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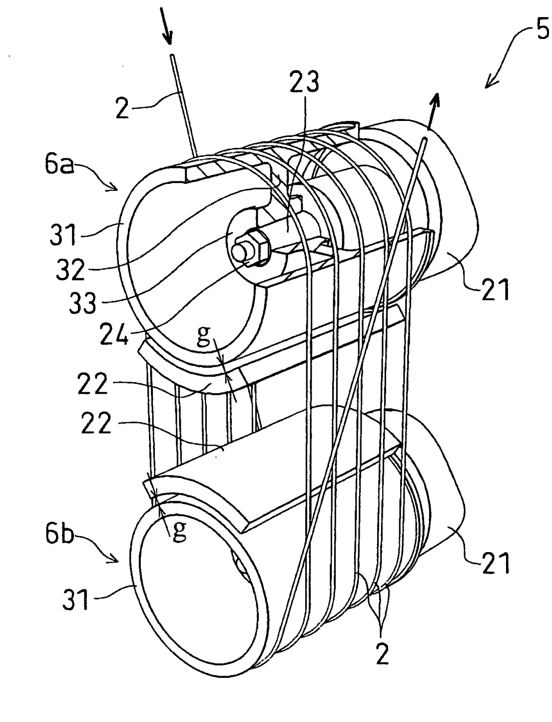
(54) **Yarn heating device**

(57) An object of the present invention is to provide a structure of a yarn heating device suitable for a high-speed heat processing of a yam.

The yarn heating device (5) comprises rollers (6a and 6b) which a yarn (2) is wound around, induction heating coils (22 and 22) as a heating means, and electric motors (21 and 21) for driving to rotate the rollers (6a and 6b). Each of the rollers (6a and 6b) includes a cylindrical portion (31) which the yarn (2) is wound around and a flange portion (32) for connecting the cylindrical portion (31) with an output shaft (23) of the electric motor (21). The induction heating coil (22) is disposed outside each of the rollers (6a and 6b), and each of the rollers (6a and 6b) is heated by the induction heating coil (22) to heat the yarn (2).

FIG. 2



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Description

[0001] The present invention relates to a structure of a yarn heating device for heating a yarn while winding the yarn around a peripheral surface of a roller.

[0002] As a yarn heating device of this type, there is known, for example, a yarn heating device disclosed in Patent Document 1 (Japanese Unexamined Patent Application Publication No. 2000-256936 (refer to Fig. 1, paragraphs 0011 and 0014)). The yarn heating device disclosed in the Patent Document 1 includes a boss portion engaged with a leading end of a driving shaft, and a cylindrical roller main body, which is integrally connected with the boss portion via a disk-like connecting section (flange portion). The roller main body is attached to the leading end of the driving shaft via the connecting section and supported in a cantilever manner. A heater is accommodated within the roller main body in a radial direction thereof, and the roller main body generates heat by receiving energy from the heater.

[0003] Recently, there has been a greater demand for a multi-end winding for winding a plurality of yarns simultaneously by a winder, and an increase in a winding speed. In the above-described structure disclosed in the Patent Document 1, since the connecting section and the boss portion are disposed at the leading end side of the driving shaft, in order to carry out the multi-end winding, the driving shaft is required to be elongated. Since the connecting section and the boss portion are disposed at the leading end side, a center of gravity of the roller is located away from the connecting section and the boss portion. Therefore, natural frequency during rotation of the roller main body is lower. Consequently, it is difficult to rotate the roller main body at a high speed. In order to respond to the recently increasing demand for a multi-end winding of yarns at a high speed, there has been still room for improvement. Since the heater is disposed within the roller main body, there is such a disadvantage that degree of freedom of designing is restricted. Therefore, for example, the thickness of the driving shaft could not be increased to improve the rigidity of the driving shaft.

[0004] The present invention has been made in view of the above problems. An object of the present invention is to provide a yarn heating device capable of increasing degree of freedom of layout inside a roller and satisfactorily heating yarns.

[0005] The problems to be solved by the present invention are as described above. Next, a description will be made of means for solving the problems and effect of such means.

[0006] According to a first aspect of the present invention, a yarn heating device includes rollers to be wound with a yarn, heating means, and roller driving sections for driving to rotate the respective rollers. Induction heating coils as the heating means are provided outside the rollers, and the rollers are heated by the induction heating coils to heat the yarn.

[0007] Accordingly, degree of freedom of layout inside the roller is increased. Since the rollers are heated by the induction heating coils provided outside the rollers, an outer peripheral surface of the rollers is most heated (skin effect). Therefore, the yarn, which is wound around the outer peripheral surface of the rollers, can be heated efficiently. There is no restriction with respect to a position where the heating means is provided. Further, since temperature inside the rollers is prevented from rising, life of auxiliary members therein can be extended.

[0008] In the yarn heating device described above, a gap between the respective induction heating coils and the respective rollers is preferably not less than 5 mm and is preferably not more than 30 mm.

[0009] Accordingly, even when the yarn is accidentally entangled around the rollers, a sufficient time can be obtained until the entangled yam influences the induction heating coils.

[0010] In the yarn heating device, the respective induction heating coils preferably face a peripheral surface of the respective rollers except a portion of the peripheral surface where the yarn is wound around.

[0011] Accordingly, since the induction heating coils do not interfere when winding the yarn around the rollers, the winding operation can be easily conducted.

[0012] Alternatively, the above-described yarn heating device may be constructed as described below. That is, at least a part of the induction heating coils is provided to face a portion of the peripheral surface of the rollers where the yarn is wound around. In an axial direction of the respective rollers, a leading end of the respective induction heating coils is positioned closer to a base end side than a leading end of the rollers.

[0013] In this case, since the induction heating coils are not provided at the leading end of the rollers, which are used for threading the yarn, and the leading end of the rollers is exposed, the yarn can be easily set in the yarn heating device.

[0014] In the yarn heating device, a high-frequency current is preferably applied to the induction heating coils to heat the rollers. The high-frequency current is different from a commercial power of 50 Hz or 60 Hz, and refers to a power of substantially 1 kHz or more.

[0015] Accordingly, the gap between the respective rollers and the respective induction heating coils can be obtained sufficiently.

[0016] According to a second aspect of the present invention, a yarn heating device having the following construction is provided. That is, the yarn heating device comprises rollers to be wound with a yarn, heating means, and roller driving sections for driving to rotate the respective rollers. The heating means is disposed outside the rollers. Each of the rollers includes a cylindrical portion which the yarn is wound around and a flange portion connecting the cylindrical portion with a shaft of the respective roller driving sections. The flange portion is positioned in a central area of the respective rollers in an axial direction thereof.

[0017] Accordingly, the shaft can be shortened and a cantilever part of the rollers can be shortened. As a result, natural frequency of the system can be reduced. Consequently, vibration is difficult to be generated even when the rollers are lengthened and driven at a high speed.

[0018]

Fig. 1 is a schematic diagram showing an entire structure of a draw spinning device having a yarn heating device;
Fig. 2 is a partial cross-sectional perspective view of the yarn heating device;
Fig: 3 is a partial cross-sectional side view of the yarn heating device;
Fig. 4 is a perspective view of a yarn heating device according to another embodiment; and
Fig. 5 is a side view of the yarn heating device according to another embodiment.

[0019] Next, referring to Fig. 1 to Fig. 3, an embodiment of the present invention will be described.

[0020] Fig. 1 shows the entire structure of a draw spinning device (manufacturing device for synthetic fiber yarn) having a yarn heating device 5 according to the present embodiment. In the draw spinning device, a filament yarn (yarn) 2, which is discharged from a mouth ring 1 and is in a state of molten polymer, is blown to cool and solidify by a cooling unit 3, and is fed to the yarn heating device 5 through an oiling device 4. The yarn heating device 5 includes two rollers 6a and 6b arranged vertically and respectively driven by electric motors. The yarn 2 is heated while being wound around these rollers 6a and 6b. A detailed structure of the yarn heating device 5 will be described later.

[0021] A pull-up roller 7 is disposed to a downstream of the yarn heating device 5. The pull-up roller 7 includes a main roller 7a and an auxiliary roller 7b. The main roller 7a is driven by a non-illustrated motor. A predetermined speed difference is made between a rotation speed of the main roller 7a of the pull-up roller 7 and a rotation speed of the rollers 6a and 6b of the yarn heating device 5, thereby the yarn 2 is drawn between the yarn heating device 5 and the pull-up roller 7. The main roller 7a of the pull-up roller 7 is provided with a heater 8 to heat the yarn 2. The heater 8 has the same structure as an induction heating coil 22 of the yarn heating device 5, which will be described later. Further, the heater 8 may be omitted.

[0022] A yarn guide 9 and a winding device 11 are disposed to a further downstream side of the pull-up roller 7. The winding device 11 is provided with a spindle 12. A plurality of cylindrical take-up bobbins 13 for winding the yarn 2 can be set on the spindle 12 to wind a plurality of the yarns 2 simultaneously. The winding device 11 is further provided with a contact roller 10. The yarn 2 is wound around the take-up bobbin 13 while the contact roller 10 makes contact at an appropriate contact pressure with an outer peripheral surface of the take-up bobbin 13 or an outer peripheral surface of a yarn layer formed by winding the yam 2 around the take-up bobbin 13. At this time, a winding speed is set to 6000 m/min, for example.

[0023] Fig. 2 and Fig. 3 show a detailed structure of the yam heating device 5. In addition to the two rollers 6a and 6b, the yarn heating device 5 includes electric motors (roller driving sections) 21 and 21 and induction heating coils (heating means) 22 and 22. The rollers 6a and 6b are made of a metal. As shown in Fig. 2 and Fig. 3, each of the rollers 6a and 6b includes a cylindrical portion 31 for winding the yarn 2 around an outer peripheral surface thereof, a flange portion (connecting section) 32, which is integrally formed with the cylindrical portion 31 and extends from an inner peripheral surface of the cylindrical portion 31 in a radially contracting direction (direction toward a center of the cylindrical portion 31), and a boss portion (connecting portion) 33, which is formed in a central area of the flange portion 32.

[0024] Each of the electric motors 21 and 21 has a housing, and an output shaft (supporting shaft, driving shaft, rotating shaft) 23 is rotatively provided via a non-illustrated bearing in the housing. The output shaft 23 protrudes from the housing of each electric motor 21 in a horizontal direction, and is supported by the housing in a cantilever manner. The boss portion 33 of each of the rollers 6a and 6b is fixed to the leading end of each of the output shafts 23 via a nut 24. As a result, the output shaft 23 of each of the electric motors 21 supports the rollers 6a and 6b in a cantilever manner, respectively. By driving the electric motors 21, the rollers 6a and 6b can be rotated at a high speed of, for example, about 6000 m/min in a peripheral surface speed.

[0025] The induction heating coils 22 are disposed outside the rollers 6a and 6b. Each of the induction heating coils 22 is fixed to a non-illustrated support and the housing of each of the electric motors 21, respectively. In particular, each of the induction heating coils 22 is attached to the support supporting each of the electric motors 21 via a non-illustrated bracket, respectively. As shown in Fig. 1 and Fig. 2, each induction heating coil 22 is formed in an arc shape in its cross-section so as to partially cover the outer periphery of the respective rollers 6a and 6b (cylindrical portion 31). An appropriate gap g is formed between the induction heating coil 22 and the roller 6a. An appropriate gap g is formed between the induction heating coil 22 and the roller 6b.

[0026] As shown in Fig. 3, heat pipes 35 extending in an axial direction of the cylindrical portion 31 are provided within each cylindrical portion 31. The heat pipes 35 are arranged with an interval between the respective heat pipes 35 in a circumferential direction. Accordingly, the cylindrical portion 31 can be heated uniformly in its axial direction.

[0027] In this arrangement, as shown in Fig. 2, the yarn 2, which is fed from the oiling device 4, is wound around the two rollers 6a and 6b alternately in the following manner. Specifically, the yarn 2 is first wound around a lower half part adjacent to a base end of the lower roller 6b, then is wound around an upper half part of the upper roller 6a, and is wound around the lower half part of the lower roller 6b again, and this is repeated several times. After being wound around the two rollers 6a and 6b several times in a spiral manner (for example, five to seven times), the yarn 2 is fed from a point adjacent to a leading end of the lower roller 6b toward the pull-up roller 7 at the downstream side. In Fig. 2 and Fig. 3, only single yarn 2 is shown. However, a plurality of yarns 2 are actually wound in parallel.

[0028] The term "leading end" herein refers to, unless otherwise noted, an end at a free end side (a side located away from the housing of the electric motor 21) of the output shaft 23, which is supported in a cantilever manner, of the electric motor 21. The term "base end" herein refers to an end at a supporting side (a side located at the housing of the electric motor 21).

[0029] In the present embodiment, one of the induction heating coils 22 is disposed to cover a lower half part of the outer peripheral surface of the upper roller 6a, that is, to face the upper roller 6a except a portion where the yarn 2 is wound. The other induction heating coil 22 is disposed to cover an upper half part of the outer peripheral surface of the lower roller 6b, that is, to face the lower roller 6b except a portion where the yarn 2 is wound.

[0030] Each of the induction heating coils 22 is connected to an individual high-frequency power source 40 via a power supply line and supplied with a high-frequency Alternating Current (AC) power of, for example, about 30 kHz. Accordingly, eddy currents are generated in the surface (outer peripheral surface of the cylindrical portion 31) of the metal rollers 6a and 6b in directions to eliminate magnetic fields, which are generated by the coils 22. The temperature of the surface of the rotating rollers 6a and 6b is increased to, for example, about 200°C by Joule heat of the eddy currents. Thus, the outer peripheral surface of each of the rollers 6a and 6b is heated in a non-contact manner, and the yarn 2 wound around the outer peripheral surface of the rollers 6a and 6b is heated.

[0031] The gap "g" between each of the rollers 6a and 6b and the respective induction heating coils 22 is preferably not less than 5 mm, and not more than 30 mm. When the gap "g" is less than 5 mm, the yarn 2 may be stuck on the rollers 6a and 6b for some reason. Then, the stuck yarn may influence the induction heating coils 22 in a short period of time, and a possibility of damage, etc., caused on the induction heating coils 22 increases. When the gap "g" exceeds 30 mm, the rollers 6a and 6b may not be sufficiently heated by the induction heating and the yarn 2 may not be heated sufficiently. In the present embodiment, the gap "g" is set to 15 mm. Since a high-frequency AC power is applied to each of the induction heating coils 22 as described above, the surface of the respective rollers 6a and 6b are heated satisfactorily even when the size of the gap g is as described above.

[0032] As shown in Fig. 3, in the present embodiment, the flange portion 32 of each of the rollers 6a and 6b is disposed at a position where the flange portion 32 is entirely overlapped with the respective induction heating coils 22 in the axial direction of the rollers 6a and 6b as observed along the radial direction of the rollers 6a and 6b. In other words, the thickness "t" of the flange portion 32 is overlapped so as to be included within the length "w" of the induction heating coil 22 in the axial direction as observed along the radial direction of the rollers 6a and 6b. According to this arrangement, the outer peripheral surface of each of the rollers 6a and 6b is widely covered with the respective induction heating coils 22, thereby the outer peripheral surface of the rollers 6a and 6b is heated uniformly and efficiently, and the flange portion 32 (boss portion 33) of the rollers 6a and 6b can be set to an appropriate position.

[0033] In the present embodiment, the flange portion 32 is arranged at a substantially central position of the rollers 6a and 6b in the axial direction thereof (central area in the axial direction). Therefore, the boss portion 33 can be disposed at a position closer to the base end than the arrangement of the Patent Document 1. Accordingly, the length of the output shaft 23 of each electric motor 21 can be reduced, and the center of gravity of the rollers 6a and 6b can also be positioned closer to the base end. As a result, the natural frequency of a system including the rollers 6a and 6b and the output shaft 23 can be reduced. Accordingly, an arrangement, which generates little vibration even when the rollers 6a and 6b are driven to rotate at a high speed, can be achieved.

[0034] As described above, the yarn heating device 5 according to the present embodiment includes the rollers 6a and 6b which the yarn 2 is wound around, and the electric motors 21 and 21 for driving to rotate the rollers 6a and 6b. The induction heating coils 22 are disposed as heating means outside the rollers 6a and 6b. AC power is applied to each of the induction heating coils 22 to heat the rollers 6a and 6b, thereby heating the yarn 2. Therefore, since the heating means is not required to be provided inside the rollers 6a and 6b, degree of freedom of layout inside each of the rollers 6a and 6b is increased. For example, diameter of each of the output shafts 23 of the electric motors 21 and 21 may be increased, or the flange portions 32 can be positioned easily at a central area of the rollers 6a and 6b. Since the rollers 6a and 6b are heated by the induction heating coils 22 disposed outside of the rollers 6a and 6b, the outer peripheral surface of the rollers 6a and 6b is heated the most (because density of eddy currents is the highest). Resulting from this skin effect, the yarn 2, which is wound around the outer peripheral surface of the rollers 6a and 6b, is heated efficiently. Meanwhile, an increase in the temperature inside (central side of) the rollers 6a and 6b can be relatively suppressed. Therefore, the heat conducted to the output shaft 23 can be reduced. Accordingly, for example, life of a non-illustrated bearing supporting the output shaft 23 in the electric motor 21 is extended.

[0035] The gap g between each of the induction heating coils 22 and the respective rollers 6a and 6b is not less than 5 mm, and is not more than 30 mm. Accordingly, it is possible to provide the yarn heating device 5, which prevents the yarn 2 from being entangled around the induction heating coils 22, and which can efficiently heat the yarn 2.

[0036] Each of the induction heating coils 22 faces the outer peripheral surface of the respective rollers 6a and 6b by avoiding the portion where the yarn 2 is wound. Therefore, since the induction heating coils 22 do not interfere when setting the yarn 2 with respect to the yarn heating device 5, the yam 2 can be set easily. Although the induction heating coils 22 have an arced shape, since the rollers 6a and 6b are driven to rotate at a high speed while being heated, the outer peripheral surface of the rollers 6a and 6b is heated uniformly in the peripheral direction, and unevenness does not generate in the heating of the yarn 2.

[0037] Each of the rollers 6a and 6b includes the cylindrical portion 31 where the yarn 2 is wound around, and the flange portion 32, which extends from the cylindrical portion 31 in the radially contracting direction to connect the cylindrical portion 31 with the output shaft 23 of the electric motor 21. The flange portion 32 is disposed at a position where the flange portion 32 overlaps with the induction heating coil 22 in the axial direction of the rollers 6a and 6b; i.e., in a central area of the rollers 6a and 6b in the axial direction. Therefore, since the flange portion 32 (boss portion 33) is not required to be disposed closer to the leading end of the rollers 6a and 6b, the length of the output shaft 23 of the electric motor 21 can be reduced. As a result, the natural frequency of the system can be reduced and the arrangement suitable for a high-speed rotation can be obtained. In the present embodiment, the flange portion 32 is disposed at a position where the length of the rollers 6a and 6b (cylindrical portion 31) is substantially bisected in its axial direction. Accordingly, vibration is difficult to be generated even when the rollers 6a and 6b are driven to rotate at a high speed of 6000 m/min in peripheral surface speed.

[0038] As shown in Fig. 4 and Fig. 5, according to another embodiment, the disposition of the induction heating coils 22 and 22 may be changed to cover an upper half part of the upper roller 6a and a lower half part of the lower roller 6b (portions where the yarn is wound). The arrangement shown in. Fig. 4 and Fig. 5 is different from the arrangement shown in Fig. 2 and Fig. 3 only in that the shape and disposition of the induction heating coils 22 and 22. Other arrangements in Fig. 4 and Fig. 5 are the same as Fig. 2 and Fig. 3.

[0039] According to the present embodiment, compared to the arrangement shown in Fig. 2 and Fig. 3, the outer peripheral surface of each of the rollers 6a and 6b can be covered easily in a wider area. Thus, each of the rollers 6a and 6b can be heated more uniformly and efficiently.

[0040] In addition, as shown in Fig. 5, the leading end of the respective induction heating coils 22 is located at a position slightly closer to the base end side by a length necessary for threading the yarn than the leading end of the rollers 6a and 6b. In other words, the outer peripheral surface at the end of the respective rollers 6a and 6b (end portion at the free end side, which is supported in a cantilever manner) is exposed without being covered by the respective induction heating coils 22.

[0041] Accordingly, the yarn 2 can be set onto the yarn heating device 5 only by winding the yarn 2 around the exposed portion. That is, in the yam heating device 5 of the present embodiment, a rotational axis line of the upper roller 6a and a rotational axis line of the lower roller 6b are not disposed in parallel with each other, and are disposed at an angle slightly displaced with respect to each other. Accordingly, when the yarn 2 is wound around the exposed leading end portions while the rollers 6a and 6b are rotated, the yam 2 automatically moves toward the base end side on the outer peripheral surfaces of the rollers 6a and 6b (so as to enter into an inner side of the induction heating coils 22). Finally, as shown in Fig. 4, a state in which the yarn 2 is wound spirally around the two rollers 6a and 6b at regular pitches can be accomplished automatically. As described above, the yarn heating device 5 of the present embodiment is arranged so that, when the yarn 2 is wound around the leading end of the rollers 6a and 6b, the yarn is naturally threaded through the yarn heating device 5. According to the above-described arrangement, since the leading ends of the rollers 6a and 6b are exposed, a yarn threading operation can be carried out easily.

[0042] In the present embodiment, as shown in Fig. 5, it is extremely preferable that the heat pipes 35 are embedded in the cylindrical portion 31 of each of the rollers 6a and 6b and the leading end of the heat pipe 35 extends to the exposed portion. Accordingly, the rollers 6a and 6b, including the leading end thereof, can heat the yarn 2 uniformly.

[0043] A preferred embodiment and another embodiment of the present invention have been described. The above-described arrangements are one of the examples of the present invention. The present invention may be modified, for example, as described below.

[0044] In place of the induction heating coil 22, for example, another heating means such as a resistance heater may be used. When using the resistance heater, since the rollers 6a and 6b are heated from the outside, it is advantageous because an increase in the temperature in the central area of the roller can be restricted, and thus the life of the bearing of the output shaft 23, etc., can be extended.

[0045] The rollers 6a and 6b may be made of another material having conductivity, in place of the metal.

[0046] The present invention may be modified to a combined arrangement of the arrangements shown in Fig. 2 and Fig. 4. That is, both of the upper half part and the lower half part of the rollers 6a and 6b may be covered by the induction heating coils 22.

[0047] It is arbitrarily selectable, depending on circumstances, with respect to the dimensions of the rollers 6a and 6b and/or how many times the yarn 2 is wound around the outer peripheral surface of the rollers 6a and 6b. Since the output shaft 23 of the electric motor 21 can be shortened and natural frequency of the system can be reduced, the arrangements of the above-described embodiments are particularly suitable when using a roller having a longer dimension in the axial direction (a roller specified so that the yarn 2 can be wound a multiple number of times), or when threading a large number of yarns.

Claims

1. A yarn heating device, comprising:

rollers to be wound with a yarn;
heating means; and
roller driving sections for driving to rotate the respective rollers,

wherein induction heating coils as the heating means are disposed outside the rollers, and the rollers are heated by the induction heating coils to heat the yarn.

2. The yarn heating device according to claim 1, wherein a gap between the respective induction heating coils and the respective rollers is not less than 5 mm and is not more than 30 mm.

3. The yarn heating device according to claim 1 or 2, wherein the respective induction heating coils face a peripheral surface of the respective rollers except a portion of the peripheral surface where the yarn is wound around.

4. The yarn heating device according to claim 1 or 2, wherein at least a part of the induction heating coils is provided to face a portion of the peripheral surface of the rollers where the yam is wound around, and in an axial direction of the respective rollers, a leading end of the respective induction heating coils is positioned closer to a base end side than a leading end of the respective rollers.

5. The yarn heating device according to any one of claims 1 to 4, wherein a high-frequency current is applied to the induction heating coils to heat the rollers.

6. A yam heating device, comprising:

rollers to be wound with a yarn;
heating means; and
roller driving sections for driving to rotate the respective rollers,

wherein the heating means is disposed outside the rollers,
each of the rollers includes a cylindrical portion which the yarn is wound around and a flange portion connecting the cylindrical portion with a shaft of the respective roller driving sections, and
the flange portion is positioned in a central area of the respective rollers in an axial direction of the rollers.

FIG. 1

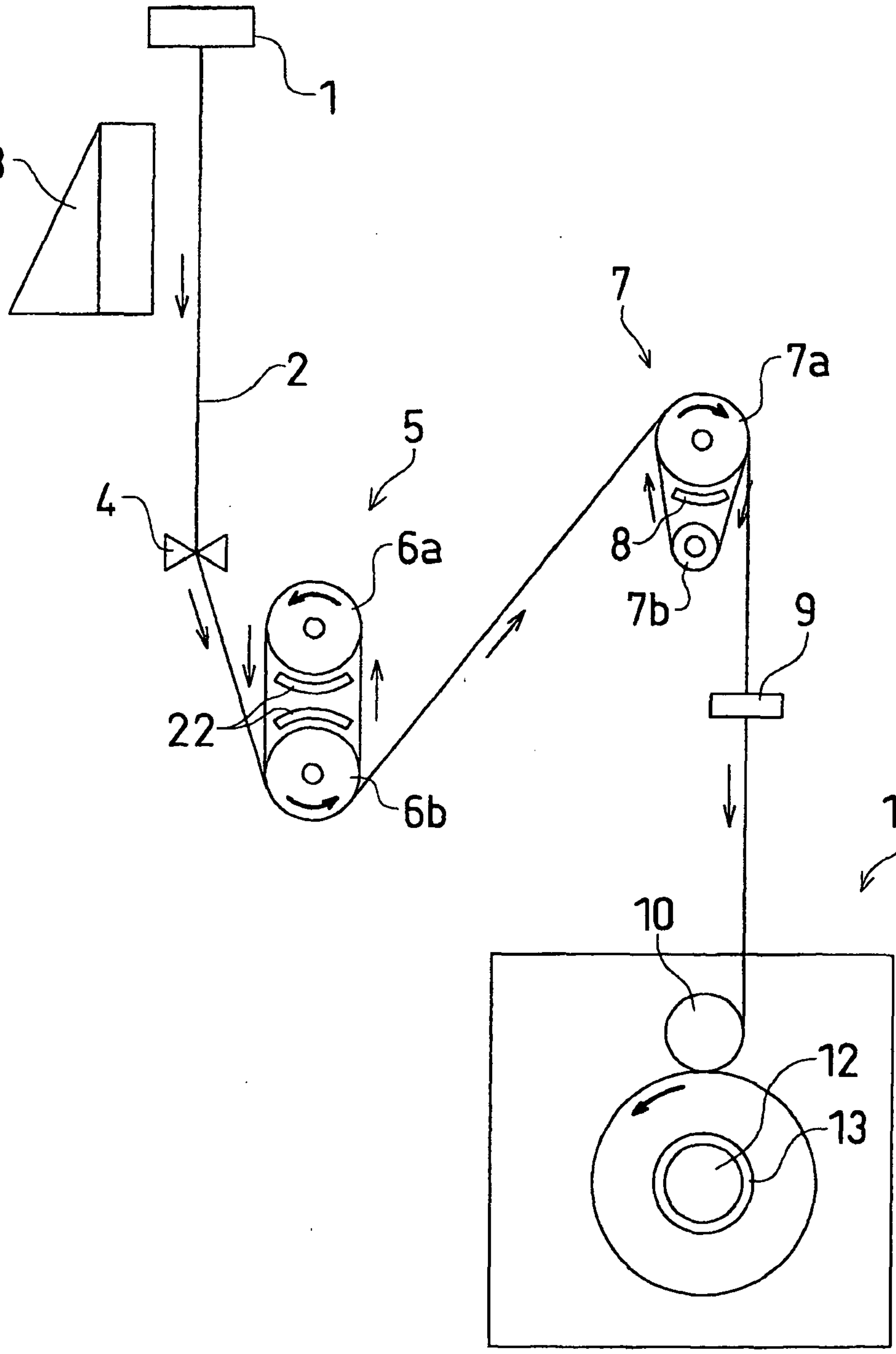
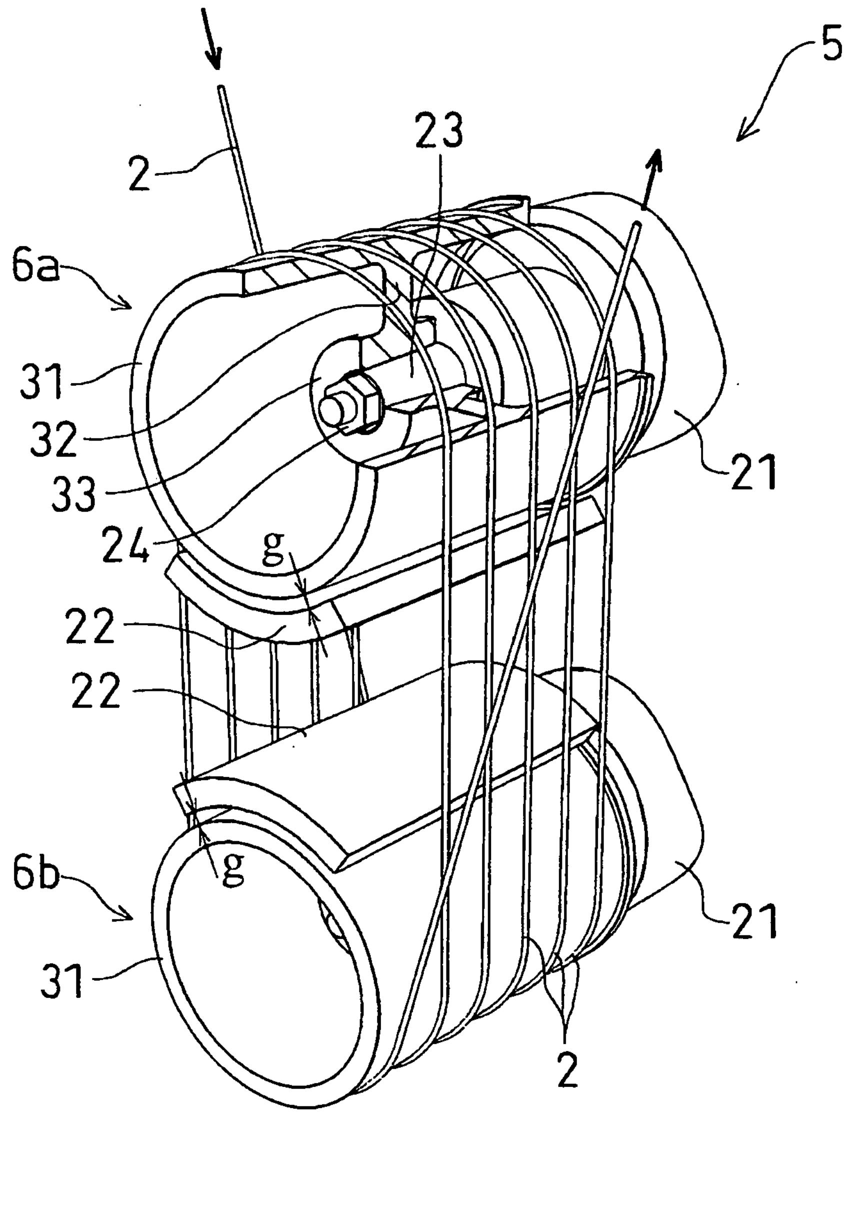


FIG. 2



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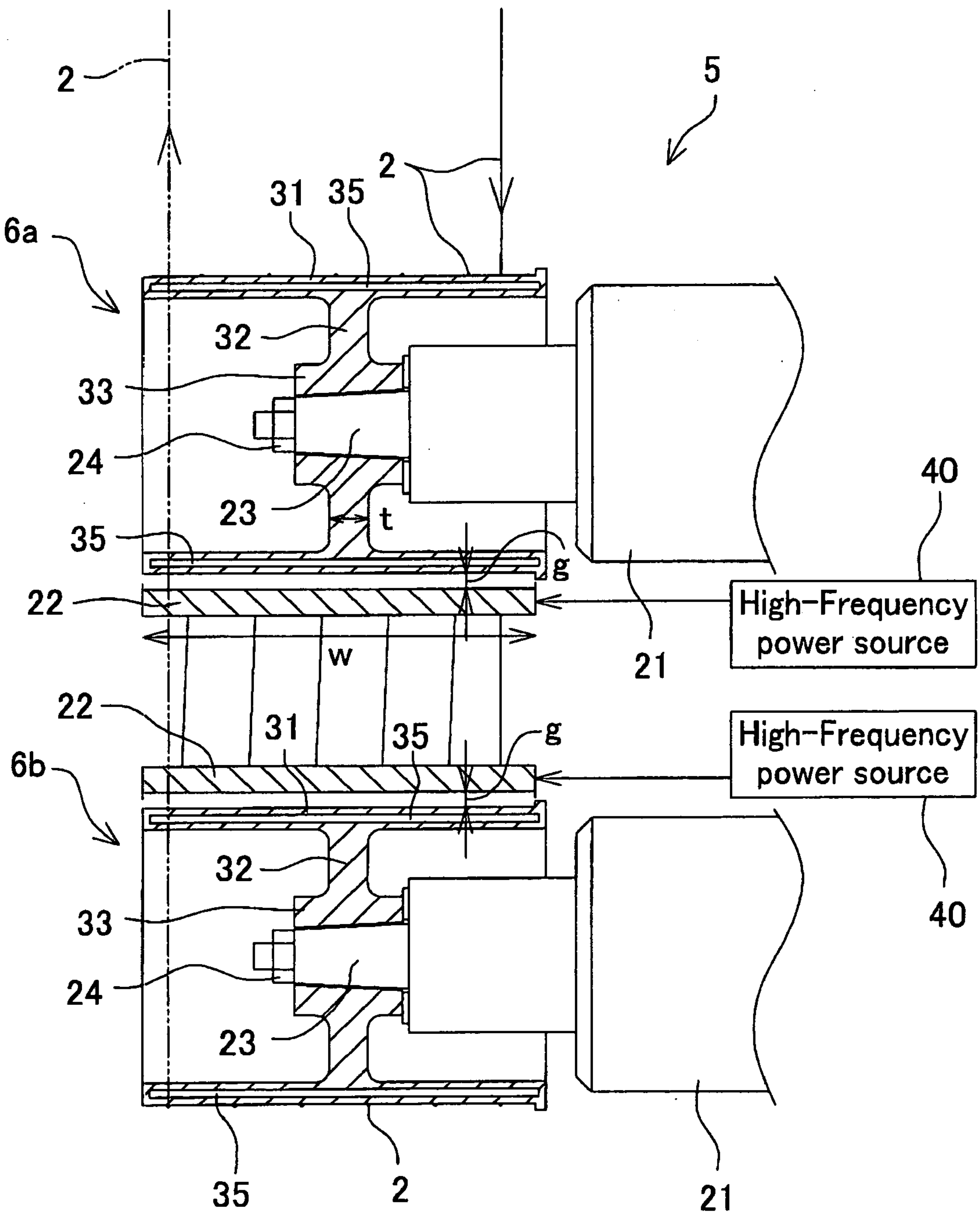

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FIG. 4

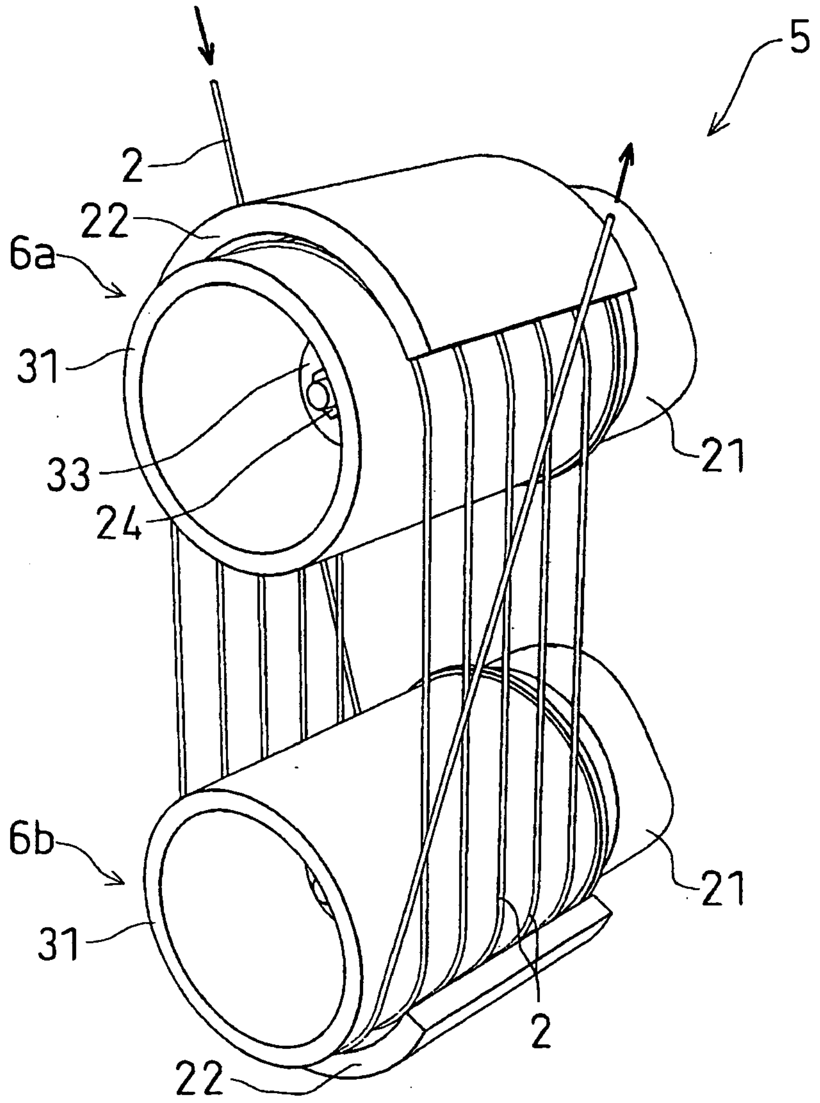
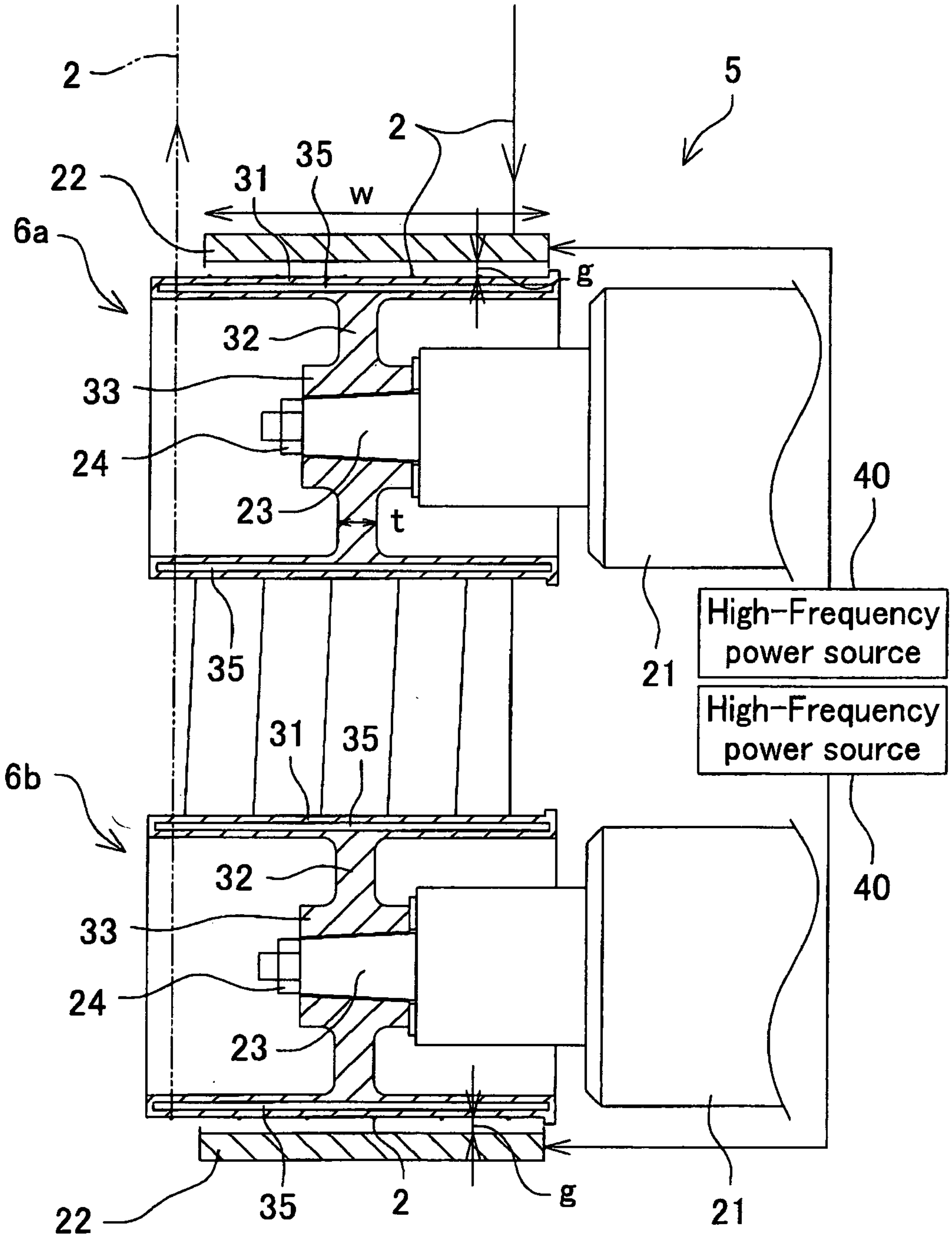


FIG.5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