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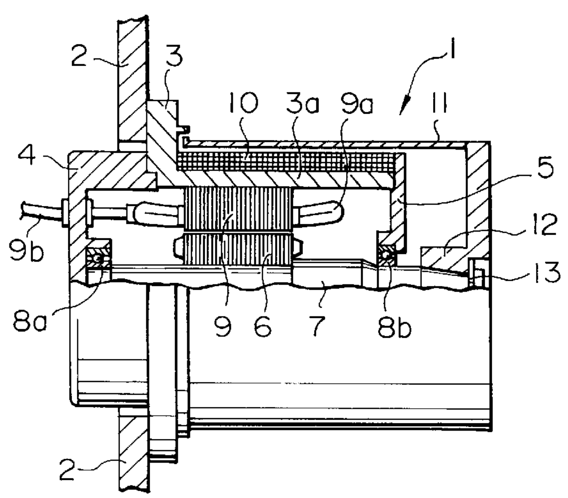
(54) Hot roller with a built-in motor.

(57) A hot roller with a built-in motor in which the whole length thereof is shortened and the heat efficiency is improved. In the hot roller, a heater coil (10) is fixedly fitted onto a surface of a motor outer housing, and a motor rotor shaft (7) of the motor is connected to a hot roller rotary shaft (12) of a hot roller rotor (11, 11A, 11B) formed so as to cover the heater coil (10). In this case, it is preferable that a ceramic bearing is used as a bearing (8a, 8b) of the motor rotor shaft (7) so as to perform oil-mist lubrication, and that heat pipes (15) are provided in the hot roller rotor (11, 11A, 11B).

FIG. 3



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The present invention relates to a hot roller connected to a rotary machine for driving the hot roller, and particularly relates to a hot roller with a built-in motor.

Hot rollers are used in a producing process in a chemical synthetic fiber factory.

A hot roller has such a structure, for example, as shown in Fig. 1 or 2, in which steam is blown into the inside of a roller, or in which a heater coil is provided in the inside of a roller.

In Fig. 1, the reference numerals 30 and 20 designates a hot roller and a rotary machine for driving the hot roller respectively. The rotary machine 20 for driving the hot roller 30 includes a motor 21 which is fixedly mounted, through a motor flange 22, on a mechanism to which the motor 21 is to be mounted. The motor 21 has a shaft 23 which is rotatably supported by the motor flange 22 at its end portion through a bearing 24 and connected to a rotary shaft 32 of a rotor 31 of the hot roller 30.

In an inside space of the rotor 31 of the hot roller 30, a heater coil 34 is fixedly fitted onto an outer surface of a hot roller boss portion 33 connected to the motor flange 22.

The bearing 24 is provided with a cooling mechanism (not shown) for supplying the bearing 24 with cooling water, cooling oil, or the like, through a cooling fan and a duct or a pipe so that the bearing 24 can stand the temperature rising inside the hot roller 30 due to the heat generated by the heater coil 34 and the motor 21.

The motor 21 is provided with a cooling ventilating fan (not shown) so as to protect the motor 21 from the heat generated by the heater coil 34 and the motor 21 per se.

In such a structure as mentioned above, when the motor 21 and the heater coil 34 are supplied with predetermined electric power, the hot roller 30 is rotated at a predetermined rotational speed while the surface temperature of the hot roller 30 is kept at a predetermined value, for example, in a range of from 150°C to 280°C, which is required in the synthetic fiber producing process.

Although the first prior art example of Fig. 1 has such a structure that the assembly of the motor and the hot roller is mounted on a vertical wall surface through the flange, a second prior example of Fig. 2 has such a structure that the assembly of the motor and the hot roller is mounted on a horizontal surface plane through a base 26.

In Fig. 2, those parts the same as those in Fig. 1 are correspondingly referenced. The example of Fig. 2 is different from that of Fig. 1 in the point that a motor flange 25 for connecting a motor 21 to a hot roller 30 is different in shape from the motor flange 22 of Fig. 1 so that the motor flange 25 is fixedly mounted, through the base 26, on a mechanism portion on which the assembly is to be mounted.

It is a matter of course that the specification and shape of the hot roller and the hot roller driving rotary machine are designed in accordance with the conditions of use. Further, as the hot roller driving rotary machine, a motor of a suitable type having a proper specification is selectively used from various motors such as an induction motor, a synchronous motor, and the like, in accordance with the requirement of the specification and performance of the hot roller.

In the hot roller having such a structure as mentioned above, however, the whole length of the assembly of the hot roller 30 and the hot roller driving mechanism 20 is so long because of serial connection of the hot roller 30 and the hot roller driving rotary machine 20 that the area efficiency of a factory equipped with the assembly is reduced.

Further, the heat generated from the motor which is the hot roller driving rotary machine is cooled by means of a self cooling fan mounted on an end portion of the motor shaft or by means of a forced cooling fan driven by a separately provided motor so that the generated heat energy is wastefully dissipated into the atmosphere.

Further, the bearing 24 which is a connection portion between the hot roller driving rotary machine 20 and the rotary shaft 32 of the hot roller rotor 31 is provided inside the hot roller rotor 31 to make the critical rotational speed of the hot roller 30 higher than the service rotational speed of the same. It is therefore necessary to provide a cooling mechanism because the portion of the bearing 24 is heated by the heat of the heater coil 34, making the cooling energy wasteful.

It is therefore an object of the present invention to solve the foregoing problems in the prior art and to provide a hot roller with a built-in motor, in which the whole length of the hot roller including the motor is shortened to thereby improve the area efficiency as well as the thermal efficiency.

In addressing the above problems, the present invention may provide a hot roller with a built-in motor in which a heater coil is fixedly fitted onto a surface of an outer housing of the motor, and a rotor shaft of the motor is connected to a rotary shaft of a hot roller rotor which is formed so as to cover the heater coil.

Preferably, a ceramic bearing is used as the bearing of the rotor shaft of the motor so as to perform oil-mist lubrication.

Further, preferably, heat pipes are provided in the hot roller rotor.

The configuration of the present invention will be described in detail in the following embodiments.

Fig. 1 is a partially longitudinally sectioned front view showing a first prior art example;

Fig. 2 is a partially longitudinally sectioned front view showing a second prior art example;

Fig. 3 is a partially longitudinally sectioned front view showing a half of the configuration of Embodiment 1 of the present invention;

Fig. 4 is a partially longitudinally sectioned front view showing a half of the configuration of Embodiment 2 of the present invention;

Fig. 5 is an enlarged sectional view taken on line X-X of Fig. 4;

Fig. 6 is an enlarged sectional view taken on line X-X of Fig. 4 and showing a structure example different from that of Fig. 5; and

Fig. 7 is a partially longitudinally sectioned front view showing a half of the configuration of Embodiment 3 of the present invention.

Referring to Figs. 3 through 7, description will be made as to the preferred embodiments of the hot roller with a built-in motor according to the present invention.

Embodiment 1

Fig. 3 shows Embodiment 1 of the present invention corresponding to the flange-mounting type of the first prior art example which has been described above with respect to Fig. 1.

In Fig. 3, a motor built-in hot roller 1 is fixedly mounted, by means of screws (not shown), to a hot roller mounting fixing plate 2 through a hot roller boss portion 3.

A motor load opposite side cover 4 and a motor load side cover 5 are provided on the front and rear sides of a cylindrical portion 3a integrally formed with the hot roller boss portion 3 so as to constitute an outer housing of a motor portion.

A shaft 7 of a motor rotor 6 is rotatably supported by the motor load opposite side cover 4 and the motor load side cover 5 through bearings 8a and 8b respectively.

A motor stator 9 having a motor armature coil 9a fitted therein is fixedly mounted on the cylindrical portion 3a formed integrally with the hot roller boss portion 3 so as to face the motor rotor 6.

The motor armature coil 9a is supplied with electric power, through a connection wire 9b, from a power source (not shown) which has a predetermined performance and which is provided outside the hot roller 1.

A heater coil 10 is fixedly fitted onto an outer surface of the cylindrical portion 3a integrally formed with the hot roller boss portion 3, and the heater coil 10 is connected, through a conductor (not shown), to a power source (not shown) provided outside the hot roller 1.

A hot roller rotor 11 is provided on an outer circumference of the heater coil 10 with a small predetermined gap therebetween. A rotary shaft 12 of the hot roller rotor 11 is connected to an end portion 13 of the shaft 7.

As the motor constituted by the foregoing constituent parts, a motor of a suitable type may be selectively used from various motors such as an induction motor, a synchronous motor, and the like, in accordance with the required rotational accuracy of the hot roller 1 and the necessary conditions of a system on which the hot roller 1 is to be mounted.

Predetermined parts of the hot roller 1 are formed by materials having necessary heat-resistant properties to cope with the temperature rising inside the hot roller 1. For example, heat-resistant wire using a polyimide group insulating material or the like having a predetermined heat-resistant property is used to form the motor armature coil 9a, a ceramic bearing is used at least as the bearing 8b so as to perform oil-mist lubrication, and so on.

In the above-mentioned structure, the motor rotor 6 rotates when the motor armature coil 9a is supplied with predetermined electric power. The shaft 7 rotates with the rotation of the motor rotor 6 so that the hot roller rotor 11 rotates at a predetermined peripheral speed. The rotary speed of the hot roller rotor 11 is controlled in accordance with a requirement by means of a controller (not shown) of a system using the hot roller 1.

When the motor mechanism operates as described above, a loss portion determined on the basis of the motor efficiency is generated as heat, and the thus generated heat is stored because it is not dissipated from the parts other than the motor load opposite side cover 4 and the like contacting with the outside air, the stored heat being transmitted from the cylindrical portion 3a integrally formed with the hot roller boss portion 3 to the hot roller rotor 11 through the heater coil 10.

When the heater coil 10 is supplied with predetermined electric power, heat is generated from the heater coil 10 and added to the heat energy transmitted from the foregoing motor mechanism so that the surface temperature of the hot roller rotor 11 rises to a predetermined value.

In continuous running, the quantity of heat energy transmitted from the above-mentioned motor mechanism is constant and this heat energy acts as base heat energy for heating the hot roller rotor 11 by the heater coil 10.

The surface temperature of the hot roller rotor 11 is controlled by a controller (not shown) of the system using the hot roller 1 so as to be kept, with predetermined accuracy, at a predetermined value, for example, in a range of from 150° to 280° .

If the surface temperature of the hot roller rotor 11 is kept, for example, at a value in a range of from 150° to 280 °, the temperature inside the hot roller rotor 11 rises to a value in a range of from 150° to 300 ° correspondingly to the heat characteristic or the like of the motor outer housing portion. However, since the parts inside the hot roller rotor 11 employ suitable heat-resistant materials to provide a heat-resistant structure so as to cope with the temperature rising, the hot roller rotor 11 functions stably without being damaged by heat.

Referring to Figs. 4 through 6, Embodiment 2 of the present invention will be described under.

In Fig. 4, the reference numeral 1A designates a hot roller which is different from Embodiment 1 only in the point that a hot roller rotor 11A is different in structure from the hot roller rotor 11B of the above Embodiment 1 of Fig. 3, and description about the other portions being omitted accordingly.

As shown in Fig. 4, heat pipes 15 having predetermined characteristics are buried at predetermined intervals and in parallel to a shaft 7, in the inside of the hot roller rotor 11A.

Fig. 5 shows a section of the hot roller rotor 11A along X-X line in Fig. 4.

As shown in Fig. 5, the heat pipes 15 are buried in the hot roller rotor 11A with heat-resistant synthetic resin 16 for fixing the respective heat pipes 15. Alternatively, in place of the heat-resistant synthetic resin 16, a heat-conductive material may be applied to cover all over the whole heat pipes 15.

The heat pipes 15 are selected to have suitable size and buried at suitable intervals according to the necessary heat specification of the hot roller 1 and corresponding to the shape, size, heat characteristics, and the like, of the hot roller rotor 11A and the heater coil 10.

As a method of burying the heat pipes 15, grooves may be formed equidistantly in an inner surface of the hot roller rotor 11A so that the heat pipes 15 are buried in the grooves as shown in Fig. 5. Alternatively, cylindrical holes are formed in a hot roller rotor 11B so that heat pipes 15 are buried as shown in Fig. 6. In this case, the heat pipes 15 may be arranged desirably and properly in accordance with the necessary heat characteristics and the processing property similarly to the case of Fig. 5.

In Fig. 4, the constituent parts the same as those in Fig. 3 are referenced correspondingly, excepting the hot roller roller rotor 11A which is changed in size from the hot roller rotor 11 of Fig. 3 in order to bury the heat pipes 15 in the inside of the hot roller rotor 11A, and the hot roller boss portion 3A which is also changed in its shape, size and the like from the hot roller boss portion 3 with the change of the hot roller rotor 11. The reference numeral of the cylindrical portion 3a integrally formed with the hot roller boss portion 3 is also changed into 3Aa.

In the foregoing configuration, the hot roller rotor 11A is rotated at a predetermined rotational speed by the motor function and the surface temperature of the hot roller rotor 11A is raised and kept by the heater coil 10 in the same manner as described in Fig. 3.

At the start of running, the heater coil 10 is supplied with electric power so that the temperature of the heater coil 10 rises and the heat is rapidly transmitted, by the function of the heat pipes 15, to an end portion 11Aa of the hot roller rotor 11A on the side opposite to the side where the heater coil 10 is attached.

Further, if the value of a current supplied to the heater coil 10 is controlled by means of a controller (not shown), the heat to be transmitted to the end portion 11Aa of the hot roller rotor 11A on the side opposite to the side where the heater coil 10 is attached can be rapidly controlled by the action of the heat pipes 15 so that temperature control can be carried out with high accuracy.

The foregoing explanation shows the fundamentals of the method and configuration for realizing the technical thought of the present invention, and therefore the method and configuration may be variously modified in structure.

For example, a modification is such that heat pipes are buried as shown in Embodiment 2. Although the description has been made above, in the explanation of Figs. 3 and 4, as to the motor built-in hot roller corresponding to the configuration which has been described in the first prior art example of Fig. 1, it will do to suitably modify the hot roller in accordance with the necessary condition of a system using the hot roller, the necessary condition of mechanism on which the hot roller is to be mounted, and the like, and in accordance with the technical thought of the present invention. For example, a suitably configured base is provided so that the hot roller can be mounted on a floor surface like in the case of the second prior art example of Fig. 2. That is, a hot roller 1B has such a configuration as illustrated in Embodiment 3 shown in Fig. 7.

In Embodiment 3 of Fig. 7, the constituent parts the same as those in Fig. 3 are referenced correspondingly, excepting that a base 16 is provided and the configuration of the hot roller boss portion 3 and the cylindrical portion 3a integrally formed with the hot roller boss portion 3 are changed and the reference numerals are therefore changed from 3 and 3a into 3B and 3Ba respectively.

As described above, according to the present invention, the heater coil is fixedly fitted onto the motor outer housing surface and the shaft of the motor rotor is connected to the rotary shaft of the hot roller rotor which is formed so as to cover the heater coil. Therefore, the whole length of the hot roller is shortened.

Further, when heat generated from the motor is used as the base of the heating energy of the heater coil, it is not necessary to provide any motor cooling fan. Accordingly, the effect by shortening the whole length of the hot roller is increased. Moreover, when heat generated from the motor is used as the base of the heating energy of the heater coil, the heat efficiency is improved.

In the case where a ceramic bearing is used as the shaft bearing of the motor rotor so as to perform oil-mist lubrication, it is not necessary to provide any cooling mechanism for the bearing. Furthermore, in the case where heat pipes are provided in the hot roller rotor, it is possible to make the temperature of the hot roller uniform rapidly.

Having such a configuration as described above, the present invention provides excellent effects as follows.

(1) No energy loss is generated because it is not necessary to provide any cooling fan for the hot roller rotor.

(2) When a ceramic bearing is used as the bearing so as to perform oil-mist cooling, it is not necessary to provide any cooling mechanism for the bearing and no energy loss is generated.

(3) Since the heat generated from the hot roller rotor portion can be used as the heat source for the hot roller, the thermal efficiency is improved.

(4) When heat pipes are buried in the hot roller rotor, heating of the hot roller rotor can be performed rapidly, stably and independently of the structural shape of and the interval between the heater coil and the hot roller rotor. It is therefore increase the degrees of freedom of the structure constituting the outer housing of the motor and the degrees of freedom of the configuration of the motor mechanism inside the housing.

(5) The whole efficiency of the hot roller can be improved by the foregoing effects (1) through (4).

(6) The shaft length of the hot roller can be shortened and the area efficiency in a factory is improved.

(7) The rotational speed of the motor can be reduced because the diameter of the hot roller can be increased. It is therefore easy to make design correspondingly to the critical rotational speed.

(8) Since the diameter of the hot roller can be increased not wastefully, the fly-wheel effect GD^2 can be increased so as to make the peripheral speed of the hot roller stable against voltage deviations and load variations.

Claims

1. A hot roller with a built-in motor, in which a heater coil (10) is fixedly fitted onto a surface of a structure constituting an outer housing of a motor acting as a hot roller driving rotary machine, and a motor rotor shaft (7) of the motor is connected to a hot roller rotary shaft (12) of a hot roller rotor (11, 11A, 11B) which is formed so as to cover said heater coil (10).

2. A motor built-in hot roller according to Claim 1, in which a ceramic bearing is used as a bearing (8a, 8b) of said motor rotor shaft (7) so as to perform oil-mist lubrication.

3. A motor built-in hot roller according to Claim 1, in which heat pipes (15) are provided in said hot roller rotor (11, 11A, 11B).

FIG. 1
PRIOR ART

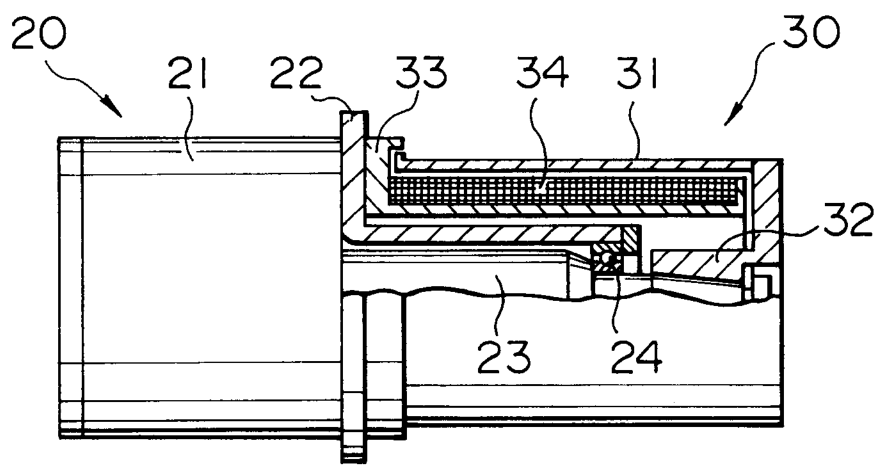

FIG. 2
PRIOR ART

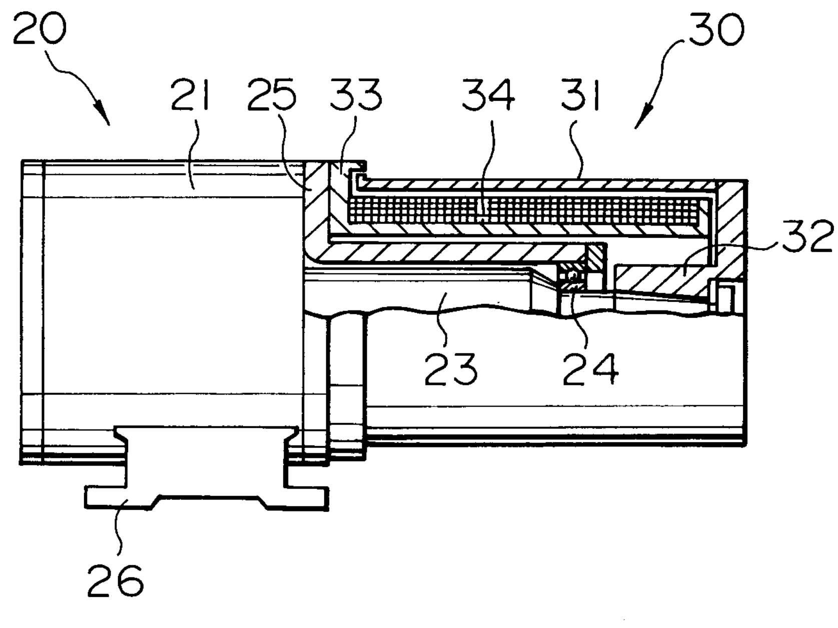

FIG. 3

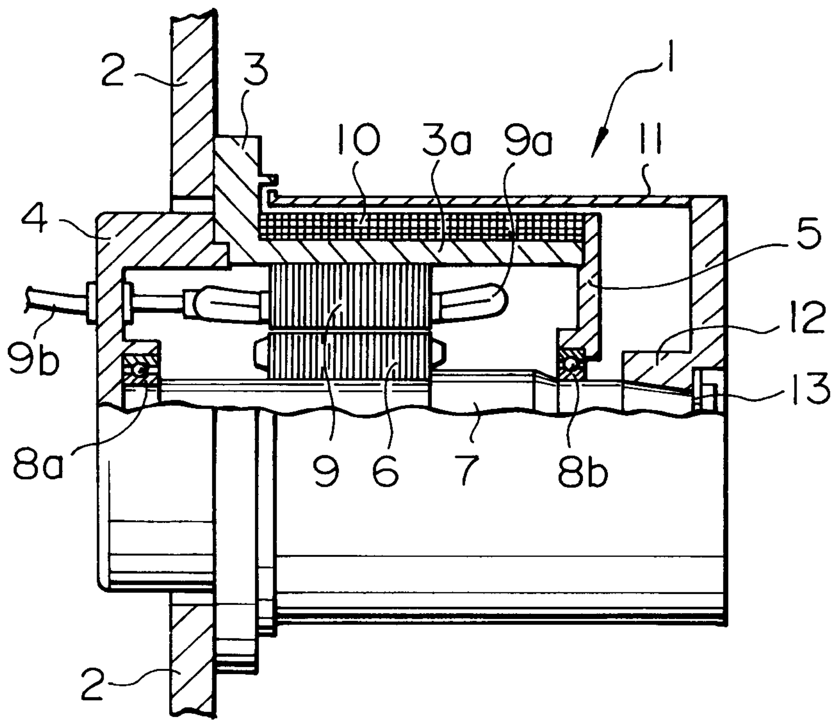
2
3
1
10
3a
9a
11
4
5
12
9b
13
8a
9
6
7
8b
2

FIG. 4

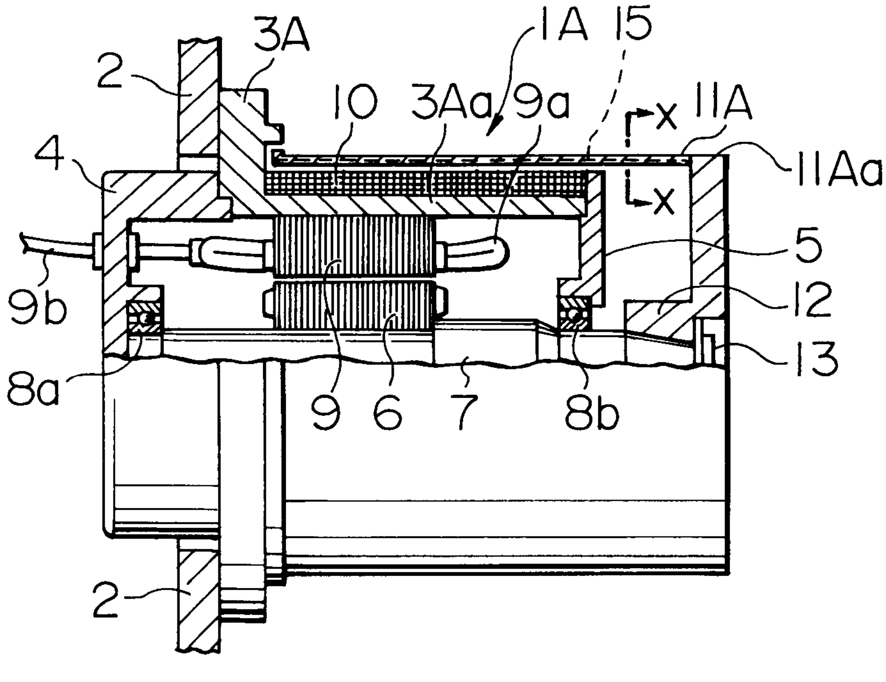
3A
2
1A
15
10
3Aa
9a
x
11A
4
11Aa
x
5
9b
12
13
8a
9
6
7
8b
2

FIG. 5

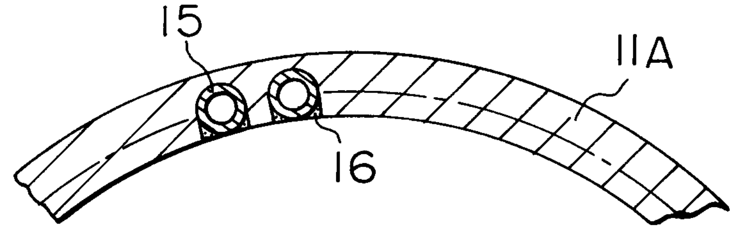

FIG. 6

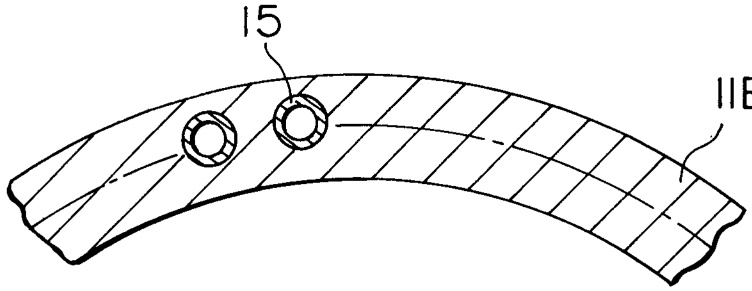

FIG. 7