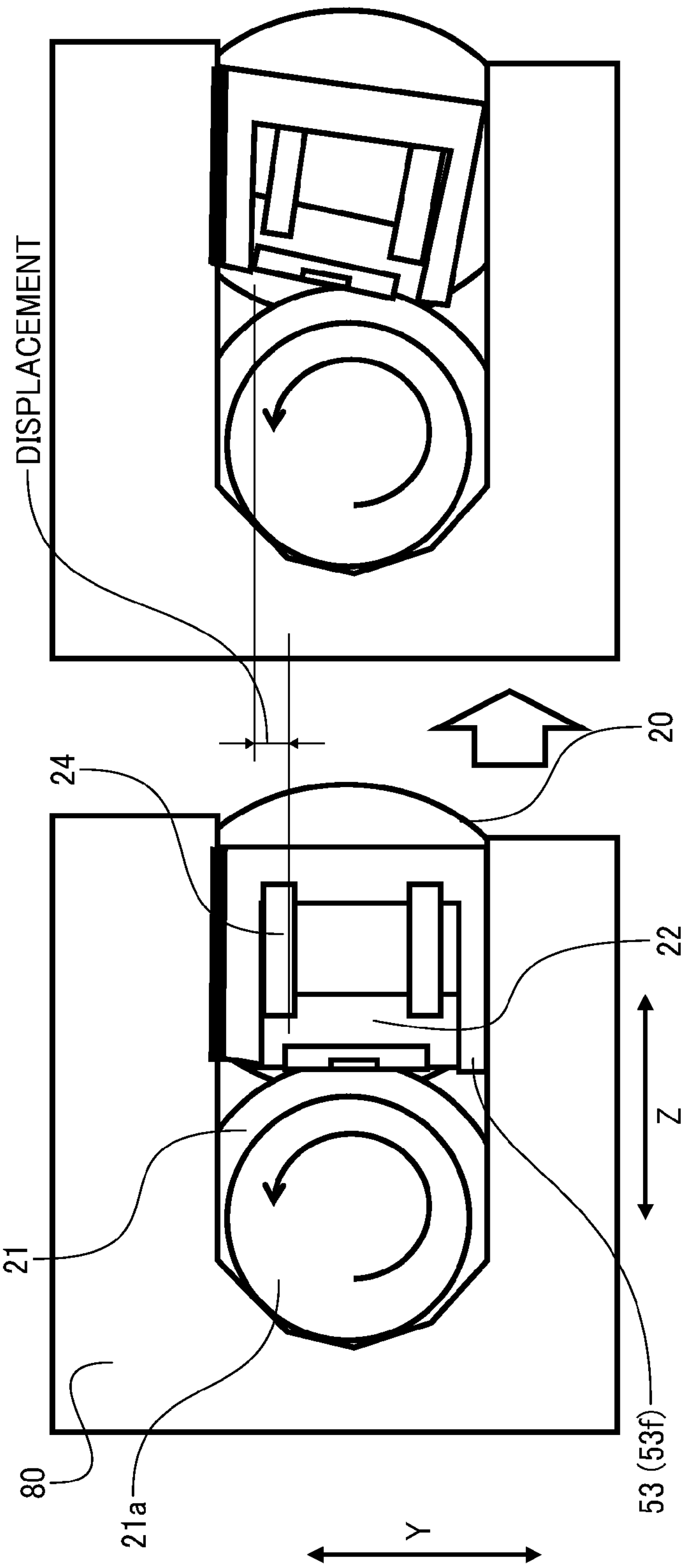


FIG. 15A

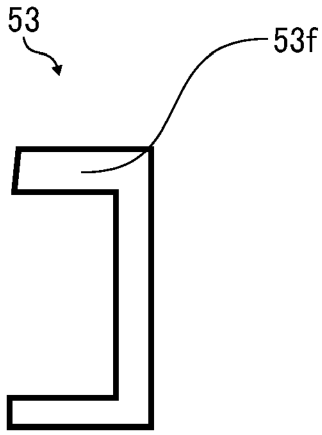


FIG. 15B

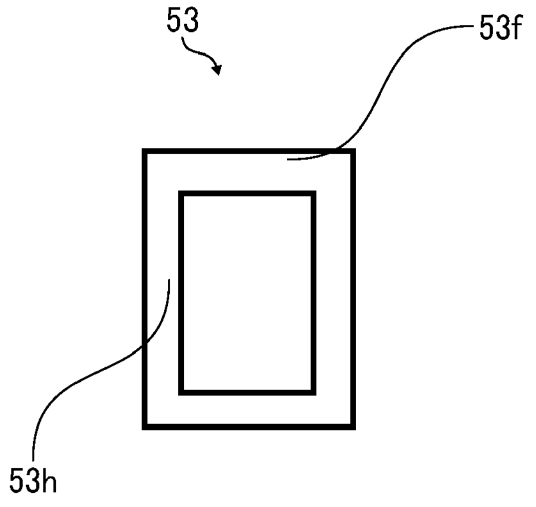
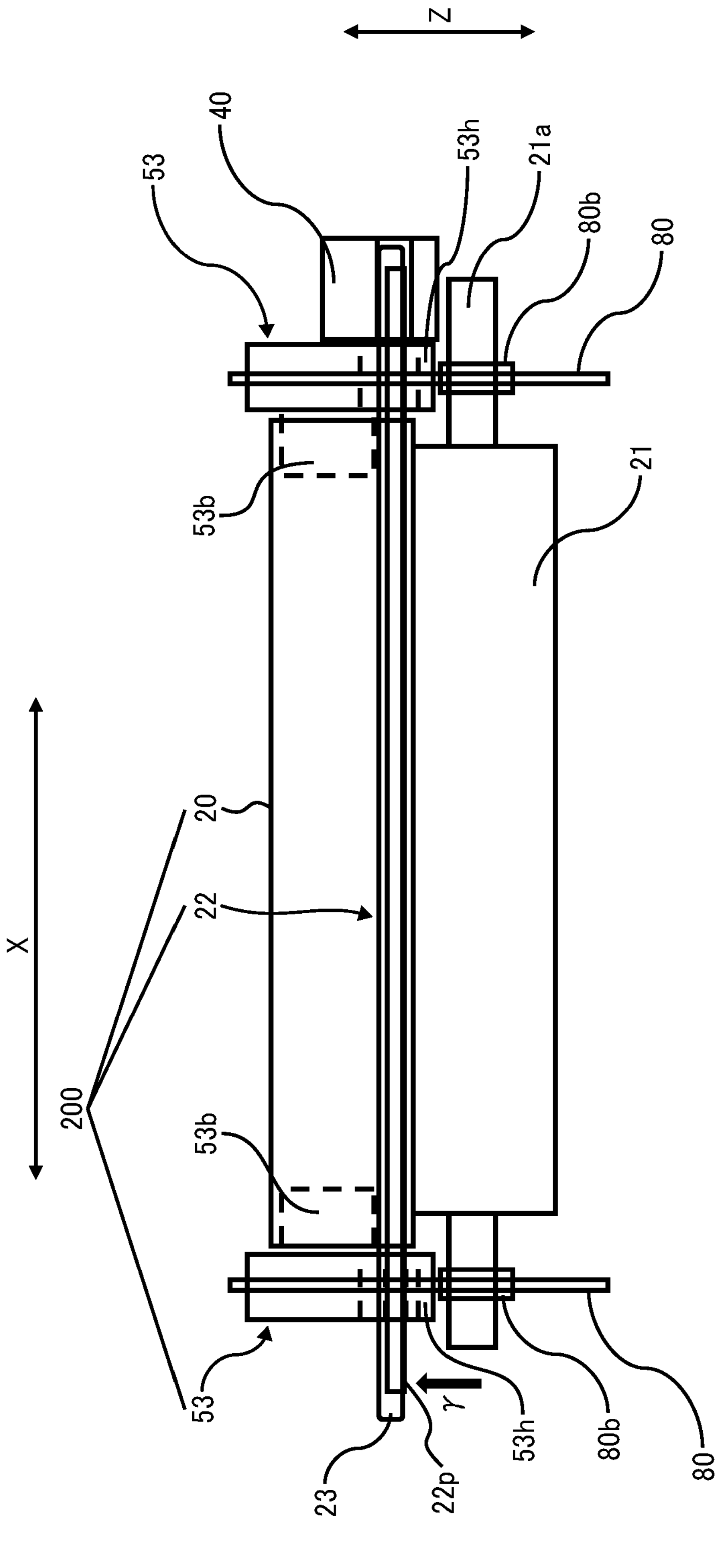


FIG. 16



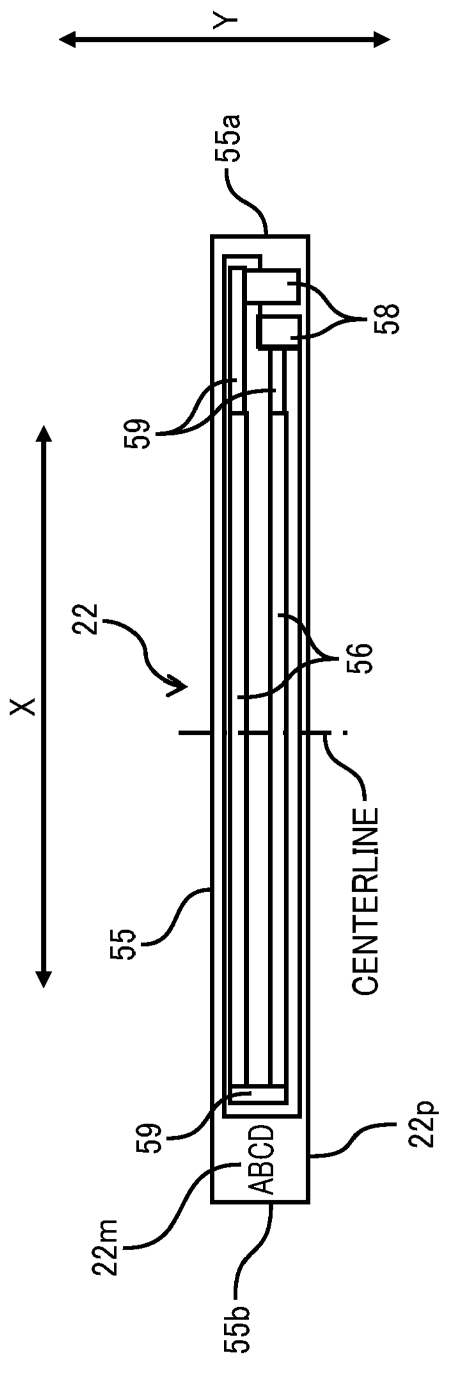


FIG. 17A

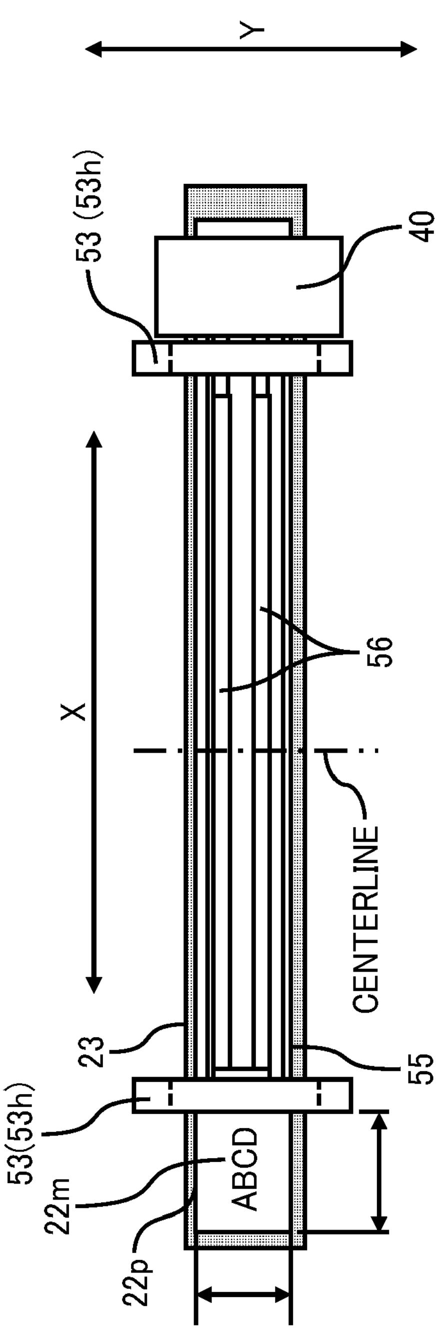


FIG. 17B

FIG. 18A

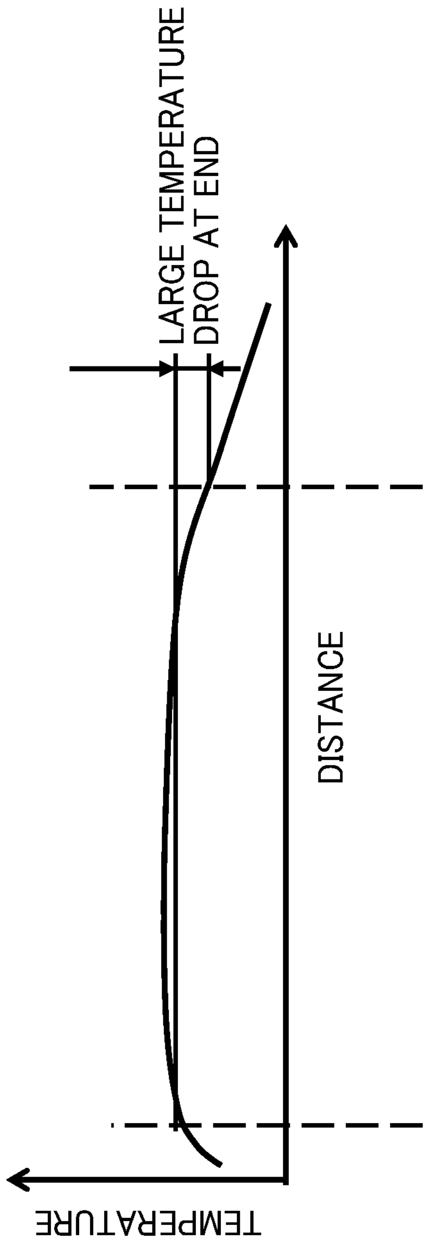


FIG. 18B

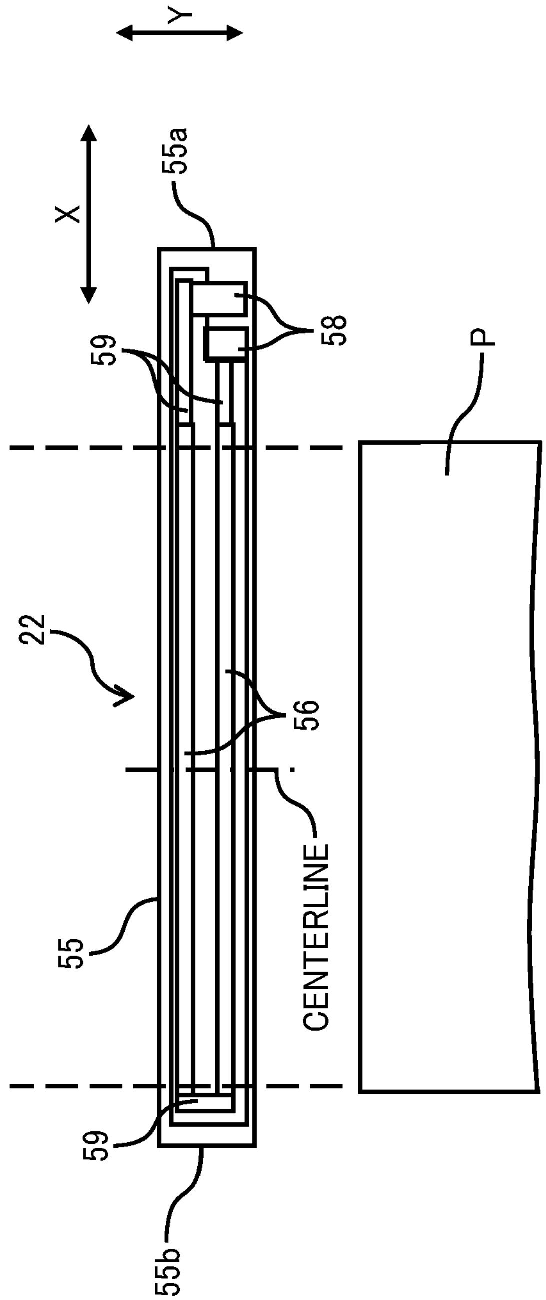


FIG. 19A

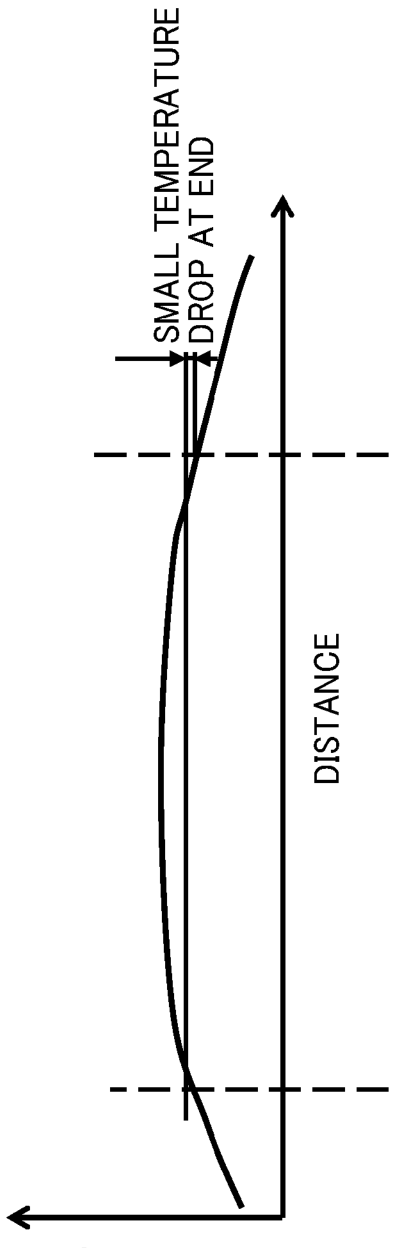


FIG. 19B

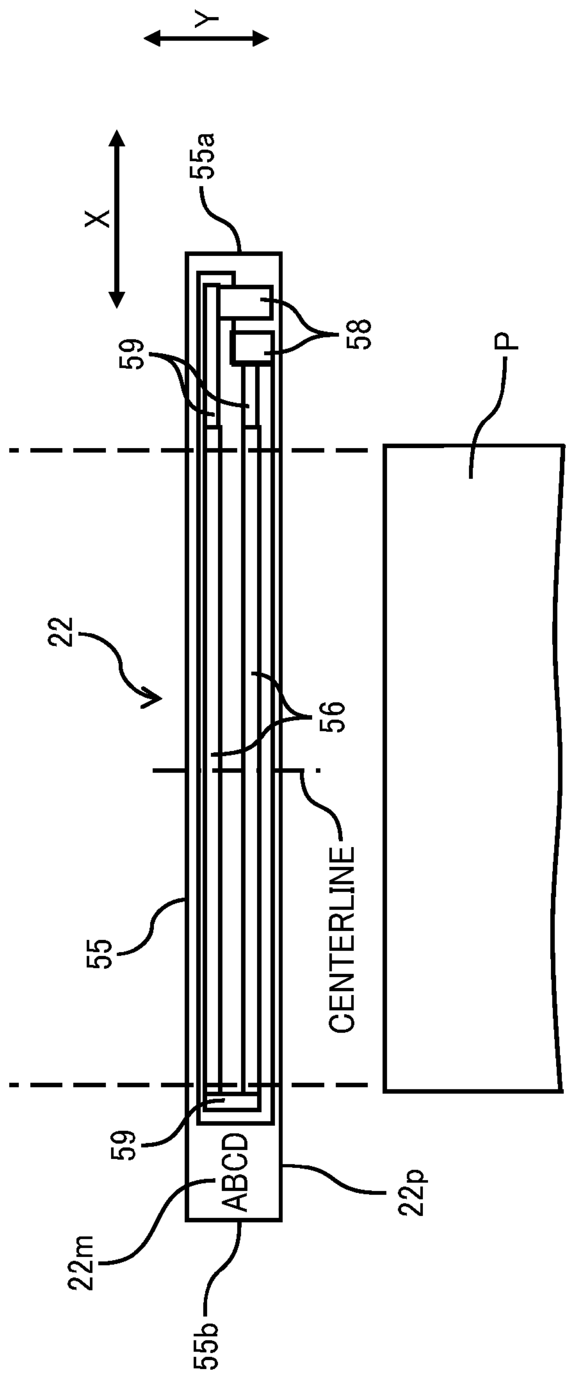


FIG. 20A

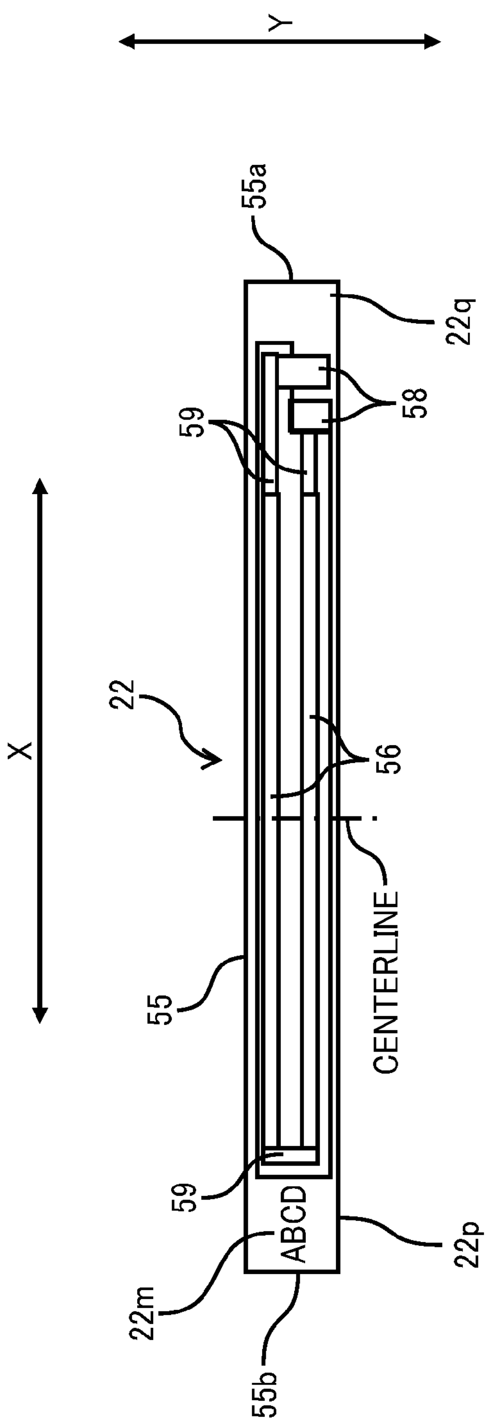


FIG. 20B

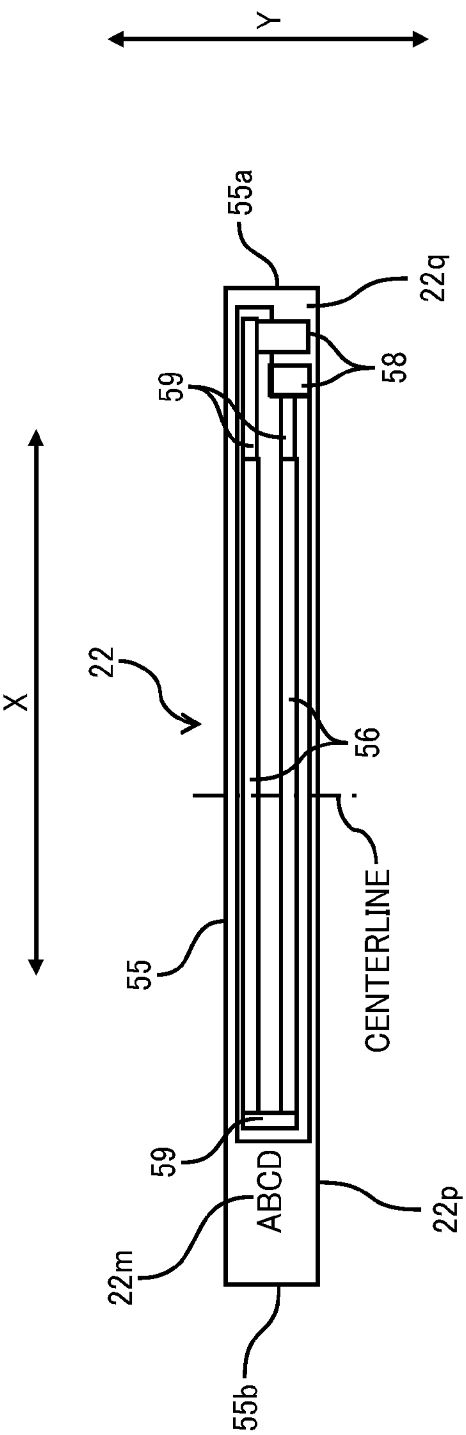


FIG. 21A

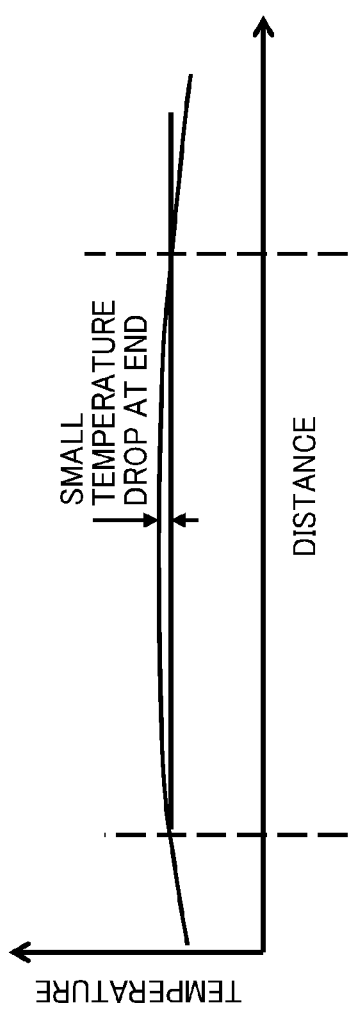


FIG. 21B

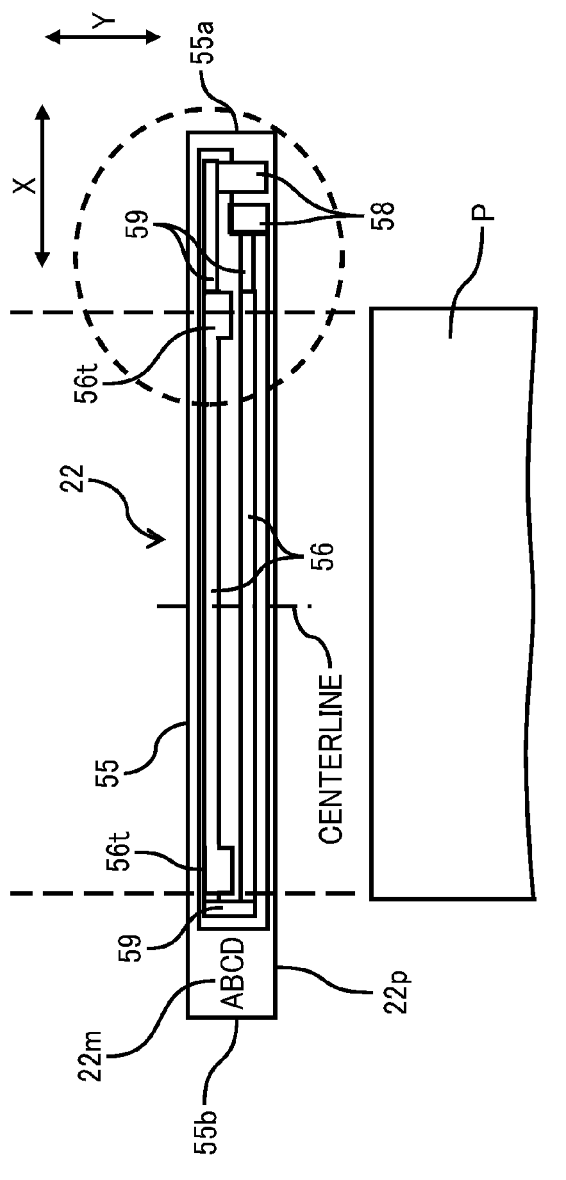


FIG. 21C

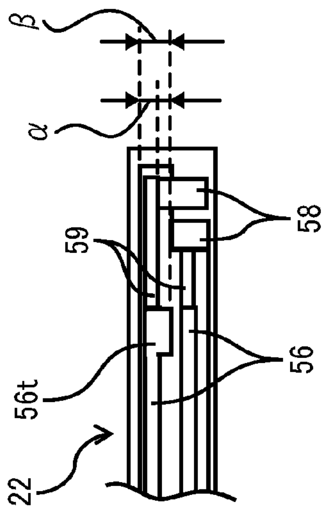


FIG. 22A

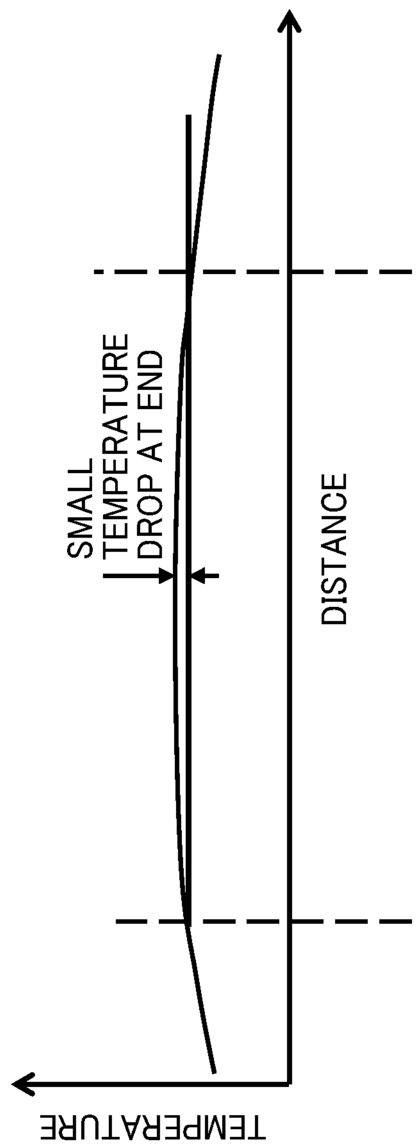


FIG. 22B

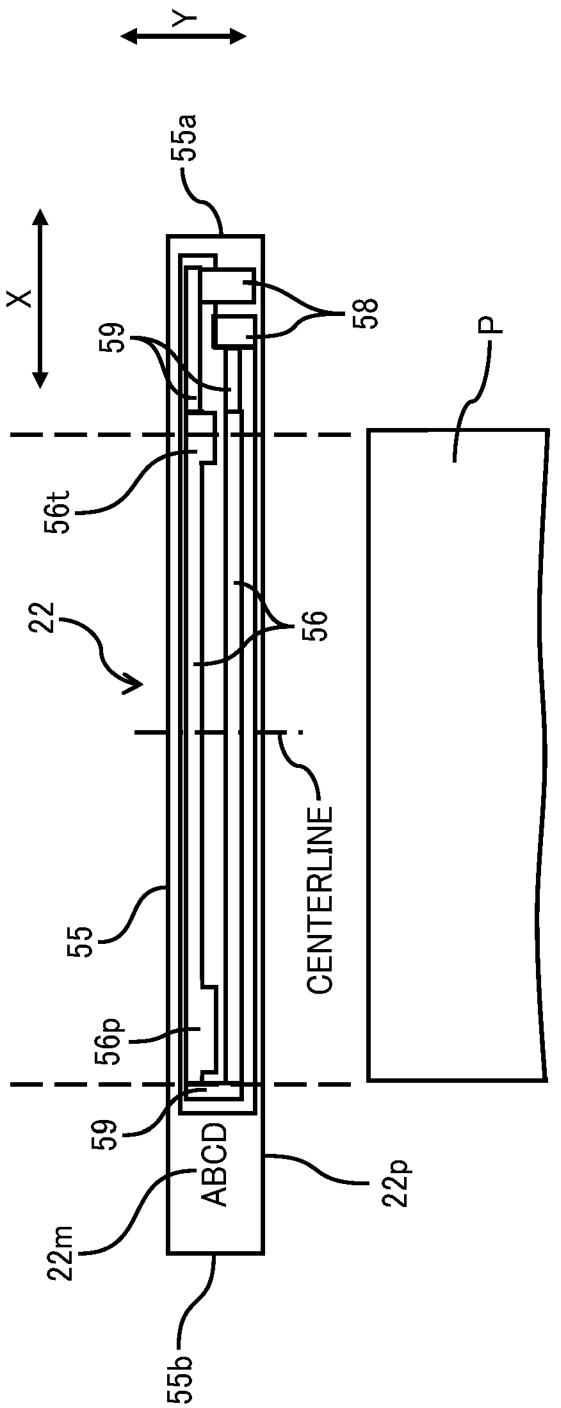


FIG. 23A

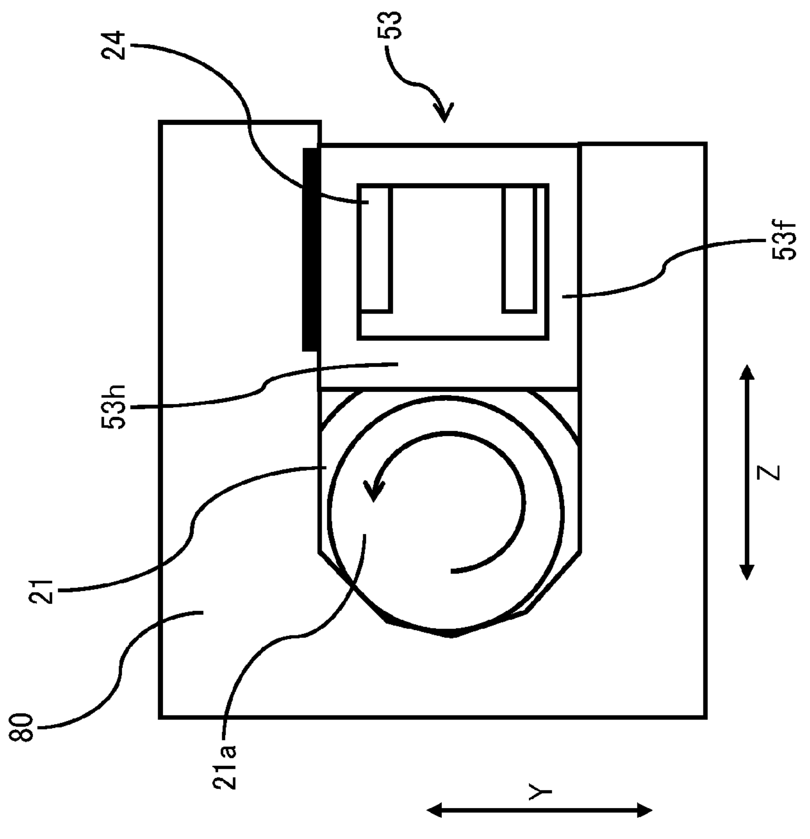


FIG. 23B

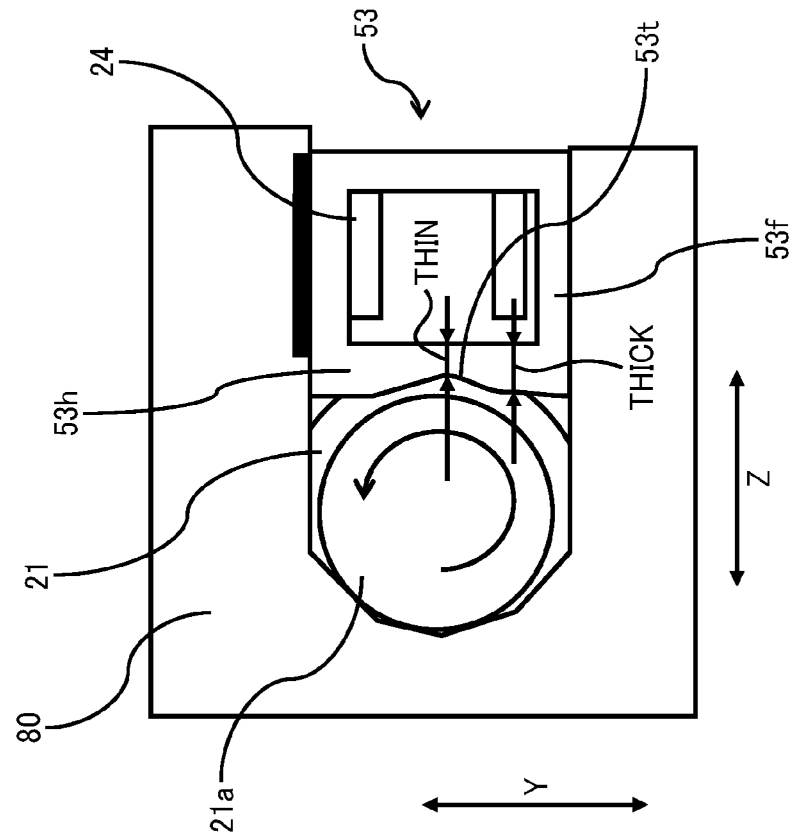


FIG. 24

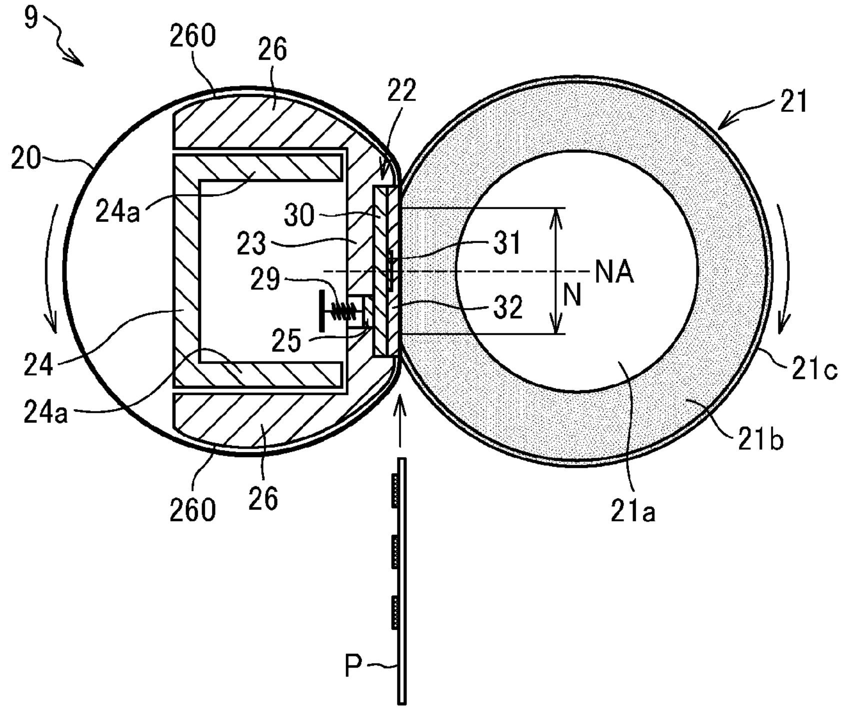

9
260
26
22
21
20
24a
30
23
31
29
NA
N
32
25
24
21c
24a
21b
260
26
21a
P

FIG. 25

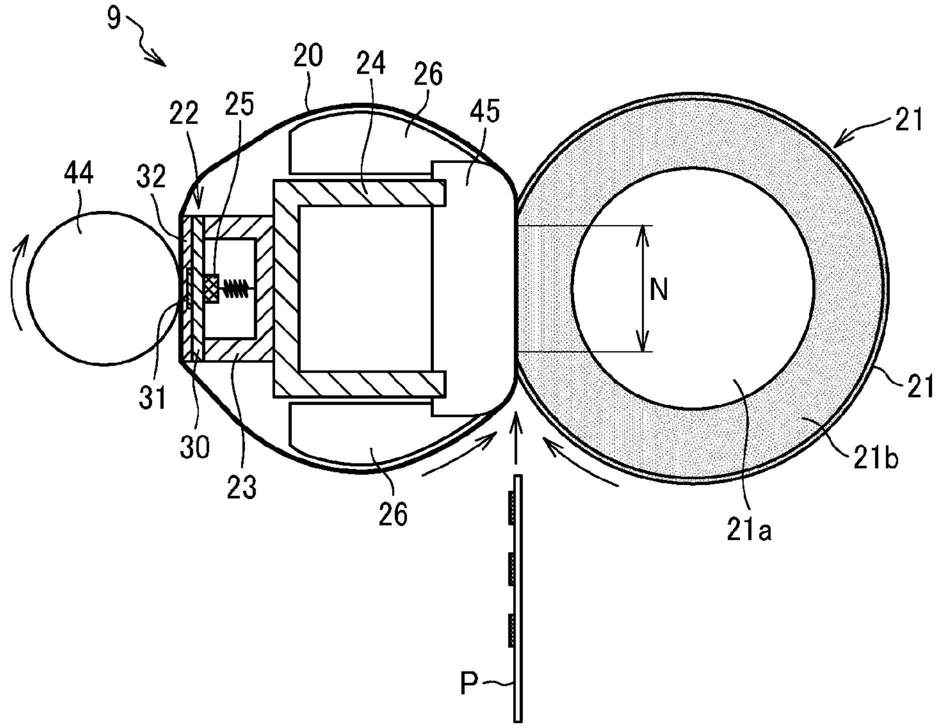

9
20
24
26
45
21
22
25
44
32
N
31
21c
30
21b
23
26
21a
P

FIG. 26

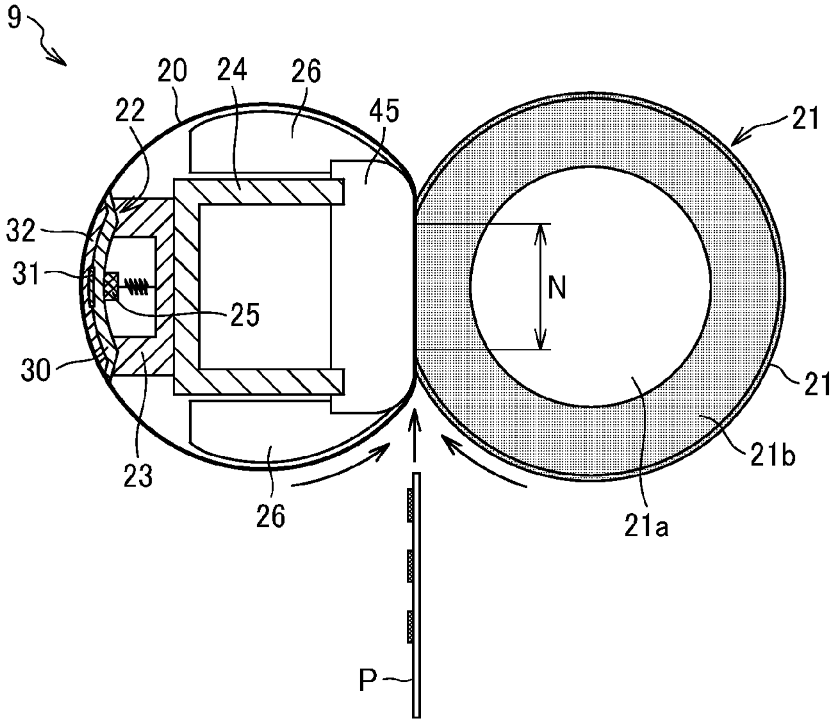

9
20
24
26
22
45
21
32
31
25
N
30
21c
23
21b
26
21a
P

FIG. 27

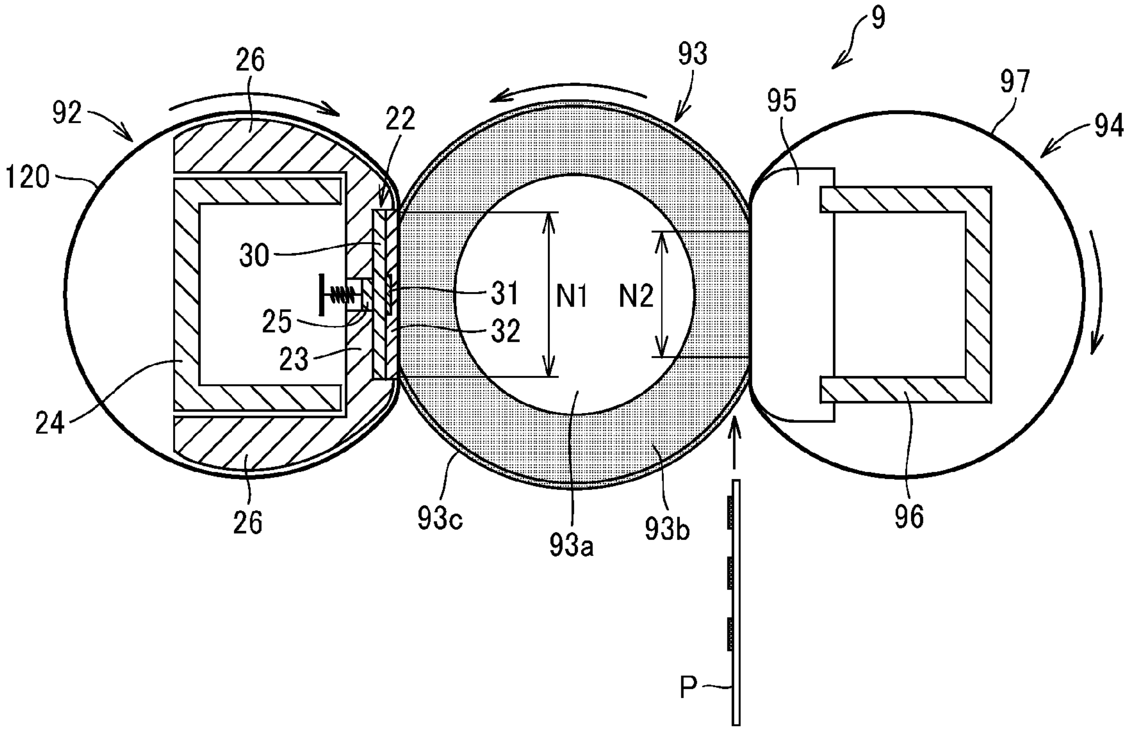

9
26
93
97
92
22
95
94
120
30
31
N1
N2
25
32
23
24
26
93c
93a
93b
96
P

FIG. 28

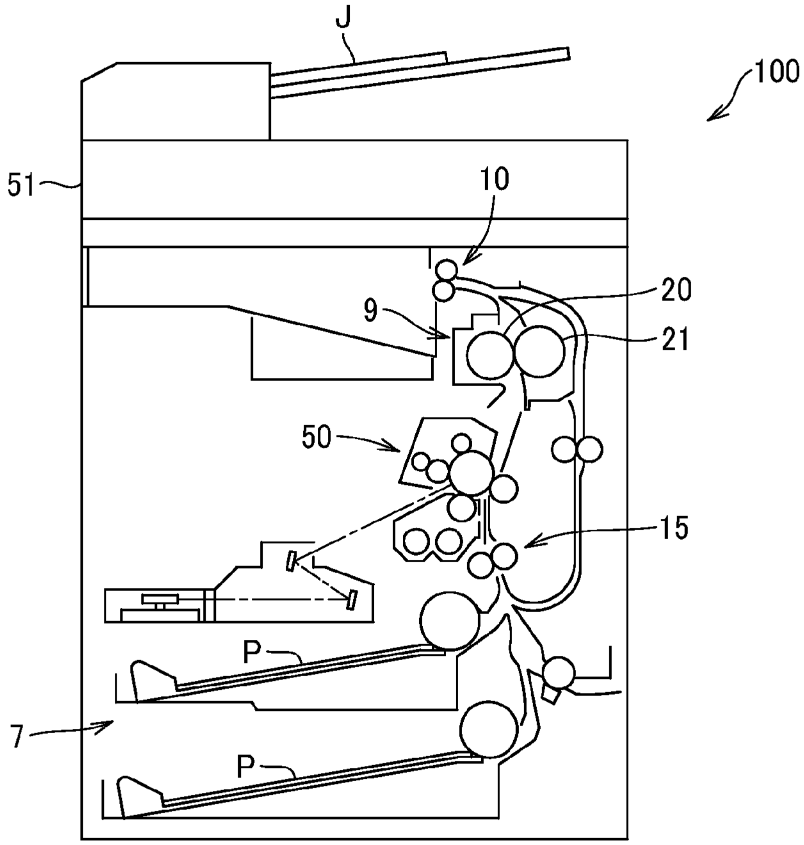


FIG. 29

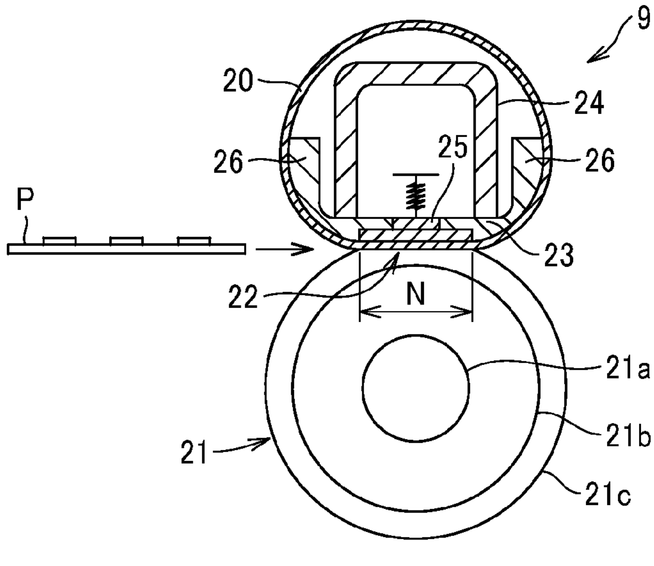


FIG. 30

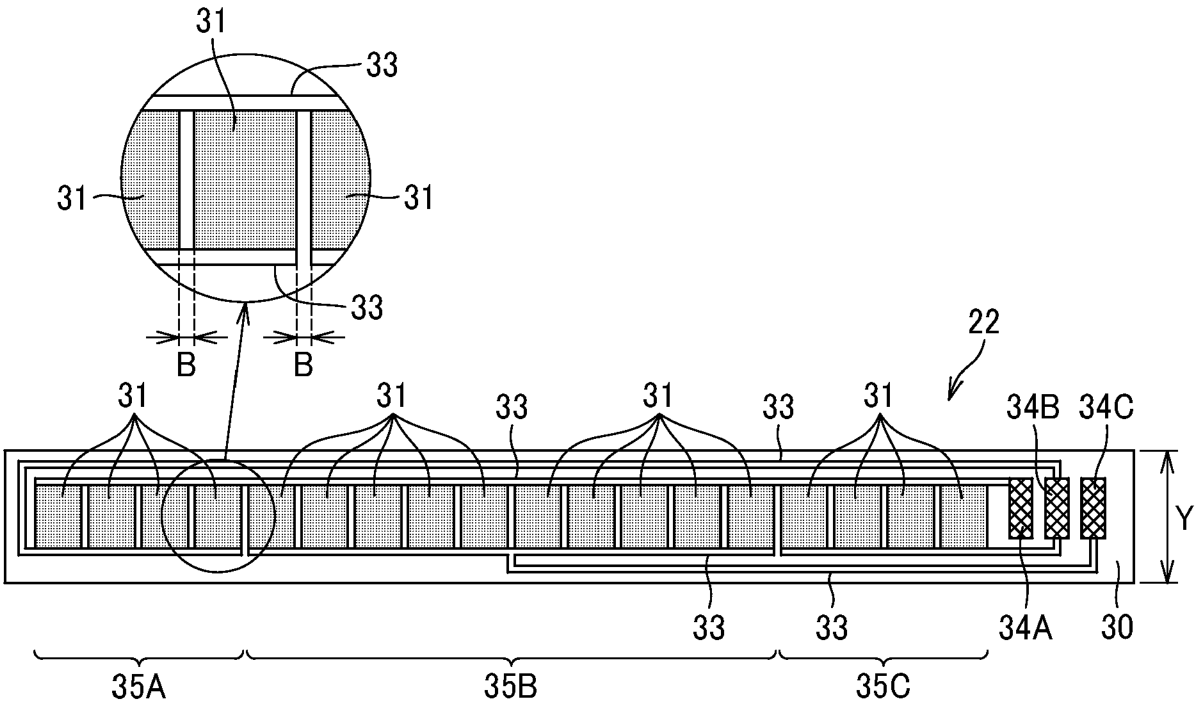

31
33
31
31
33
B
B
22
31
31
33
31
33
31
34B
34C
Y
33
33
34A
30
35A
35B
35C

FIG. 31

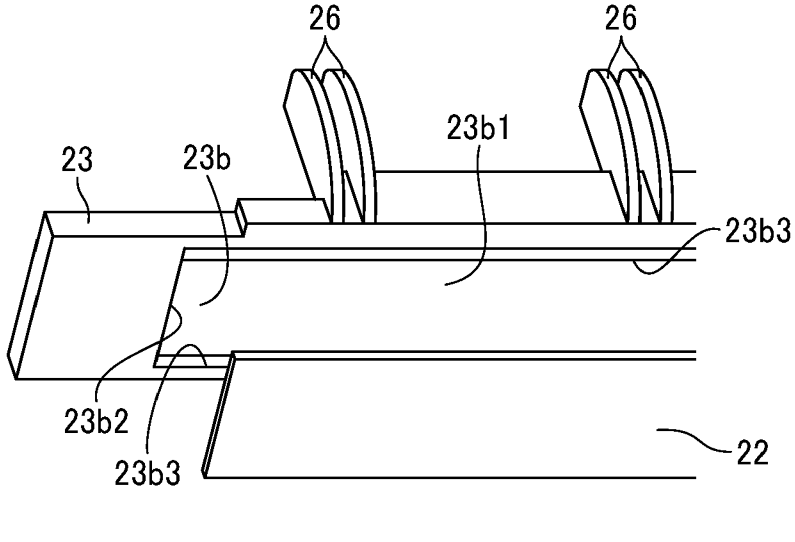

26
26
23b1
23
23b
23b3
23b2
23b3
22

FIG. 32

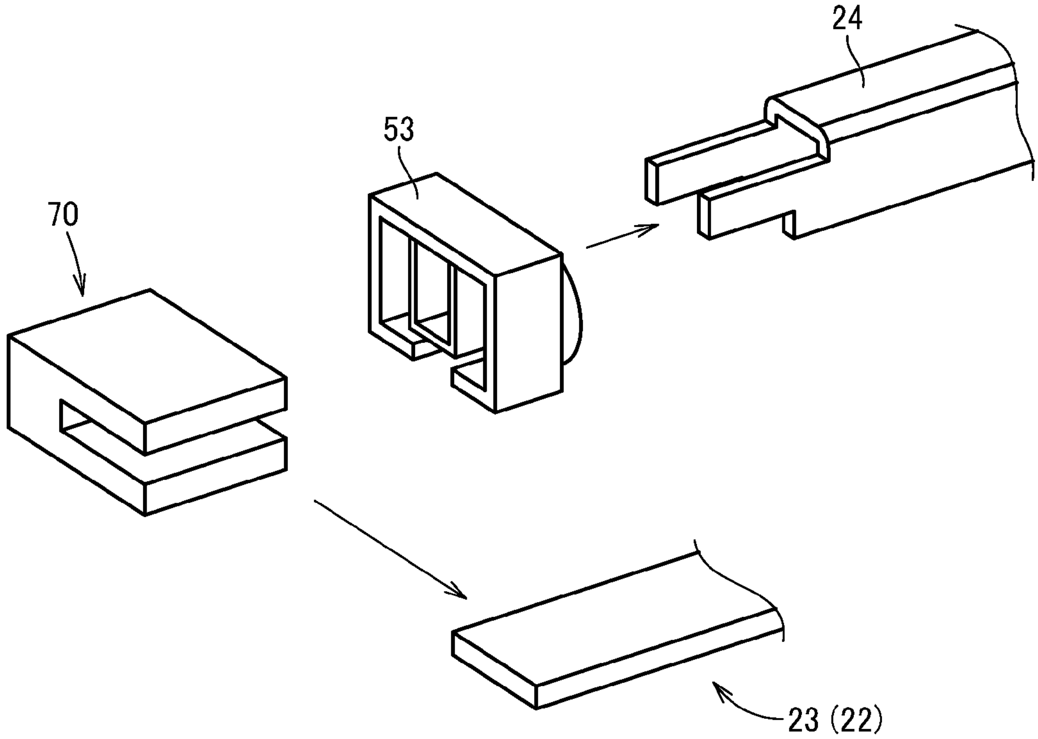


FIG. 33

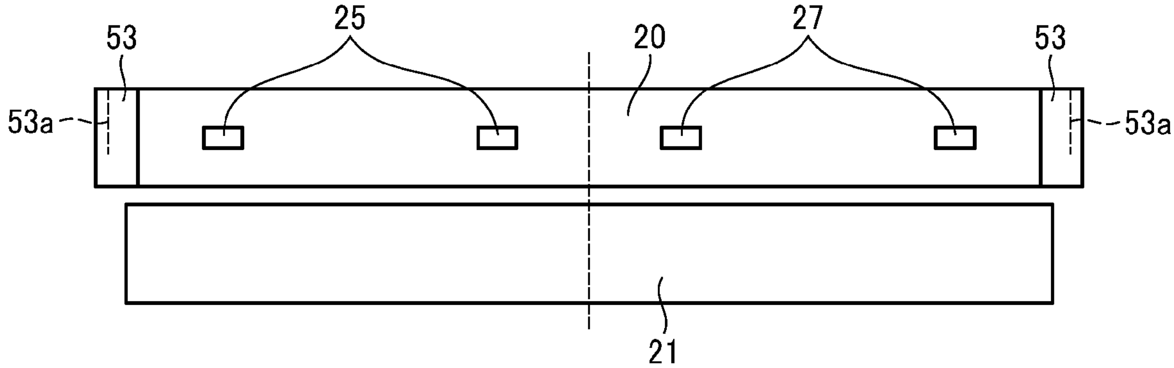


FIG. 34

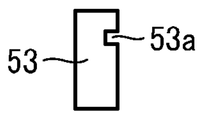


FIG. 35

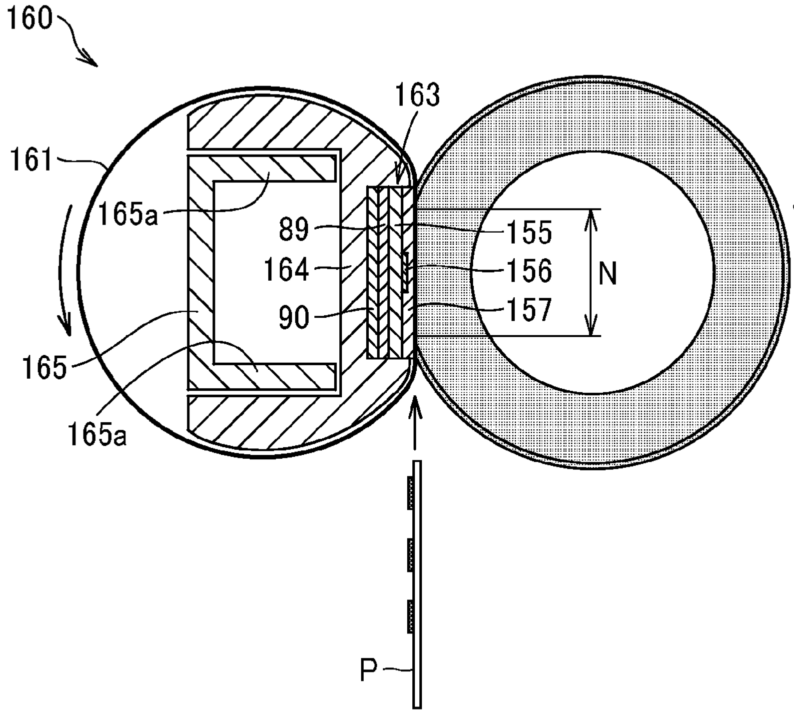


FIG. 36

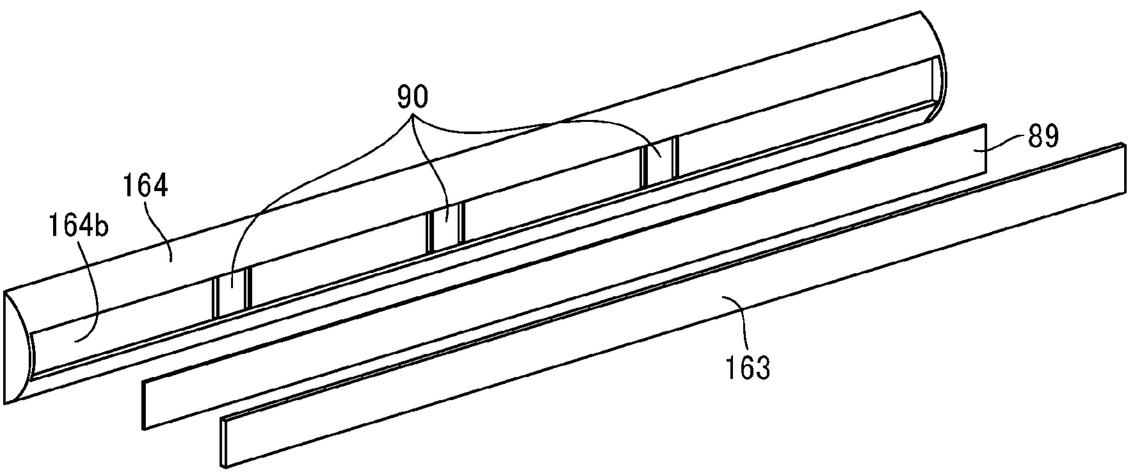


FIG. 37

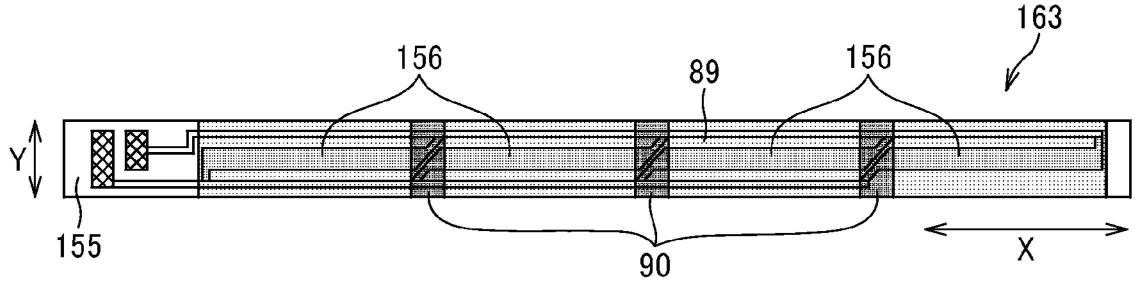


FIG. 38

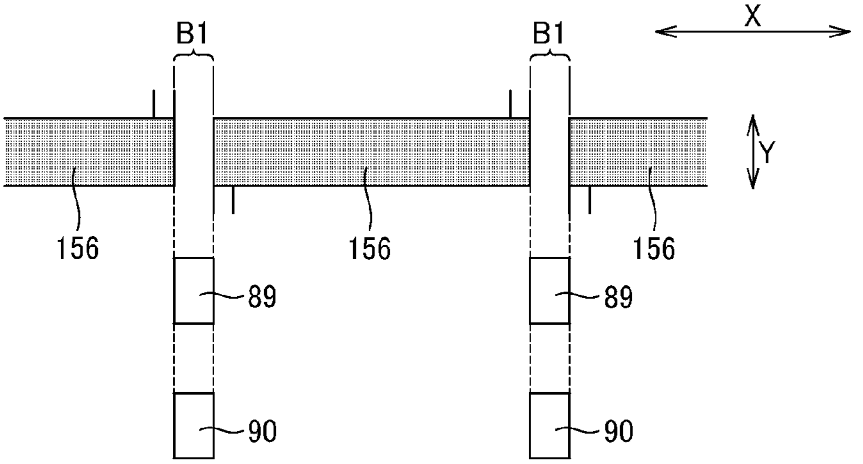


FIG. 39

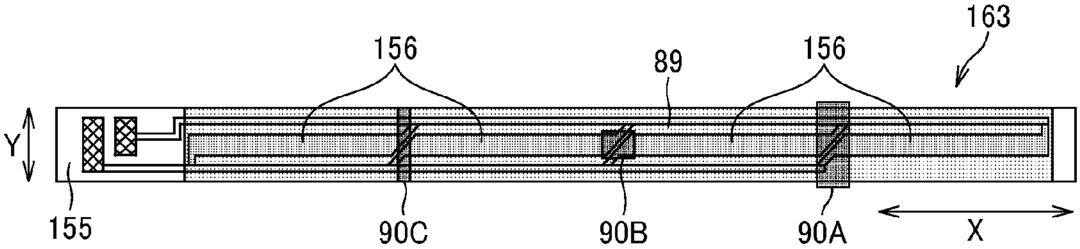


FIG. 40

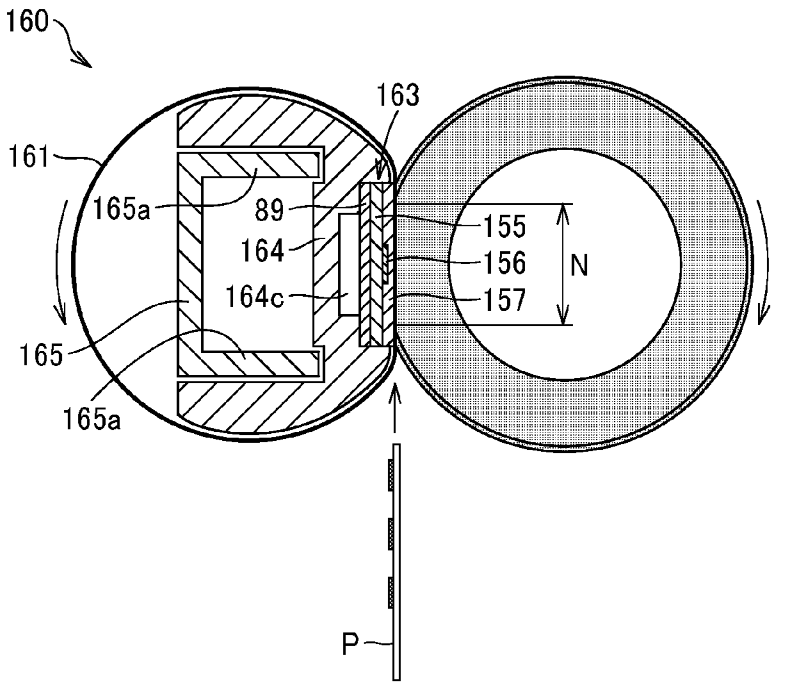


FIG. 41

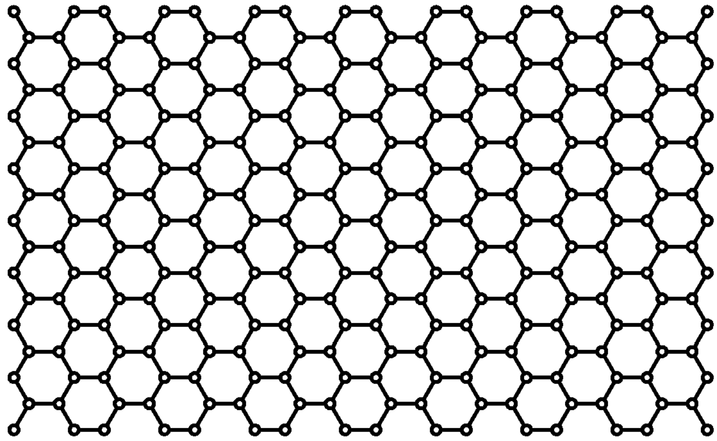
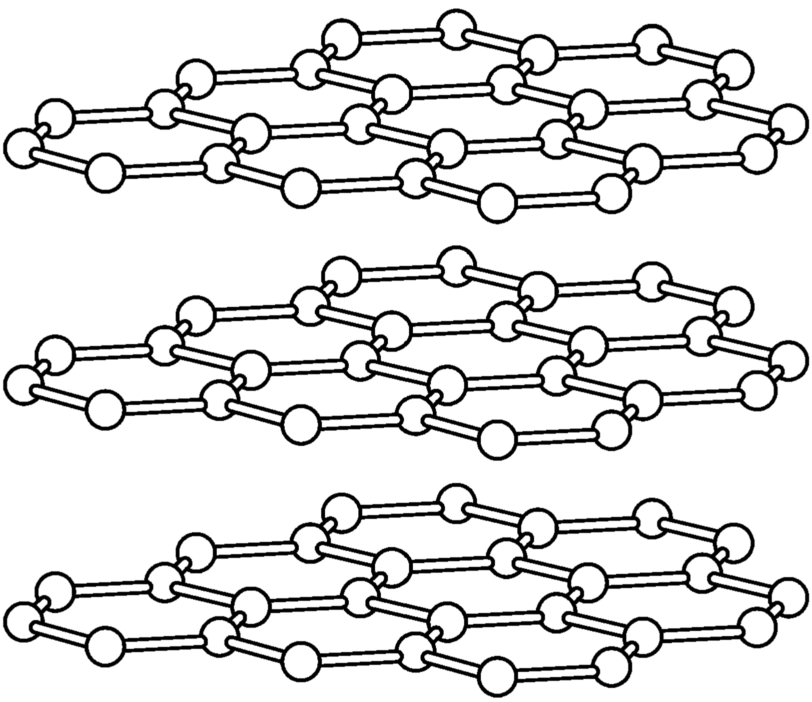


FIG. 42



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EUROPEAN SEARCH REPORT

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	4 December 2024	Urbaniec, Tomasz

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