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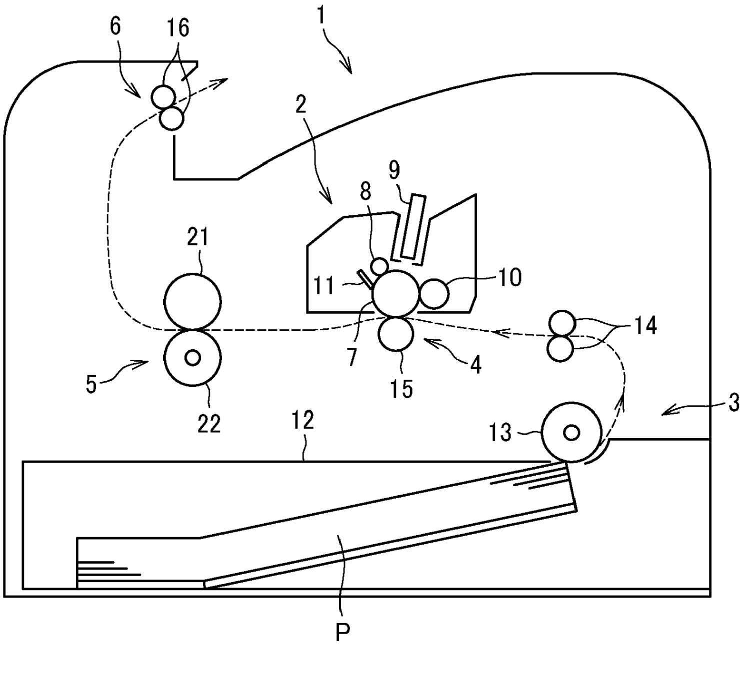
(54) FIXING DEVICE AND IMAGE FORMING APPARATUS INCLUDING SAME

(57) A fixing device (5) includes a fixing member (21), an opposed member (22), a nip formation member (24), a heating member (23), and a reflector (26). The fixing member (21) is in a cylindrical form. The opposed member (22) is opposed to an outer surface of the fixing member (21). The nip formation member (24) is inside a loop of the fixing member (21) to form a nip (N) with the opposed member (22) with the fixing member (21) interposed between the opposed member (22) and the nip formation member (24). The heating member (23) is inside the loop of the fixing member (21) to heat the fixing member and the nip formation member. The reflector (26) is inside the loop of the fixing member (21) to reflect light or heat from the heating member (23). The reflector (26) has a convex surface protruding toward the heating member (23).

FIG. 1



EP 3 690 554 A1

Description

BACKGROUND

Technical Field

[0001] Aspects of the present invention relate to a fixing device and an image forming apparatus including the fixing device.

Related Art

[0002] An electrophotographic image forming apparatus such as a copier and a printer includes a fixing device to convey a recording medium such as a sheet on which an unfixed image is formed to a nip formed between members such as rollers or belts opposed to each other, heat the recording medium, and fix the unfixed image on the recording medium.

[0003] As this type of fixing device, for example, JP-2009-093141-A discloses a fixing device that includes a heating unit to heat both a belt unit and a nip forming unit that forms a nip.

[0004] By the way, when a radiation heater such as a halogen heater or a carbon heater is used as a heating unit to heat the belt unit and the nip forming unit, light or heat from the heater can be reflected by a reflector onto heating target members such as a fixing belt or a nip formation member, to enhance the heating efficiency of the heating target members.

[0005] However, some of the light or heat reflected by the reflector are reflected not toward the heating target member but toward the heater. When the amount of light or heat reflected toward the heater increases, the amount of light or heat reflected toward the heating target members decreases, which causes a problem such as a decrease in heating efficiency.

SUMMARY

[0006] In an aspect of the present disclosure, there is provided a fixing device includes a fixing member, an opposed member, a nip formation member, a heating member, and a reflector. The fixing member is in a cylindrical form. The opposed member is opposed to an outer surface of the fixing member. The nip formation member is inside a loop of the fixing member to form a nip with the opposed member with the fixing member interposed between the opposed member and the nip formation member. The heating member is inside the loop of the fixing member to heat the fixing member and the nip formation member. The reflector is inside the loop of the fixing member to reflect light or heat from the heating member. The reflector has a convex surface protruding toward the heating member.

[0007] In another aspect of the present disclosure, there is provided an image forming apparatus that includes an image forming device and the fixing device. The image forming device forms an image on a recording medium. The fixing device fixes the image formed by the image forming device on the recording medium.

[0008] According to the present invention, a surface of a reflector facing a heating member has a convex shape protruding toward the heating member, thus allowing enhancement of heating efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] A more complete appreciation of the 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 view of a configuration of an image forming apparatus according to a first embodiment of the present invention;
FIG. 2 is a cross-sectional side view of a fixing device according to an embodiment of the present invention;
FIG. 3 is a perspective view of the fixing device with a vertical cross-sectional view of the fixing device;
FIG. 4 is a vertical cross-sectional view of the fixing device viewed from a front side of the fixing device;
FIG. 5 is a perspective view of a belt holder;
FIG. 6 is a perspective view of a variation of the belt holder;
FIG. 7 is a cross-sectional view of a variation of reflectors;
FIG. 8 is a cross-sectional view of another variation of the reflectors;
FIG. 9 is a vertical cross-sectional view of the fixing device according to a second embodiment of the present invention viewed from a lateral side of the fixing device;
FIG. 10 is a vertical cross-sectional view of the fixing device according to a third embodiment of the present invention viewed from a lateral side of the fixing device;
FIG. 11 is a perspective view of a stay and a reflector;
FIG. 12 is a comparative diagram comparing a rectangular through-hole with the elliptical through-hole;
FIG. 13 is a cross-sectional view of reflectors, stays, and a halogen heater as viewed from above or below in FIG. 10;
FIG. 14 is a perspective view of the stay according to a fourth embodiment of the present invention;
FIG. 15 is a cross-sectional view illustrating an example of a stay arrangement;
FIG. 16 is a cross-sectional view illustrating another example of the stay arrangement;
FIG. 17 is a plan view of a nip formation member according to a fifth embodiment of the present invention;
FIG. 18 is an end perspective view of a nip formation member;

FIG. 19 is a cross-sectional view illustrating an operation of the nip formation member;

FIG. 20 is a cross sectional view illustrating an example of inclined surfaces having different inclination angles;

FIG. 21 is a plan view of an example in which recesses are inclined with respect to a belt rotation direction;

FIG. 22 is a schematic view of an example of a configuration of the image forming apparatus including a fixing device to convey a sheet in a vertical direction; and

FIG. 23 is a side sectional view of a fixing device according to a comparative example.

[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.

DETAILED DESCRIPTION

[0011] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the present disclosure. 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.

[0012] 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.

[0013] With reference to drawings attached, a description is given below of the present invention. In the drawings for illustrating embodiments of the present invention, identical reference numerals are assigned to elements such as members and parts that have an identical function or an identical shape as long as differentiation is possible and descriptions of such elements may be omitted once the description is provided.

[0014] FIG. 1 is a schematic view of a configuration of an image forming apparatus according to an embodiment of the present invention. Referring to FIG. 1, a configuration and operation of the image forming apparatus according to the present embodiment are described below.

[0015] An image forming apparatus 1 illustrated in FIG. 1 is illustrated as a monochrome electrophotographic laser printer. Note that the image forming apparatus according to an embodiment of the present invention may be a printer, a copier, a facsimile machine, a multifunction peripheral (MFP) having at least two of copying, printing, scanning, facsimile, and plotter functions. The image forming apparatus is not limited to a monochrome image forming apparatus and may be a color image forming apparatus.

[0016] As illustrated in FIG. 1, the image forming apparatus 1 according to the present embodiment includes an image forming device 2 to form an image, a recording medium feeding device 3 to feed a sheet P as a recording medium, a transfer device 4 to transfer the image onto the fed sheet P, a fixing device 5 to fix the image transferred onto the sheet P, and a sheet ejection device 6 to eject the sheet P with the fixed image to an outside of the image forming apparatus 1.

[0017] The image forming device 2 includes a drum-shaped photoconductor 7, a charging roller 8 as a charging device to charge a surface of the photoconductor 7, an exposure device 9 as a latent image forming device that exposes the surface of the photoconductor 7 to form an electrostatic latent image on the photoconductor 7, a developing roller 10 as a developing device that supplies toner as a developer to the surface of the photoconductor 7 to visualize the electrostatic latent image, and a cleaning blade 11 as a cleaner to clean the surface of the photoconductor 7.

[0018] As the start of image forming operation is instructed, in the image forming device 2, the photoconductor 7 starts rotating, and the charging roller 8 uniformly charges the surface of the photoconductor 7 to a high potential. Next, based on image data of a document read by a scanner or print data transmitted by a terminal device, the exposure device 9 exposes the surface of the photoconductor 7. Then, the potential of an exposed surface drops, and the electrostatic latent image is formed on the photoconductor 7. The developing roller 10 supplies toner to the electrostatic latent image, thereby developing the latent image into a toner image on the photoconductors 7.

[0019] The toner image formed on the photoconductor 7 is transferred onto the sheet P in a transfer nip between the photoconductor 7 and a transfer roller 15 disposed in the transfer device 4. The sheet P is fed from the recording medium feeding device 3. In the recording medium feeding device 3, a sheet feeding roller 13 feeds the sheet P from a sheet tray 12 to a feeding path one by one. A timing roller pair 14 sends out the sheet P fed from the sheet tray 12 to a transfer nip, timed to coincide with the toner image on the photoconductor 7. The toner image on the photoconductor 7 is transferred onto the sheet P in the transfer nip. After the toner image is transferred from the photoconductors 7 onto the sheet P, the cleaning blade 11 removes residual toner on the photoconductor 7.

[0020] The sheet P bearing the toner image is conveyed to the fixing device 5. In the fixing device 5, heat and pressure when the sheet P passes through between a fixing belt 21 and a pressure roller 22 fixes the toner image onto the sheet P. Subsequently, the sheet P is conveyed to the sheet ejection device 6, and an ejection roller pair 16 ejects the sheet P outside the image forming apparatus 1. Then, a series of print operations completes.

[0021] With reference to FIGS. 2 to 6, a detailed description is provided of a configuration of the fixing device 5 according to a first embodiment of the present invention.

[0022] FIG. 2 is a vertical cross-sectional view of the fixing device 5 viewed from a lateral side of the fixing device 5. FIG. 3 is a perspective view of the fixing device 5 with the vertical cross-sectional view of the fixing device 5. FIG. 4 is a vertical cross-sectional view of the fixing device 5 viewed from a front side of the fixing device 5. FIG. 5 is a perspective view of a belt holder to support a fixing belt. FIG. 6 is a perspective view of a variation of the belt holder.

[0023] As illustrated in FIG. 2, the fixing device 5 includes the fixing belt 21, the pressure roller 22, a halogen heater 23, a nip formation member 24, a stay 25, a reflector 26, guides 27, and temperature sensors 28.

[0024] The fixing belt 21 is a cylindrical fixing member to fix an unfixed image (unfixed toner image) T to the sheet P and is disposed on an image bearing side of the sheet P on which the unfixed image is borne. The fixing belt 21 in the present embodiment is an endless belt or film that includes a base layer formed on an inner side of the fixing belt 21 and made of a metal such as nickel and stainless used steel (SUS) or a resin such as polyimide, and a release layer formed on the outer side of the fixing belt 21 and made of tetrafluoroethylene-perfluoroalkylvinylether copolymer (PFA), polytetrafluoroethylene (PTFE), or the like. Optionally, an elastic layer made of rubber such as silicone rubber, silicone rubber foam, or fluoro rubber may be interposed between the base layer and the release layer. While the fixing belt 21 and the pressure roller 22 press the unfixed toner image T against the sheet P to fix the toner image onto the sheet P, the elastic layer having a thickness of about 100 micrometers elastically deforms to absorb slight surface asperities of the fixing belt 21, thus preventing variation in gloss of the toner image on the sheet P. Additionally, in the present embodiment, the fixing belt 21 is thin and has a small loop diameter to decrease the thermal capacity of the fixing belt 21. For example, the base layer of the fixing belt 21 has a thickness of from 20 μm to 50 μm and the release layer has a thickness of from 10 μm to 50 μm. Thus, the fixing belt 21 has a total thickness not greater than 1 mm. In addition, when the fixing belt 21 includes the elastic layer, the thickness of the elastic layer may be set to 100 to 300 μm. In order to further decrease the thermal capacity of the fixing belt 21, the fixing belt 21 may have the total thickness not greater than 0.20 mm and preferably not greater than 0.16 mm. In the present embodiment, the fixing belt 21 may have a loop diameter from 20 to 40 mm. Preferably, the loop diameter of the fixing belt 21 may not be greater than 30 mm.

[0025] The pressure roller 22 is an opposed member opposed to an outer surface of the fixing belt 21. The pressure roller 22 includes a cored bar; an elastic layer coating the cored bar and being made of silicone rubber foam, fluoro rubber, or the like; and a release layer coating the elastic layer and being made of PFA, PTFE, or the like. According to the present embodiment, the pressure roller 22 is a solid roller. Alternatively, the pressure roller 22 may be a hollow roller. When the pressure roller 22 is the hollow roller, a heating member such as a halogen heater may be disposed inside the pressure roller 22. The elastic layer of the pressure roller 22 may be made of solid rubber. Alternatively, if no heating member is disposed inside the pressure roller 22, the elastic layer of the pressure roller 22 is preferably made of sponge rubber to enhance thermal insulation of the pressure roller 22. Such a configuration reduces heat conduction from the fixing belt 21 to the pressure roller 22 and improves heating efficiency of the fixing belt 21.

[0026] A driver disposed inside the image forming apparatus 1 drives and rotates the pressure roller 22 in a direction indicated by arrow A in FIG. 2. The rotation of the pressure roller 22 drives the fixing belt 21 to rotate in a direction B in FIG. 2 due to frictional force therebetween. After the toner image is transferred onto the sheet P, the sheet P bearing the unfixed toner image T is conveyed to a nip N between the fixing belt 21 and the pressure roller 22. The rotating fixing belt 21 and the rotating pressure roller 22 conveys the sheet P, and the sheet P passes through the nip N. Heat and pressure are applied to the sheet P to fix the unfixed toner image T onto the sheet P.

[0027] The pressure roller 22 and the fixing belt 21 are configured to be able to approach and move away from each other. If the sheet is jammed in the nip N, separating the pressure roller 22 and the fixing belt 21 from each other and opening the nip N enables the jammed sheet to be removed. One of the pressure roller 22 and the fixing belt 21 may be configured to be fixed and the other may be configured to be movable so that the pressure roller 22 and the fixing belt 21 contact and separate each other. Alternatively, both the pressure roller 22 and the fixing belt 21 may be configured to move so that the pressure roller 22 and the fixing belt 21 contact and separate each other.

[0028] The halogen heater 23 is a heating member disposed inside a loop of the fixing belt 21 and emitting infrared light, and radiant heat from the halogen heater 23 heats the fixing belt 21 and the nip formation member 24. Alternatively, instead of the halogen heater 23, a carbon heater, a ceramic heater or the like may be employed as the heating member. In the present embodiment, only one halogen heater 23 is disposed in the loop of the fixing belt 21, but a plurality of halogen heaters 23 having different heat-generating areas may be used according to the width of the sheet.

[0029] The nip formation member 24 and the pressure roller 22 sandwich the fixing belt 21 to form the nip N. Specifically, the nip formation member 24 extends in a longitudinal direction thereof parallel to a width direction of the fixing belt 21 and has a planar nip formation portion 24a that is in contact with an inner circumferential surface of the fixing belt 21 and a pair of bent portions 24b that are bent from both end portions of the nip formation portion 24a in a belt rotation direction B to the opposite side to the pressure roller 22. A pressing member such as a spring presses the pressure roller 22 against the nip formation member 24, which causes the pressure roller 22 to contact the fixing belt 21 and forms the nip N therebetween.

[0030] The nip formation surface 24c of the nip formation member 24 on the fixing belt 21 side may be coated with an alumite treatment or a fluororesin material in order to improve abrasion resistance and slidability when the fixing belt 21 rotates. Furthermore, a lubricant such as a fluorine-based grease may be applied to the nip formation surface 24c in order to ensure the slidability over time. In the present embodiment, the nip formation surface 24c is planar. Alternatively, the nip formation surface 24c may define a recess or other shapes. For example, the nip formation surface 24c having a concave shape recessed to the side opposite to the pressure roller 22 leads the outlet of the sheet in the fixing nip N to be closer to the pressure roller 22, which improves separation of the sheet from the fixing belt 21.

[0031] The nip formation member 24 is made of a material having a thermal conductivity larger than that of the stay 25. For example, the material of the nip formation member 24 is preferably copper (thermal conductivity: 398 W / mk) or aluminum (thermal conductivity: 236 W / mk). The nip formation member 24 made of the material having such a large thermal conductivity absorbs the radiant heat from the halogen heater 23 and effectively transmits heat to the fixing belt 21. For example, setting the thickness of the nip formation member 24 to 1 mm or less can shorten a heat transfer time in which the heat transfers from the nip formation member 24 to the fixing belt 21, which is advantageous in shortening a warm-up time of the fixing device 5. In contrast, setting the thickness of the nip formation member 24 to be larger than 1 mm and 5 mm or less can improve a heat storage capacity of the nip formation member 24.

[0032] The stay 25 is a support member to support the nip formation member 24 against the pressing force from the pressure roller 22. Note that "supporting" the nip formation member 24 means that the support member (in the present embodiment, the stay 25) is in contact with the nip formation member 24 on the side opposite to the side facing the pressing roller 22 to restrain the nip formation member 24 from being bent by the pressure from the pressing roller 22, particularly, restrain the nip formation member 24 from being bent in the longitudinal direction. In the present embodiment, a pair of stays 25, each formed in a flat plate shape, are arranged in parallel with each other with the halogen heater 23 interposed between the pair of stays 25. Similar to the nip formation member 24, each stay 25 extends in a longitudinal shape in the width direction of the fixing belt 21 and is disposed inside the loop of the fixing belt 21. The pair of stays 25 are in contact with both ends of the nip formation member 24 in the belt rotation direction B via the reflector 26. Since the nip formation member 24 is supported by the respective stays 25 at both ends of the nip formation member 24, the bending of the nip formation member 24 in the pressing direction is restrained and the nip N having a uniform width across the longitudinal direction can be obtained. The stay 25 is preferably made of an iron-based metal such as SUS or steel electrolytic cold commercial (SECC) that is electrogalvanized sheet steel to ensure rigidity.

[0033] The reflectors 26 reflect infrared light (or radiant heat) emitted from the halogen heater 23 and are disposed on both sides of the halogen heater 23 in the fixing belt 21 with the halogen heater 23 interposed between the reflectors 26. In the present embodiment, each reflector 26 includes a reflecting portion 26a facing the halogen heater 23 and a pair of bent portions 26b provided at both ends of the reflecting portion 26a. Each bent portion 26b of the reflector 26 is engaged with an end surface on the nip N side (a lower end surface in FIG. 2) of the stay 25 and the opposite end surface (an upper end surface in FIG. 2). Thus, the reflector 26 is supported by the stay 25.

[0034] As illustrated in FIG. 2, of the infrared light emitted from the halogen heater 23, the infrared light emitted upward or downward in FIG. 2 is directly applied to the fixing belt 21 or the nip formation member 24. On the other hand, the infrared light emitted from the halogen heater 23 in a lateral direction in FIG. 2 (toward the reflector 26) is reflected by the reflector 26 and is irradiated on the fixing belt 21 or the nip formation member 24. As described above, the infrared light emitted from the halogen heater 23 is directly applied to the fixing belt 21 or the nip formation member 24, and the infrared light reflected by the reflector 26 is also irradiated onto the fixing belt 21 or the nip formation member. Thus, both the fixing belt 21 and the nip formation member 24 can be efficiently heated.

[0035] The reflection surface 260 of the reflector 26 facing the halogen heater 23 is treated with mirror finish or the like to increase reflectance. In the present embodiment, reflectance is measured using the spectrophotometer that is the ultraviolet visible infrared spectrophotometer UH4150 manufactured by Hitachi High-Technologies Corporation in which the incident angle is set to be 5°. In general, the color temperature of the halogen heater varies depending on the application. The color temperature of the heater for the fixing device is about 2500 K. The reflectance of the reflection surface 260 is preferably 70% or more with wavelengths of high emission intensity in the halogen heater 23, that is, specifically the wavelengths of 900 to 1600 nm and more preferably 70% or more with the wavelengths of 1000 to 1300 nm.

[0036] Further, the function of the reflector 26 may be provided to the stay 25. For example, the inner surface of the stay 25 (the surface facing the halogen heater 23) may be mirror-finished so that the stay 25 also functions as the reflector 26. Such a configuration can obviate the reflector 26 that is a separate component from the stay 25. The reflectance of the stay 25 subjected to the mirror finishing is preferably similar to the reflectance of the reflector 26.

[0037] The guides 27 contacts the inner peripheral surface of the fixing belt 21 to guide the rotating fixing belt 21. In the present embodiment, the guides 27 are disposed on both the upstream side and the downstream side of the nip N in the belt rotational direction B. The guide 27 includes an attachment portion 27a fixed to the stay 25 and a curved guide portion 27b in contact with the inner peripheral surface of the fixing belt 21. As illustrated in FIG. 3, the guide portion 27b includes a plurality of ribs 27c that are projections provided at equal distances in the belt width direction on a guide surface of the guide portion 27b that is the surface of the guide portion 27b in the fixing belt 21 side. Guiding the fixing belt 21 along the guide surface having the plurality of ribs 27c enables smooth rotation of the fixing belt 21 without large deformation of the fixing belt 21.

[0038] The temperature sensors 28 are opposed to the outer surface of the fixing belt 21 to detect temperatures of the fixing belt 21. In the present embodiment, the temperature sensors 28 are disposed at two positions, the central position of the fixing belt 21 in the belt width direction, and one end position of the fixing belt 21 in the belt width direction. The temperature sensor 28 detects the temperature of the outer circumferential surface of the fixing belt 21, and output of the halogen heater 23 is controlled based on the detected temperatures so that the temperature of the fixing belt 21 becomes a desired temperature that is a fixing temperature. The temperature sensor 28 may be either contact type or non-contact type. The temperature sensor 28 may be a known temperature sensor such as a thermopile, a thermostat, a thermistor, a non contact (NC) sensor.

[0039] As illustrated in FIG. 4, each cylindrical belt holder 30 is inserted in both lateral ends of the fixing belt 21. As described above, the belt holders 30 inserted into the both lateral ends of the fixing belt 21 support the fixing belt 21 in a state in which the fixing belt 21 is not basically applied with tension in a circumferential direction thereof while the fixing belt 21 does not rotate, that is, by a free belt system.

[0040] As illustrated in FIGS. 3 to 5, the belt holder 30 includes a C-shaped supporter 30a inserted into the inner periphery of the fixing belt 21 to support the fixing belt 21 and a flange 30b that contacts an end surface of the fixing belt 21 to stop a movement of the fixing belt 21 in the width direction, that is, walking of the fixing belt 21 in the width direction. As illustrated in FIG. 6, the supporter 30a may have a cylindrical shape which is continuous over its entire circumference. As illustrated in FIG. 4, the belt holders 30 are fixed on a pair of side plates 31 that are frames of the fixing device 5. The belt holder 30 has an opening 30c as illustrated in FIG. 5, and both ends of the halogen heater 23 and the stays 25 are supported by the side plates 31 through the openings 30c. Further, the halogen heater 23 and the stay 25 may be supported by the belt support member 30.

[0041] By the way, infrared light emitted from a radiation heater such as a halogen heater is emitted so as to diffuse from the halogen heater to the surroundings. Reflecting the infrared light to heating target members such as the fixing belt and the nip formation member allows the heating target members to be efficiently heated. However, some infrared light reflected by the reflector is reflected toward the halogen heater. For example, in a configuration in which a pair of planar reflectors 26 are arranged in parallel with each other as in a comparative example illustrated in FIG. 23, infrared light emitted from the halogen heater 23 in substantially horizontal directions (lateral directions in FIG. 23), of the infrared light emitted from the halogen heater 23, is reflected toward the halogen heater 23. When the amount of light or heat reflected toward the halogen heater increases, the amount of light or heat reflected toward a heating target member decreases, which leads to a decrease in heating efficiency. In the configuration in which the pair of planar reflectors 26 are arranged in parallel with each other, the number of reflections until the infrared light is irradiated on the fixing belt 21 and the nip formation member 24 is likely to increase. For this reason, the heat energy of the infrared light is attenuated more due to the repeated reflection, which may cause a decrease in the heating efficiency. In addition, when the number of reflections increases, the amount of heat stored in the reflector also increases. Therefore, when the halogen heater is used continuously for a long time, the reflector might be discolored by high temperature and the reflectance might decrease.

[0042] Therefore, in the fixing device according to embodiments of the present invention, the following measures are taken to enhance the heating efficiency. Hereinafter, embodiments of the present invention are described.

[0043] As illustrated in FIG. 2, in the fixing device 5 according to an embodiment of the present invention, unlike the comparative example illustrated in FIG. 23, the reflection surface 260 of each reflector 26 has a convex shape protruding toward the halogen heater 23. As described above, the reflection surface 260 of each reflector 26 has a convex shape protruding toward the halogen heater 23, thus allowing the infrared light from the halogen heater 23 to be efficiently reflected toward the fixing belt 21 and the nip formation member 26. In other words, according to the present embodiment, the reflector 26 can more easily reflect and distribute the infrared light upward and downward in FIG. 2 than the comparative example illustrated in FIG. 23. Such a configuration can reduce the infrared light reflected toward the halogen heater 23 and irradiate the fixing belt 21 and the nip formation member 24 with the infrared light with a smaller number of reflections. Thus, the heating efficiency can be enhanced, which can provide a fixing device that is excellent in energy saving.

[0044] In addition, enhancing the heating efficiency can reduce the heating time (first print time) from a heating standby state to a state where fixing operation is executable, and eliminate the shortage of heat during high-speed rotation. In addition, since the number of reflections of infrared light by the reflector 26 is reduced, the amount of heat stored in the reflector 26 can be reduced and a rise in the temperature of the reflector 26 can be restrained. Accordingly, even if the halogen heater 23 is used continuously for a long time, it is possible to prevent a decrease in reflectance due to the high temperature discoloration of the reflector 26, and to maintain a high heating efficiency.

[0045] In the present embodiment, to effectively distribute and reflect the infrared light emitted from the halogen heater 23, each reflection surface 260 protrudes toward the halogen heater 23 at a portion at which the reflector 26 is relatively closer to the halogen heater 23, that is, a center side of the reflection surface 260 rather than both end sides of the reflection surface 260 in the vertical direction in FIG. 2. Note that how the reflection surface 260 protrudes can be appropriately changed according to the relative positions between the halogen heater 23 and each reflector 26 and the like.

[0046] Further, in the present embodiment, the reflection surface 260 of each reflector 26 is formed in a generally curved shape (convex, curved surface shape) in the cross section illustrated in FIG. 2 (cross section intersecting the width direction of the fixing belt 21). However, the curve forming the reflection surface 260 may be a curve having the same radius of curvature throughout the entire curve or a curve obtained by joining curves having different radii of curvature as in an example illustrated in FIG. 7. In the example illustrated in FIG. 7, in the reflector 26, the radius of curvature R2 of the portion closest to the halogen heater 23 is smaller (the curvature is larger) than any of the radii of curvature R1 and R3 of the other portions ($R1 = R3 > R2$). Such a configuration can reduce heat and light reflected toward the halogen heater 23 while securing the entire area of the reflector 26. Further, the reflection surface 260 is not limited to a curved line, and may be formed in a convex shape by connecting a plurality of straight lines.

[0047] Further, in the present embodiment, the reflector 26 also functions as a shielding member to shield the stay 25 from being irradiated with infrared light, thus restraining wasteful consumption of heat energy due to the heating of the stay 25. Further, as illustrated in FIG. 2, in the present embodiment, the back surface 261 opposite to the reflection surface 260 is formed in a concave shape that is recessed toward the halogen heater 23. Thus, a gap S (air layer) is formed between the back surface 261 and the planar stay 25 opposing the back surface 261 in the sheet conveyance direction (a direction in which a recording medium passes through the nip N). Thus, the gap S between the reflector 26 and the stay 25 can restrain heat transfer from the reflector 26 to the stay 25. That is, the gap S functions as a heat insulating layer (air layer) between the reflector 26 and the stay 25. Further, in the present embodiment, the size of the gap S is maximum at a location at which the reflector 26 is easily affected by the heat of the halogen heater 23, that is, at a portion at which the halogen heater 23 and the reflector 26 oppose each other at the closest distance. Such a configuration can effectively restrain heat transfer from the reflector 26 to the stay 25, thus allowing enhancement of the energy saving effect. Here, "opposing" of the halogen heater 23 and the reflector 26 means that the halogen heater 23 and the reflector 26 oppose each other, and is not limited to the case where the halogen heater 23 and the reflector 26 are arranged to directly face each other. Note that, even if the back surface 261 of the reflector 26 is not formed in a concave shape that is recessed toward the halogen heater 23, it is enough to form the reflection surface 260 of the reflector 26 so that the reflection surface 260 protrudes toward the halogen heater 23. Such a configuration can reduce the infrared light reflected toward the halogen heater 23, thus exerting the above-described effect of enhancing the heating efficiency. Therefore, embodiments of the present invention include an example in which the back surface 261 of the reflector 26 is not formed in a concave shape (for example, is formed in a flat shape) as illustrated in FIG. 8. When the back surface 261 of the reflector 26 is formed in a flat shape as in the example illustrated in FIG. 8 and no gap is between the reflector 26 and the stay 25, the reflector 26 has an increased thickness. Accordingly, deformation of the reflector 26 due to heat can be restrained.

[0048] Other embodiments different from the above-described first embodiment is described below. Differences from the first embodiment are mainly described below and other configurations are basically similar to the configurations of the above-described embodiment. Therefore, descriptions of such similar configurations are omitted below.

[0049] FIG. 9 is a vertical sectional view of the fixing device according to a second embodiment of the present invention, viewed from a lateral side of the fixing device.

[0050] In the above-described embodiment, the bent portions 26b of the reflector 26 directly contact the end surfaces (the upper end surface and the lower end surface in FIG. 2) of the stay 25 to support the reflector 26 by the stay 25. However, in the second embodiment illustrated in FIG. 9, each end surface of the stay 25 and each bent portion 26b of the reflector 26 are in contact with each other via a low heat conductor 33 having a lower heat conductivity than the stay 25 and the reflector 26. For this reason, in the present embodiment, the length K1 from an end of the convex portion of the reflector 26 on a side closer to the nip formation member 24 (hereinafter, the nip formation member 24 side) to another end of the convex portion on the opposite side to the nip formation member 24 side is greater than the length K2 from an end of the stay 25 on the nip formation member 24 side to another end of the stay 25 on the opposite side. As described above, the stay 25 and the reflector 26 are in indirect contact with each other via the low heat conductor 33. Such a configuration can more effectively restrain heat transfer from the reflector 26 to the stay 25, thus further reducing the consumption of unnecessary heat energy. Therefore, further enhancement of the energy saving effect can be expected by adopting such a configuration.

[0051] FIG. 10 is a vertical sectional view of the fixing device according to a third embodiment of the present invention, viewed from a lateral side of the fixing device.

[0052] In the third embodiment illustrated in FIG. 10, through-holes 25c and 26c penetrating through a side facing the halogen heater 23 (the halogen heater 23 side) and an opposite side facing an inner surface of the fixing belt 21 are provided at portions at which the stay 25 and the reflector 26 are disposed closer to the halogen heater 23. The through-holes 25c and 26c are provided so as to at least partially overlap each other, and the infrared light emitted in a substantially horizontal direction from the halogen heater 23 is directly applied to the fixing belt 21 through the through-holes 25c and 26c. If the through-holes 25c and 26c are not provided, the infrared light emitted in a substantially horizontal direction from the halogen heater 23 is repeatedly reflected and applied to the fixing belt 21 or the nip formation member 24. Accordingly, heat energy would be attenuated. Therefore, in the case of the third embodiment illustrated in FIG. 10, the attenuation of energy due to such reflection can be reduced, thus allowing enhancement of the heating efficiency.

[0053] Further, the infrared light emitted from the halogen heater 23 is likely to spread as the distance from the halogen heater 23 increases. Hence, as illustrated in FIG. 10, in the stay 25 located at a position farther from the halogen heater 23 than the reflector 26, the diameter d1 (area) of the through-hole 25c is larger than the diameter d2 (area) of the through-hole 26c of the reflector 26 so that the infrared light passing through the through-hole 26c of the reflector 26 does not hit an edge of the through-hole 25c of the stay 25. Such a configuration can avoid unnecessary consumption of heat energy due to hitting of the infrared light on the edge of the through-hole 25c of the stay 25 and enhance the heating efficiency.

[0054] The shape of each of the through-holes 25c and 26c is desirably, for example, an elliptical shape extending in the longitudinal direction of the stay 25 or the reflector 26 as illustrated in FIG. 11. As described above, since the through-holes 25c and 26c are formed to be longer in the direction intersecting the pressing direction E of the pressing roller 22, the section modulus of the stay 25 and the reflector 26 in the pressing direction E can be secured, thus facilitating the strength to be maintained.

[0055] Note that, as in an example illustrated on the left side of FIG. 12, each of the through-holes 25c and 26c can be formed in a rectangular shape. However, in order to ensure the same opening width as the elliptical through-holes 25c and 26c in the rectangular through-holes 25c and 26c, the opening widths of the rectangular through-holes 25c and 26c in the pressing direction E increase particularly at the longitudinal ends of the through-holes 25c and 26c (h1 > h2). Therefore, the elliptical shape is preferable to the rectangular shape in order to secure the opening widths to some extent and further secure the strength.

[0056] FIG. 13 is a cross-sectional view of the stays 25, the reflectors 26, and the halogen heater 23 viewed from above or below in FIG. 10.

[0057] As illustrated in FIG. 13, in the present embodiment, the through-holes 25c and 26c on the right side of FIG. 13 and the through-holes 25c and 26c on the left side of FIG. 13 are arranged in a staggered manner so as to be shifted from each other in the width direction of the fixing belt 21 (the vertical direction in FIG. 13). As described above, the through-holes 25c and 26c on the upstream side and the through-holes 25c and 26c on the downstream side from the halogen heater 23 in the paper passing direction (recording medium conveyance direction) with the halogen heater 23 interposed between the through-holes 25c and 26c on the upstream side and the through-holes 25c and 26c on the downstream side are shifted from each other in the belt width direction. With such a configuration, a region that is not directly irradiated with the infrared light through the through-holes 25c and 26c on one of the upstream side and the downstream side in the sheet conveyance direction can be supplementarily irradiated directly with the infrared light through the through-holes 25c and 26c on the other of the upstream side and the downstream side. Thus, the region of the fixing belt 21 that is not directly heated can be eliminated or reduced over the belt width direction. As a result, the above-described structure can substantially uniformly heat the fixing belt 21 over the width direction and prevent fixing failure due to temperature unevenness.

[0058] FIG. 14 is a perspective view of a stay according to a fourth embodiment of the present invention.

[0059] As in the fourth embodiment illustrated in FIG. 14, the above-described pair of stays 25 may be molded as a single stay 25. In such a case, the stay 25 includes a pair of side walls 25a arranged in parallel with each other and a bottom wall 25b connecting both longitudinal ends of each side wall 25a. The above-described stay 25 configured as one component can obviate separate positioning and assembly of the two stays 25, thus enhancing ease of assembling and maintenance. An opening 25d is formed between the bottom wall 25b on one end and the bottom wall 25b on the other end to allow infrared light from the halogen heater 23 to pass through the opening 25d. As illustrated in FIG. 15, the opening 25d of the stay 25 is directed upward (toward the side opposite to the nip N), thus allowing infrared light from the halogen heater 23 to be directly applied to the fixing belt 21 through the opening 25d. Alternatively, as illustrated in an example illustrated in FIG. 16, the opening

25d of the stay 25 may be directed downward (toward the nip N side). Such a configuration allows the nip formation member 24 toe be directly irradiated with infrared light through the opening 25d. To sufficiently secure a range that is directly irradiated with the infrared light, the width Y of the opening 25d is preferably larger than the maximum sheet conveyance span W, as illustrated in FIG. 14. Here, the "maximum paper passing width (maximum recording medium passage width)" is a width area through which the paper passes when ideally conveyed without any positional deviation or skew of the paper (recording medium). Means Hereinafter, the same applies.

[0060] FIGS. 17 to 19 are schematic views of a configuration of a fifth embodiment of the present invention.

[0061] As illustrated in FIG. 17, in the fifth embodiment of the present invention, the nip formation member 24 has a plurality of inclined surfaces 24e on a light receiving surface 24d on the halogen heater side of the nip formation member 24 (nip formation portion 24a). The plurality of inclined surfaces 24e is inclined with respect to the light receiving surface 24d. Each inclined surface 24e is provided in a region outside the maximum sheet conveyance span W on each end in the longitudinal direction of the nip formation member 24.

[0062] Each of the inclined surfaces 24e is inclined to face the center side of the fixing belt 21 in the belt width direction as illustrated by arrows C in FIGS. 17 and 18. Thus, as illustrated in FIG. 19, the inclined surfaces 24e inclined to face the center side of the fixing belt 21 in the belt width direction reflect the infrared light R emitted from the halogen heater 23 toward the center side of the fixing belt 21 in the belt width direction. Then, the reflected light is further reflected by the reflector 26 and is applied to an area inside the maximum sheet conveyance span W.

[0063] As described above, according to the configuration of the fifth embodiment, a part of the infrared light (radiant heat) emitted to the outside of the maximum sheet conveyance span W is reflected by the inclined surfaces 24e and can be used as heat energy for heating the area inside the maximum sheet conveyance span W, thus enhancing the heat energy efficiency. Especially, according to the present embodiment including the heat generation portion 23a of the halogen heater 23 longer than the maximum sheet conveyance span W, that is, when a heat length is longer than the maximum sheet conveyance span W, as illustrated in FIG. 19, the halogen heater 23 irradiates the area outside the maximum sheet conveyance span W in the nip formation member with a large amount of infrared light. The inclined surfaces 24e reflect a part of the infrared light to the center side of the nip formation member in the belt width direction. The part of the infrared light is effectively used as the thermal energy to heat the area inside the maximum sheet conveyance span W in the nip formation member. As a result, the thermal energy efficiency can be enhanced.

[0064] In addition, the reflection of the infrared light by the inclined surfaces 24e reduces the heat absorbed by the area outside the sheet conveyance span W in the nip formation member 24. Such a configuration can restrain an excessive rise in temperature outside the maximum sheet conveyance span W during continuous sheet passing, thus reducing the risk of failure of the fixing device. Such a configuration can obviate measures such as lowering the printing speed when the temperature rises, thus allowing enhancement of productivity (fixing speed).

[0065] Further, in the present embodiment, as illustrated in FIG. 17, the light receiving surface 24d inside the maximum sheet conveyance span W of the nip formation member 24 is coated with black, thus enhancing the heat absorption rate inside the maximum paper conveyance span W. On the other hand, in the areas outside the maximum sheet conveyance span W, the light receiving surface 24d and the inclined surface 24e are not coated with black, and the reflectance is increased.

[0066] In addition, coating fine particles that may be a black paint by using a coating method such as spray may set surface roughness of the area inside the maximum sheet conveyance span W on the light receiving surface 24d to be larger than surface roughness of the area outside the maximum sheet conveyance span W on the light receiving surface 24d. Coating fine particles also improves the thermal energy efficiency because the heat absorptivity of the area inside the maximum sheet conveyance span W on the light receiving surface 24d becomes larger than that of the area outside the maximum sheet conveyance span W on the light receiving surface 24d. The surface roughness Ra of the light receiving surface 24d inside the maximum sheet conveyance span W is preferably 0.5 or more.

[0067] Although the inclined surfaces 24e may be configured separately from the nip formation member 24, making the inclined surfaces 24e and the nip formation member 24 as one component is preferable from the viewpoint of manufacturing cost. In the present embodiment, the inclined surfaces 24e are formed as a single component by a drawing process using a press. When the inclined surface 24e is formed by drawing, it is desirable that the depth Z of the drawing (the height of the inclined surface 24e illustrated in FIG. 19) be about 0.5 mm to 2 mm.

[0068] Changing a length L of the drawing process, which is a length of the inclined surface 24e illustrated in FIG. 19 in the belt width direction, under the constant depth Z of drawing process allows appropriately adjusting the inclination angle θ of the inclined surface 24e. For example, as in the example illustrated in FIG. 20, the inclination angle θ1 of the inclined surface 24e on the outer side (left side in FIG. 20) in the belt width direction is set to be larger than the inclination angle θ2 of the inclined surface 24e on the inner side (right side in FIG. 20). Accordingly, the reflection angle of light by the inclined surface 24e on the outer side in the belt width direction can be increased, so that the infrared light R on the outer side is more likely to be reflected to the area inside the maximum sheet conveyance span W.

[0069] When the inclined surfaces 24e are formed by drawing process, as illustrated in FIG. 19, recesses 24f are formed on a back side of the surface (nip formation surface 24c) on which the inclined surfaces 24e are formed. A lubricant such as grease may be stored in the recesses 24f thus formed. In such a case, since the lubricant is held in the recesses 24f, the lubricant can be interposed between the nip formation member 24 and the fixing belt 21 for a long time, thus allowing extension of the product lives and maintenance cycles of the nip formation member 24 and the fixing belt 21.

[0070] Additionally, as in the example illustrated in FIG. 21, the longitudinal direction of the recess 24f may be inclined toward the downstream side in the belt rotation direction B so that a portion of the recesses 24f downstream side is toward the central portion of the nip formation member 24 in the belt width direction. In such a case, as the fixing belt 21 rotates, the lubricant stored in the recesses 24f move in directions indicated by arrows D in FIG. 22 along the longitudinal direction of the recesses 24f, thus allowing the lubricant to be actively supplied to the center side in the belt width direction. Further, since the outflow of the lubricant to the outer side in the belt width direction can be refrained, the lubricant can be interposed between the nip formation member 24 and the fixing belt 21 for a long time.

[0071] Additionally, as illustrated in FIG. 17, when the plurality of inclined surfaces 24e is close to each other, a shape between inclined surfaces 24e next to each other is preferably a flat surface 24g and not the inclined surface 24e. In such a case, a flat surface 24h is also formed between the recesses 24f on the back side of the inclined surfaces 24e (see FIG. 19), thus allowing the fixing belt 21 to be supported by the flat surface 24h. Such a configuration can refrain the deformation of the fixing belt 21 at the portions at which the recesses 24f are provided, thus preventing the fixing belt 21 from being damaged such as buckling breakage (kinking).

[0072] As described above, according to at least one embodiment of the present invention, a fixing device (e.g., the fixing device 5) includes a fixing member (e.g., the fixing belt 21) in a cylindrical form; an opposed member (e.g., the pressure roller 22) opposed to an outer surface of the fixing member; a nip formation member (e.g., the nip formation member 24) inside a loop of the fixing member to form a nip (e.g., the nip N) with the opposed member with the fixing member interposed between the opposed member and the nip formation member; a heating member (e.g., the halogen heater 23) inside the loop of the fixing member to heat the fixing member and the nip formation member; and a reflector (e.g., the reflector 26) inside the loop of the fixing member to reflect light or heat from the heating member, the reflector having a convex surface protruding toward the heating member.

[0073] In addition, according to at least one embodiment of the present invention, a fixing device (e.g., the fixing device 5) includes a fixing member (e.g., the fixing belt 21) in a cylindrical form; an opposed member (e.g., the pressure roller 22) opposed to an outer surface of the fixing member; a nip formation member (e.g., the nip formation member 24) inside a loop of the fixing member to form a nip (e.g., the nip N) with the opposed member with the fixing member interposed between the opposed member and the nip formation member; a heating member (e.g., the halogen heater 23) inside the loop of the fixing member to heat the fixing member and the nip formation member; a reflector (e.g., the reflector 26) inside the loop of the fixing member to reflect light or heat from the heating member; and a support (e.g., the support 25) supporting the nip formation member, the support and the reflector including through-holes penetrating through a first side facing the heating member and a second side facing an inner surface of the fixing member.

[0074] Embodiments of the present invention are not limited to the above-described embodiments and various modifications and improvements are possible.

[0075] The fixing device according to an embodiment of the present invention is not limited to the fixing device 5 that conveys a sheet in the horizontal direction as illustrated in FIG. 1. The location and orientation of the fixing device 5 may be appropriately changed. For example, the present invention may be applicable to the fixing device 5 as illustrated in FIG. 22 that conveys a sheet in the vertical direction. Further, in the above-described embodiments, the case where the present invention is applied to a fixing device having a halogen heater as a heating member has been described as an example. However, embodiments of the present invention are not limited to the example and also applicable to, for example, a fixing device having a carbon heater.

Claims

1. A fixing device (5) comprising:

a fixing member (21) in a cylindrical form;
an opposed member (22) opposed to an outer surface of the fixing member (21);
a nip formation member (24) inside a loop of the fixing member (21) to form a nip (N) with the opposed member (22) with the fixing member (21) interposed between the opposed member (22) and the nip formation member (24);
a heating member (23) inside the loop of the fixing member (21) to heat the fixing member and the nip formation member; and
a reflector (26) inside the loop of the fixing member (21) to reflect light or heat from the heating member (23),
the reflector (26) having a convex surface protruding toward the heating member (23).

2. The fixing device (5) according to claim 1, further comprising a support (25) supporting the nip formation member (24) with a gap (S) between the support

(25) and the reflector (26).

3. The fixing device (5) according to claim 2, wherein the gap (S) between the support (25) and the reflector (26) is maximum at a portion at which the heating member (23) and the reflector (26) oppose each other at a closest distance.

4. The fixing device (5) according to any of claims 1 to 3, wherein a length from an end of a convex portion of the reflector (26) on a nip formation member side to another end of the convex portion on an opposite side of the nip formation member side is longer than a length from an end of the support (25) on the nip formation member side to another end of the support on the opposite side.

5. The fixing device (5) according to claim 1, further comprising a support (25) supporting the nip formation member,
wherein the support (25) and the reflector (26) include through-holes penetrating through a first side facing the heating member (23) and a second side facing an inner surface of the fixing member (21).

6. The fixing device (5) according to claim 5, wherein the through-hole (25c) of the support (25) is farther from the heating member (23) than the through-hole (26c) of the reflector (26) is,
wherein an area of the through-hole (25c) of the support (25) is greater than an area of the through-hole (26c) of the reflector (26).

7. The fixing device (5) according to claim 5 or 6, wherein the reflector (26) and the support (25) are disposed upstream from the heating member (23) in a recording-medium conveyance direction,
wherein another reflector (26) and another support (25) are disposed downstream from the heating member (23) in the recording-medium conveyance direction,
upstream through-holes of the reflector (26) and the support (25) disposed upstream from the heating member (23) in the recording-medium conveyance direction and downstream through-holes of said another reflector (26) and said another support (25) disposed downstream from the heating member (23) in the recording-medium conveyance direction are arranged in a staggered manner so that the upstream through-holes and the downstream through-holes are shifted from each other in a width direction of the fixing member (21).

8. An image forming apparatus (1) comprising:

   an image forming device (2) to form an image on a recording medium; and
   the fixing device according to any one of claims 1 to 7 to fix the image formed by the image forming device on the recording medium.

FIG. 1

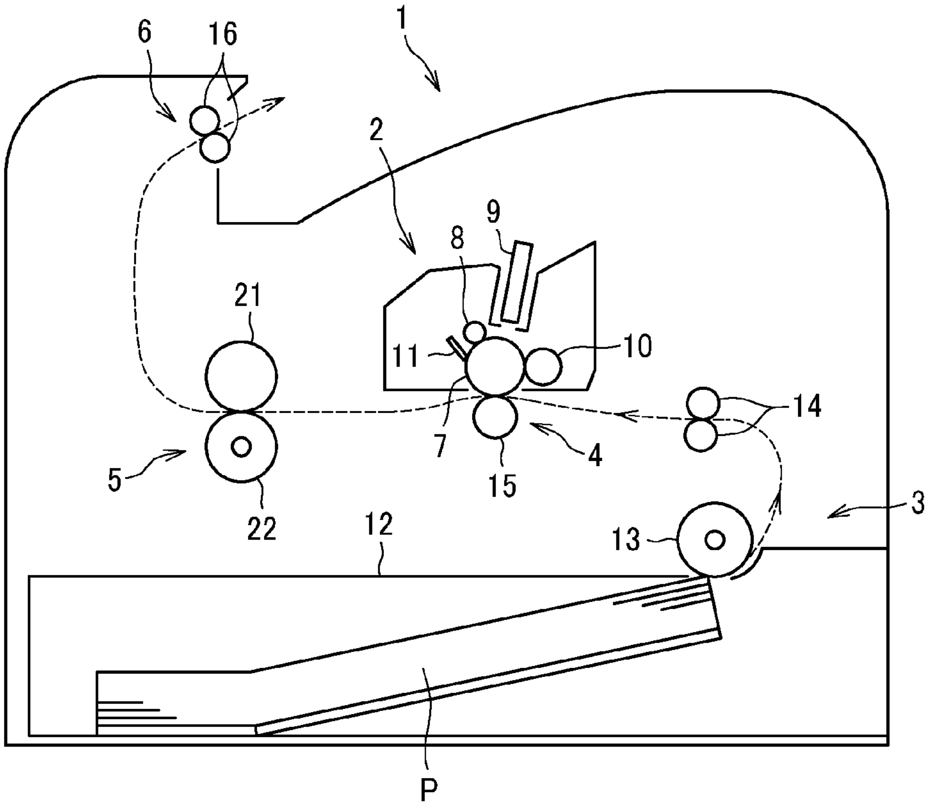

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
21
22
P

FIG. 2

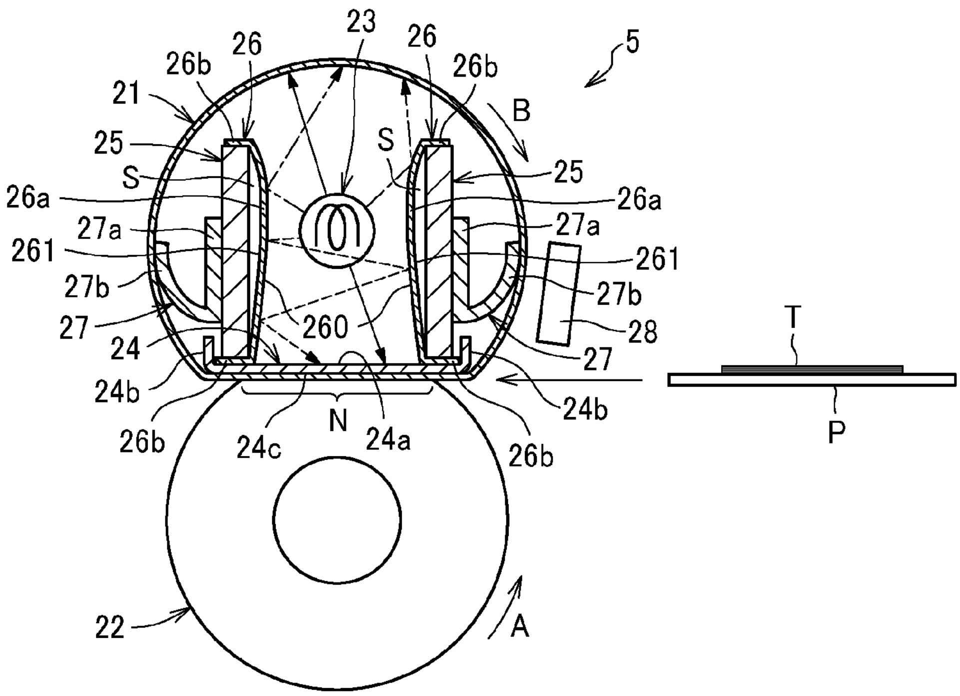

5
21
22
23
24
24a
24b
24c
25
26
26a
26b
260
261
27
27a
27b
28
S
B
A
N
T
P

FIG. 3

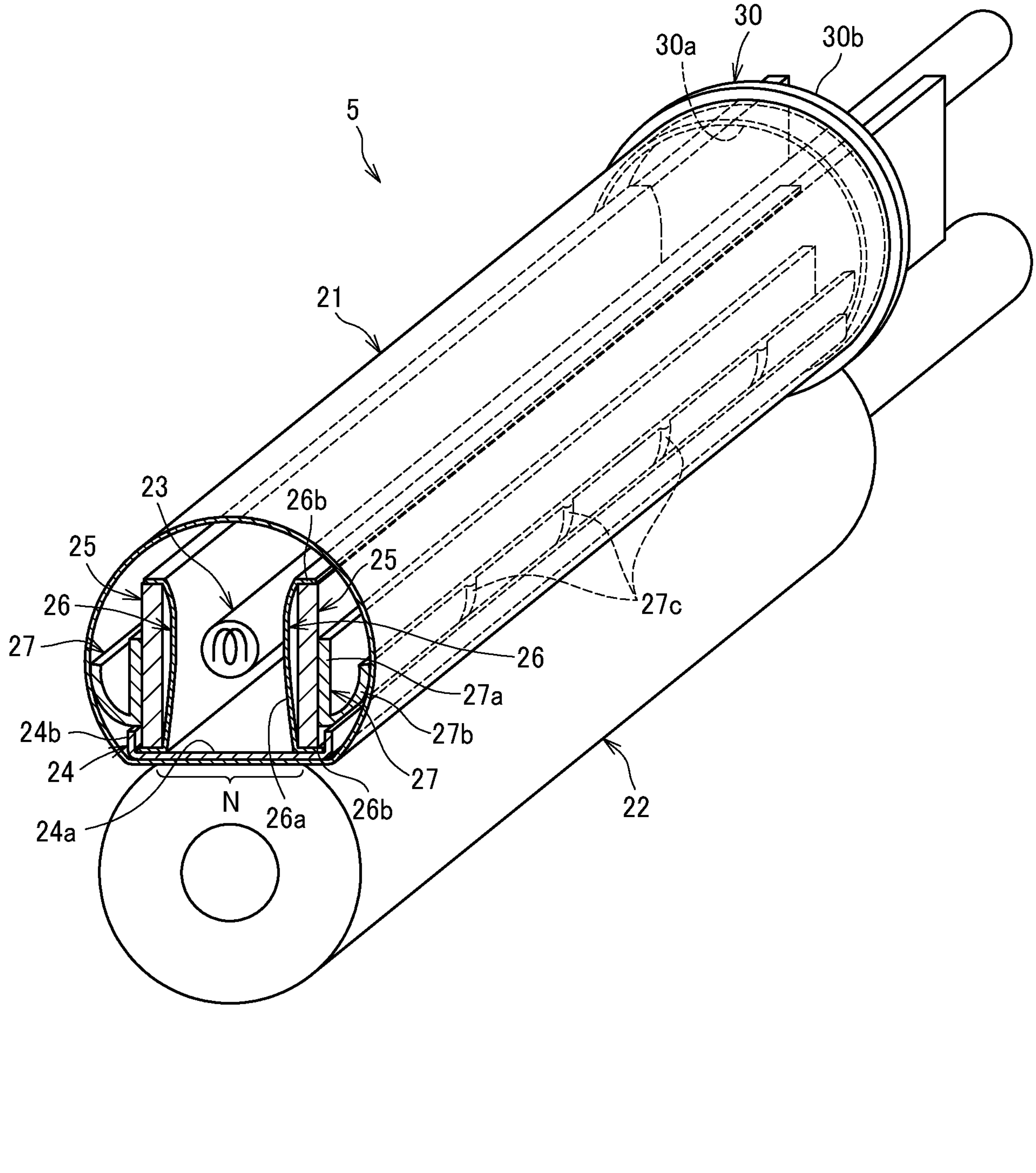

5
30
30a
30b
21
23
26b
25
25
26
26
27
27a
27b
27
24b
24
24a
N
26a
26b
27c
22

FIG. 4

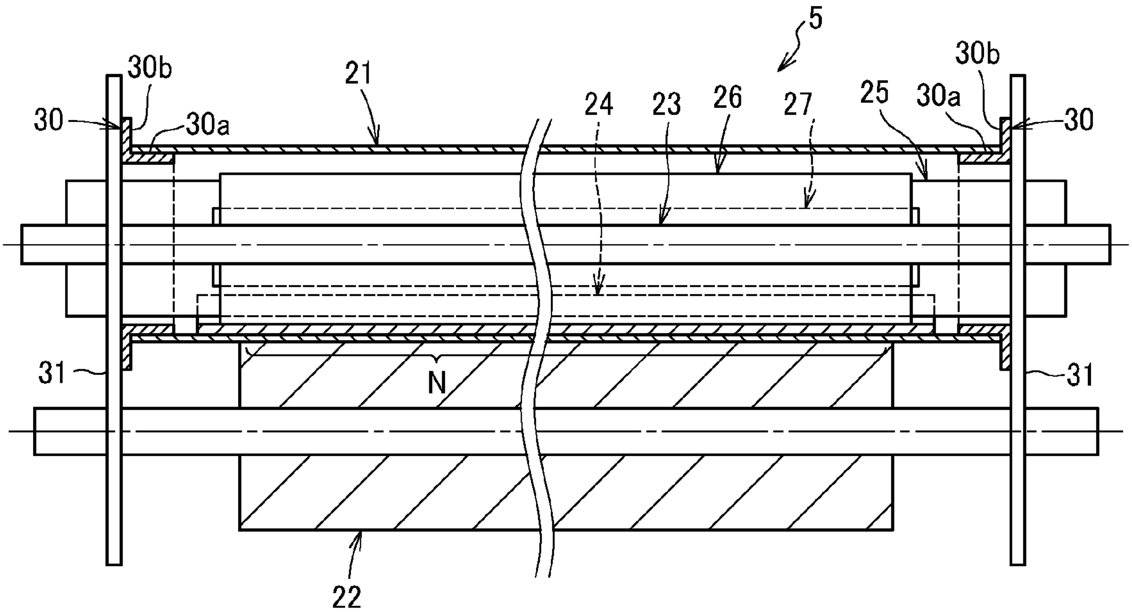


FIG. 5

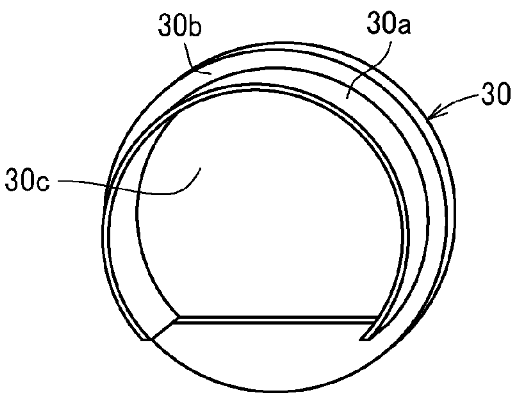


FIG. 6

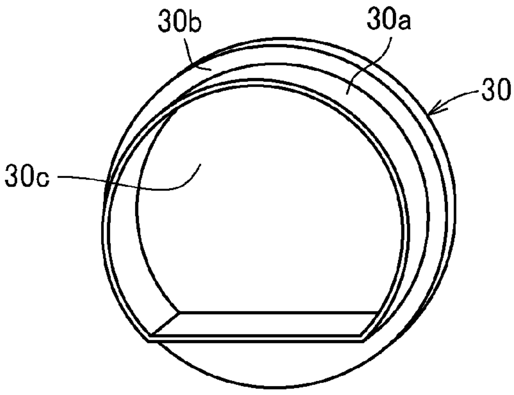


FIG. 7

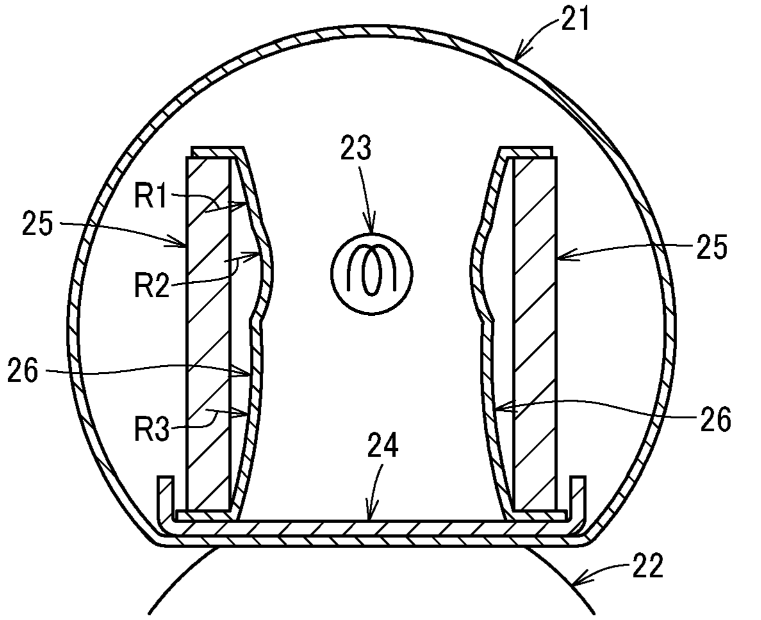


FIG. 8

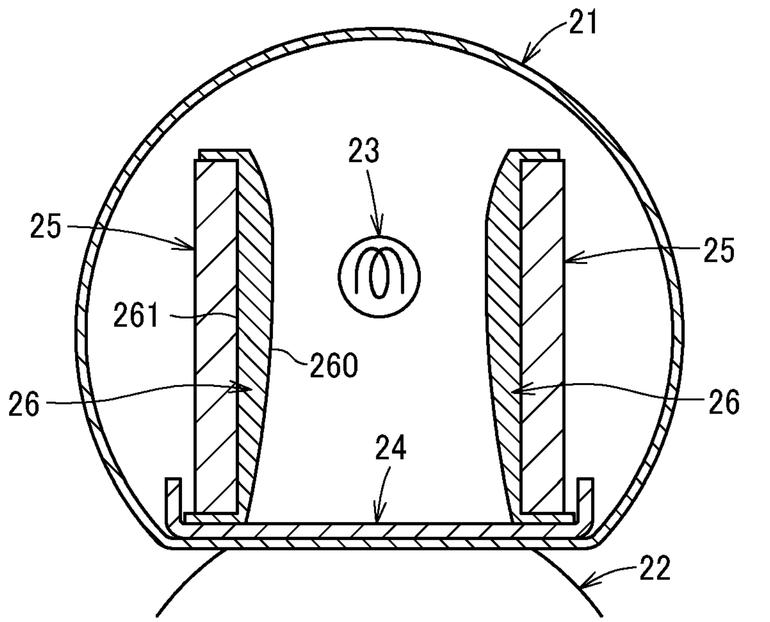


FIG. 9

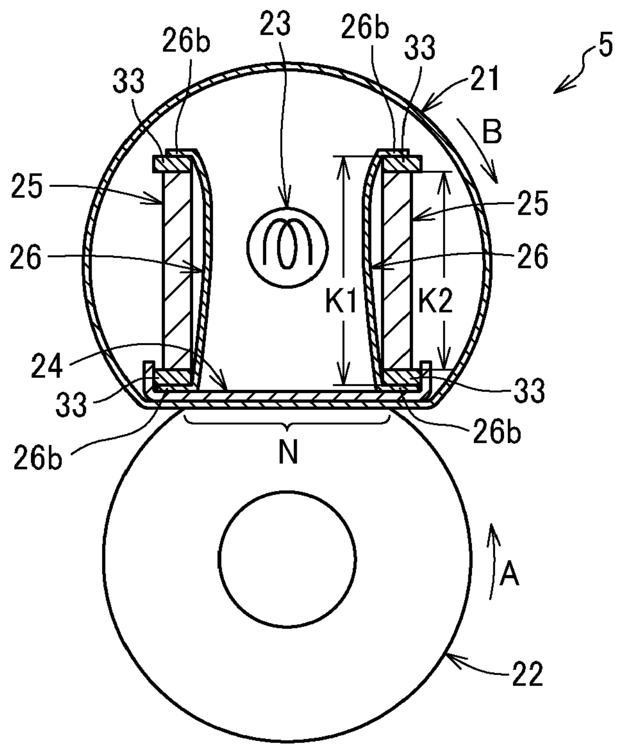

23
26b
26b
33
5
33
21
B
25
25
26
26
K1
K2
24
33
33
26b
26b
N
A
22

FIG. 10

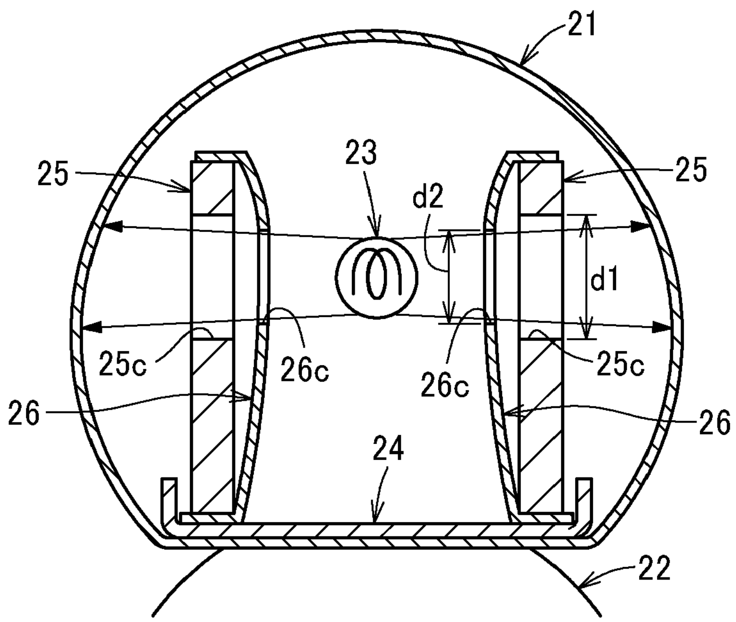

21
23
25
25
d2
d1
25c
26c
26c
25c
26
26
24
22

FIG. 11

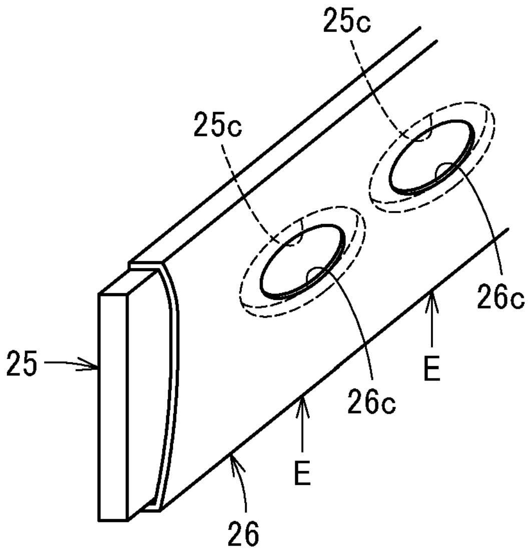


FIG. 12

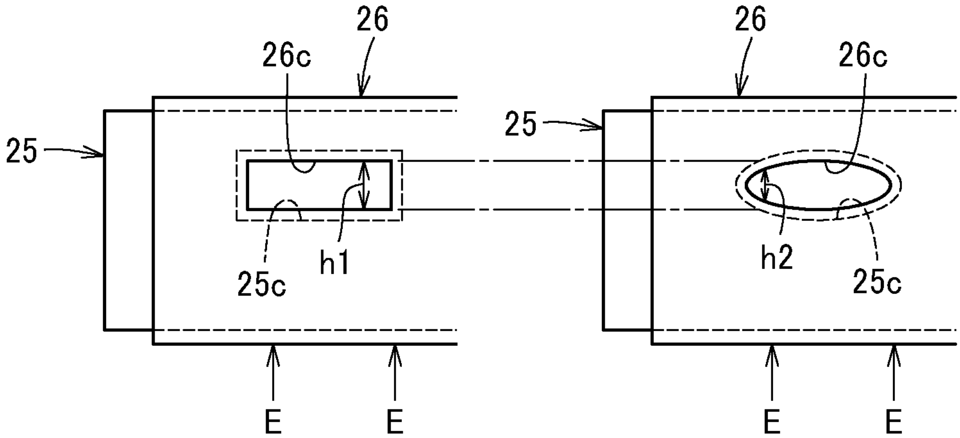


FIG. 13

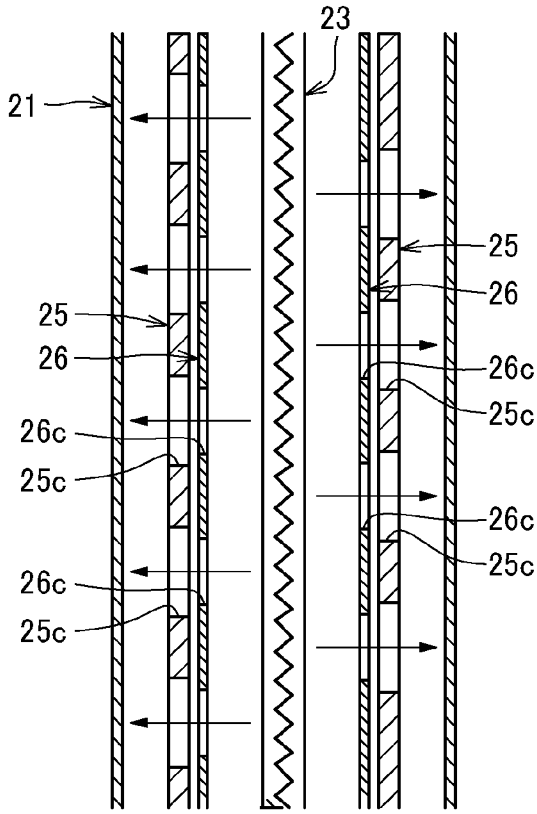

23
21
25
26
25
26
26c
25c
26c
25c
26c
25c
26c
25c

FIG. 14

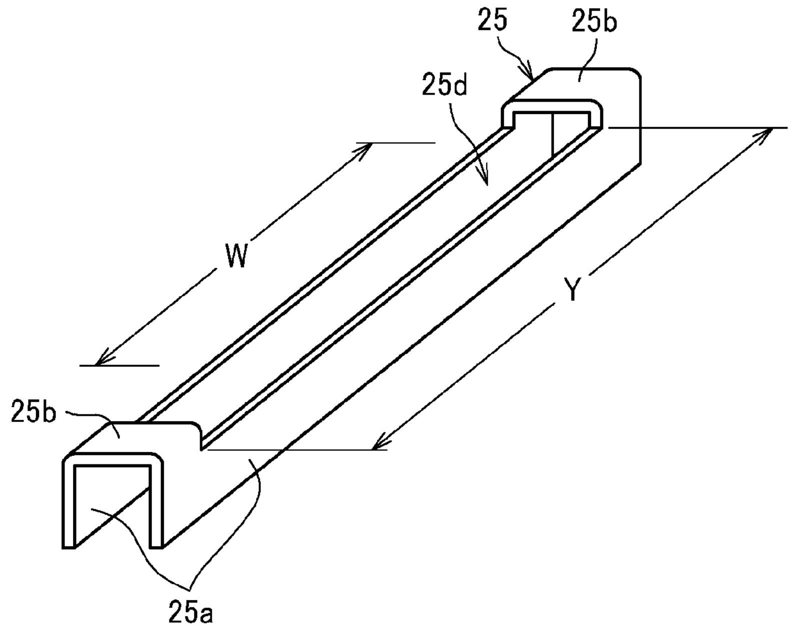

25
25b
25d
W
Y
25b
25a

FIG. 15

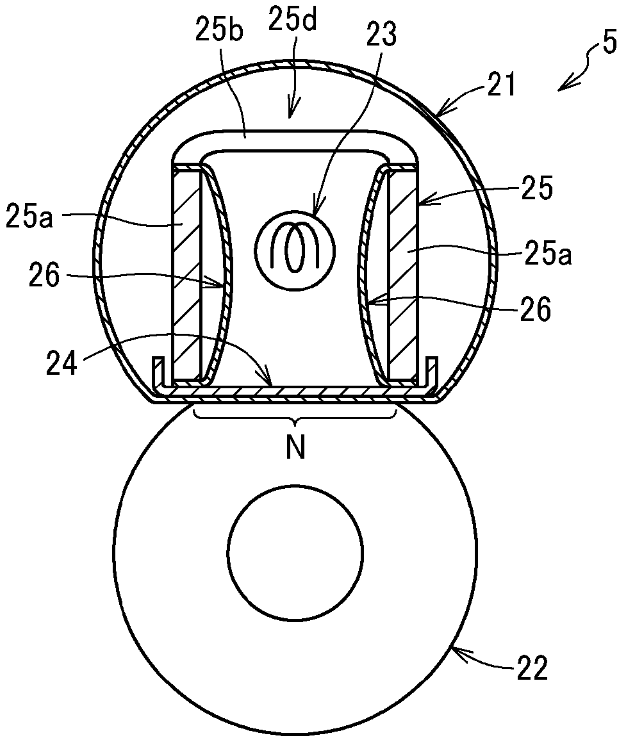

25b
25d
23
5
21
25
25a
25a
26
26
24
N
22

FIG. 16

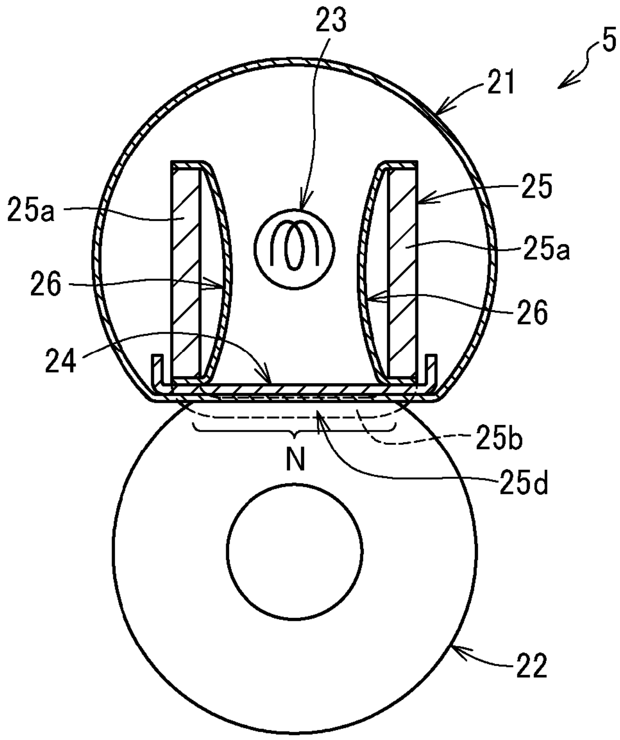

23
5
21
25
25a
25a
26
26
24
25b
25d
N
22

FIG. 17

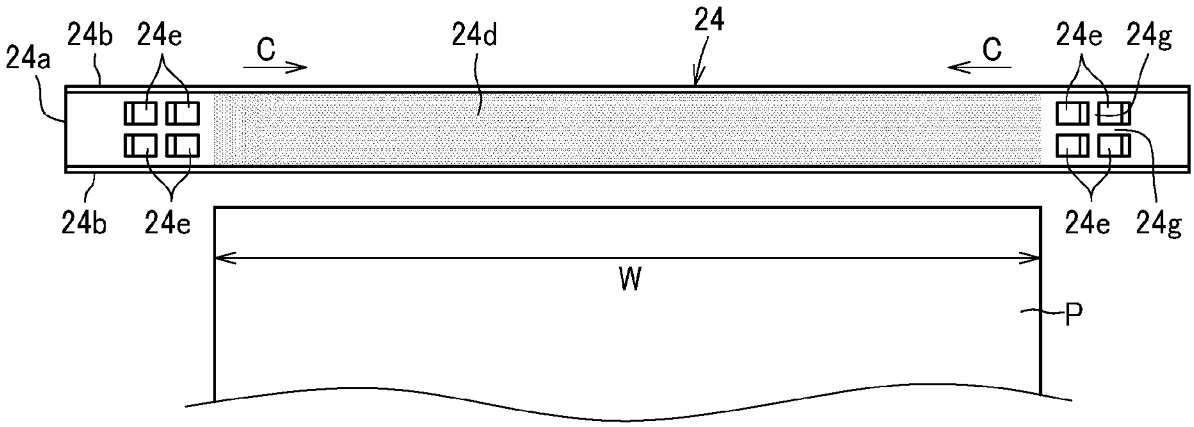


FIG. 18

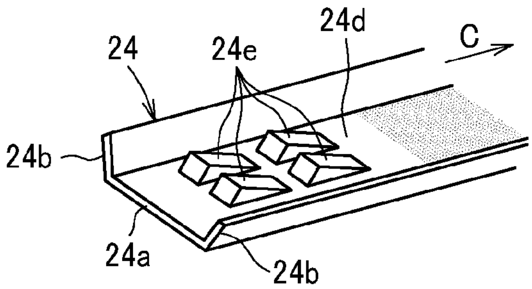


FIG. 19

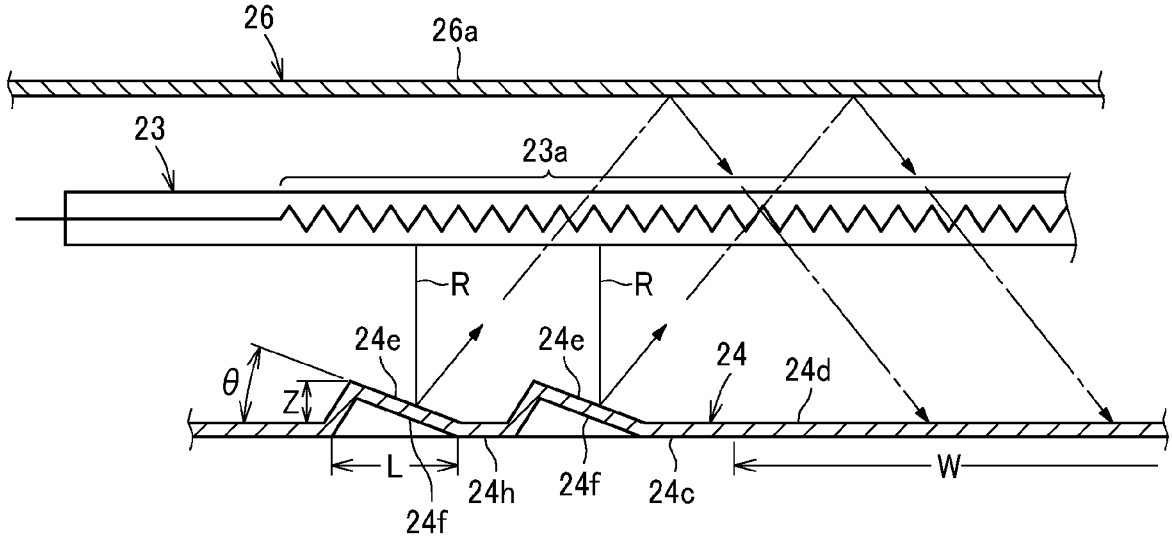


FIG. 20

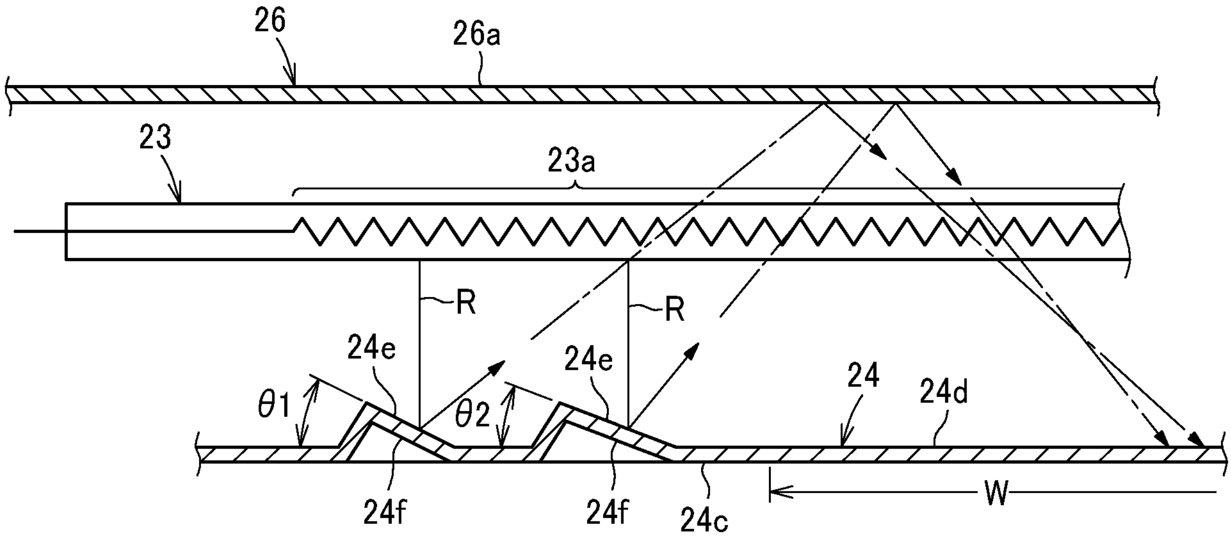

26
26a
23
23a
R
R
24e
24e
θ1
θ2
24
24d
24f
24f
24c
W

FIG. 21

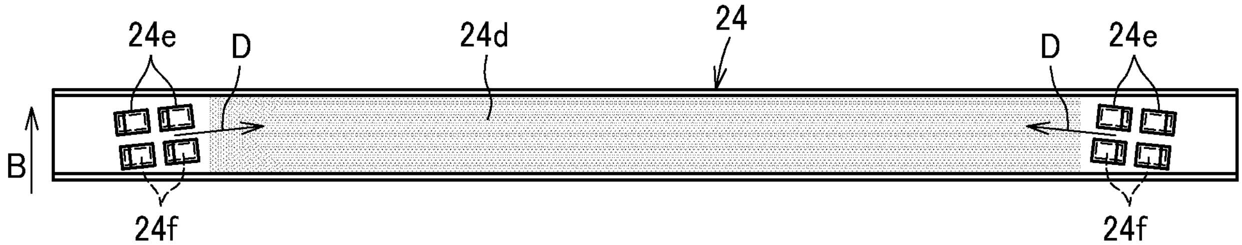

24e
D
24d
24
D
24e
B
24f
24f

FIG. 22

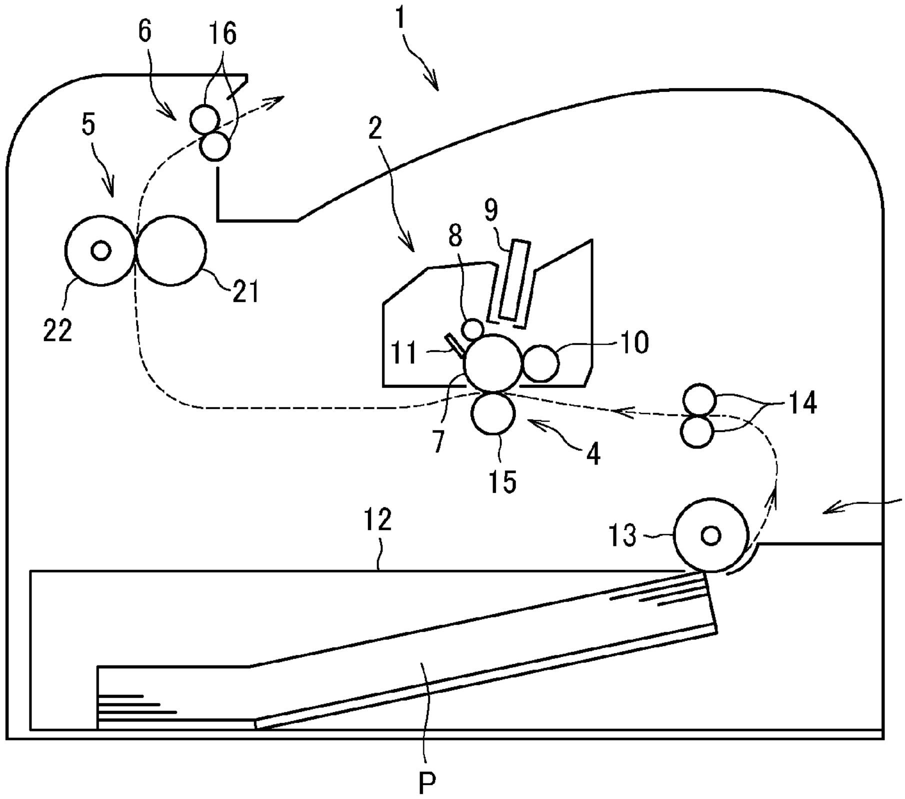
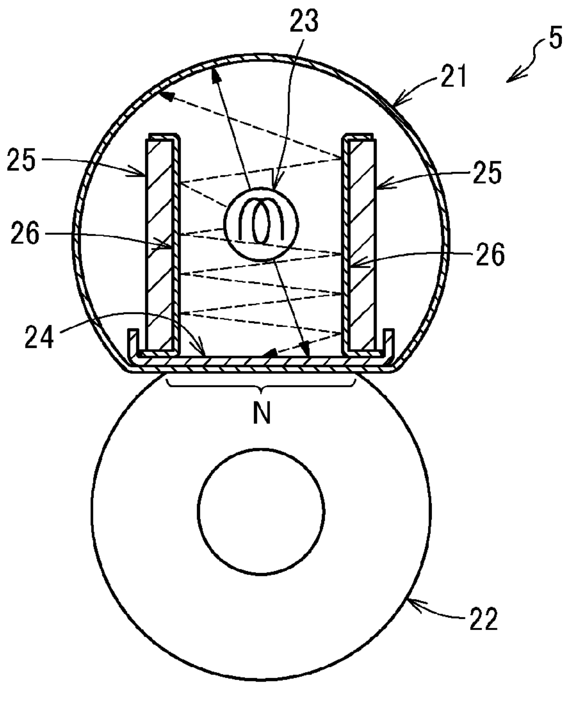


FIG. 23



Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 20 15 3423

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	JP 2019 003036 A (RICOH CO LTD) 10 January 2019 (2019-01-10) * abstract; figures 1,2,4,11-13 *	1-3,5-8 4	INV. G03G15/20
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Place of search	Date of completion of the search	Examiner
Munich	15 June 2020	Urbaniec, Tomasz

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X : particularly relevant if taken alone
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