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(54) Title: CYLINDRICAL SYMMETRIC POSITIVE DISPLACEMENT MACHINE

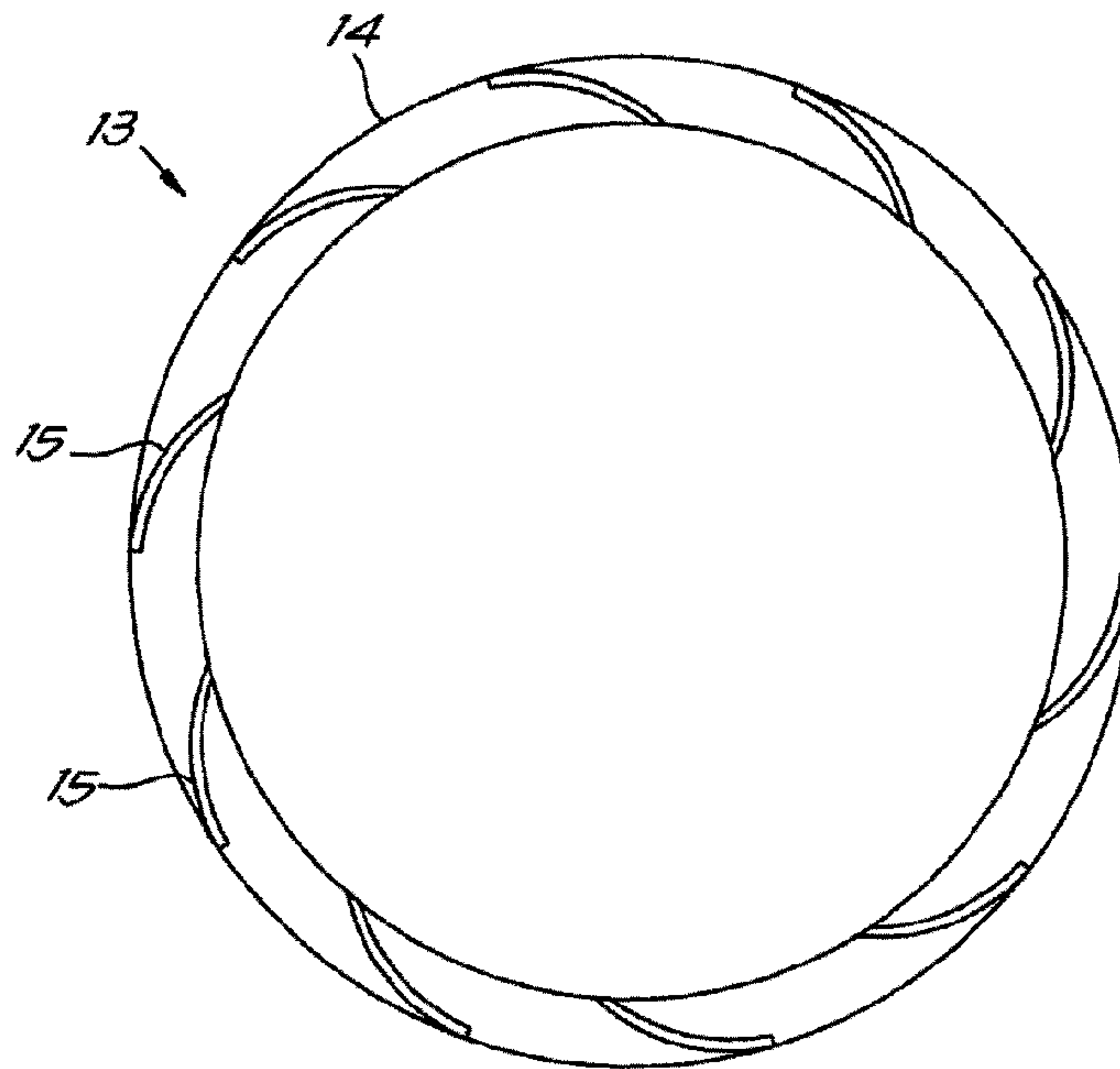


Fig. 2

(57) **Abrégé/Abstract:**

Cylindrical symmetric volumetric machine, which machine (1) comprises a housing (2) with two co-operating rotors (6a, 6b) therein, namely an outer rotor (6a) mounted rotatably in the housing (2) and an inner rotor (6b) mounted rotatably in the outer rotor (6a), whereby a compression chamber (8) is located between the rotors (6a, 6b), which will move by rotation of the rotors (6a, 6b) from the inlet side (9a) of the rotors (6a, 6b) to the outlet side (9b) of the rotors (6a, 6b), characterised in that the inlet side (9a) of the outer rotor (6a) is provided with a ventilator (12), to supply air to the compression chamber (8).

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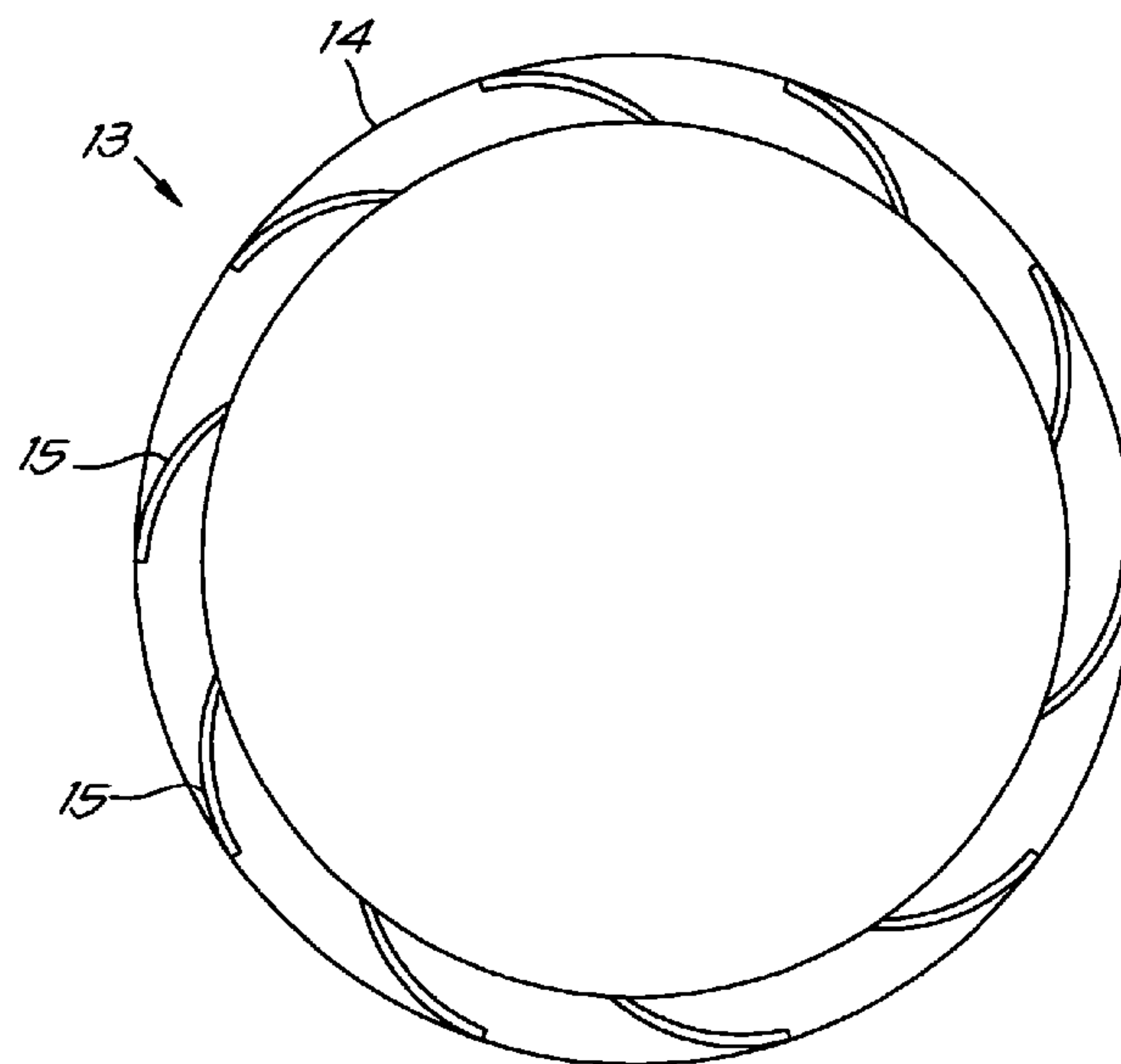
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*Fig. 2*

(57) Abstract: Cylindrical symmetric volumetric machine, which machine (1) comprises a housing (2) with two co-operating rotors (6a, 6b) therein, namely an outer rotor (6a) mounted rotatably in the housing (2) and an inner rotor (6b) mounted rotatably in the outer rotor (6a), whereby a compression chamber (8) is located between the rotors (6a, 6b), which will move by rotation of the rotors (6a, 6b) from the inlet side (9a) of the rotors (6a, 6b) to the outlet side (9b) of the rotors (6a, 6b), characterised in that the inlet side (9a) of the outer rotor (6a) is provided with a ventilator (12), to supply air to the compression chamber (8).

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WO 2019/058212 A1

WO 2019/058212 A1



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Cylindrical symmetric positive displacement machine

The present invention relates to a cylindrical symmetric
5 volumetric machine.

A volumetric machine is also known under the name "positive displacement machine".

10 In particular, the invention is intended for machines such as expanders, compressors and pumps with a cylindrical symmetry with two rotors, namely an inner rotor mounted rotatably in an outer rotor.

15 Such machines are already known and are described in US 1.892.217 among others. It is also known that the rotors can have a cylindrical or conical shape.

It is known that such machines can be driven with an
20 electric motor.

From Belgian patent application no. BE 2017/5459 it is already known that the electric motor can be mounted around the outer rotor, whereby the motor stator directly drives
25 the outer rotor.

Such machine has many advantages in relation to the known machines whereby the motor shaft is connected by means of a transmission with the rotor shaft of the outer or inner
30 rotor.

Thus, the machine will not only be a lot more compact, such that the footprint is smaller, it also means less shaft seals and bearings are required.

- 5 The efficiency of the machine is largely determined by the fill ratio of the so-called compression chamber, this is a space between the lobes of the rotors which will move by rotation of the rotors from the inlet side to the outlet side and thereby decreases in volume such that the gas
10 enclosed in the space will be compressed.

The purpose of the present invention is to improve the fill ratio of such machine.

- 15 To this end, the invention relates to a cylindrical symmetric volumetric machine, whereby the machine comprises a housing with two co-operating rotors therein, namely an outer rotor mounted rotatably in the housing and an inner rotor mounted rotatably in the outer rotor, whereby a
20 compression chamber is located between the rotors, which moves by rotation of the rotors from the inlet side to the outlet side, characterised in that the inlet side of the outer rotor is provided with a ventilator, to supply air to the compression chamber.

25

This provides the advantage that the ventilator will ensure a centripetal flow of air at the inlet, such that a better filling of the compression chamber is obtained.

- 30 Therefore, the performance of the machine will increase.

This will also offset any premature compression chamber volume reduction occurring before it closes.

Another advantage is that the actively sucked in air is
5 also suitable to cool, for example, a motor which drives the machine, the outlet or the oil that is used for the lubrication and/or cooling of components of the machine.

That can be realised by sending the sucked in air along or
10 via said components before it ends up in the compression chamber.

In a practical embodiment the outer rotor is provided with an attachment on its inlet side wherein the ventilator is
15 built in, which is attached to the outer rotor.

This attachment can consist of a hollow cylindrical element, which is placed with its axis in the extension of the axis of the outer rotor.

20

According to a preferred characteristic of the invention the outer rotor is mounted rotatably in the housing by means of a bearing on or to said attachment.

25 The advantage is that a smaller bearing can be used. Indeed, the attachment can itself be provided with a radially inward oriented collar, for example, such that the bearing can be attached to or on this collar.

30 With the intention of better showing the characteristics of the invention, a few preferred embodiments of a cylindrical symmetric volumetric machine according to the invention are

described hereinafter by way of an example, without any limiting nature, with reference to the accompanying drawings, wherein:

5 figure 1 schematically shows a cylindrical symmetric volumetric machine according to the invention;
figure 2 shows a cross-section according to line II-II of figure 1;
figure 3 schematically shows an alternative embodiment
10 of the section indicated in figure 1 with F3;
figure 4 schematically shows a variant of figure 3;
figure 5 schematically shows another variant of figure 3.

15 The machine 1 schematically shown in figure 1 is a compressor device in this case.

According to the invention it is also possible that the machine 1 relates to an expander device. The invention can
20 also relate to a pump device.

The machine 1 is a cylindrical symmetric volumetric machine 1. This means that the machine 1 has a cylindrical symmetry, i.e. the same symmetrical properties as a cone.

25

The machine 1 comprises a housing 2 that is provided with an inlet opening 3 to suck in gas to be compressed and with an outlet opening 4 for compressed gas. The housing defines a chamber 5.

30

Two co-operating rotors 6a, 6b, namely an outer rotor 6a mounted rotatably in the housing 2 and an inner rotor 6b

mounted rotatably in the outer rotor 6a are located in the chamber 5 in the housing 2 of the machine 1.

Both rotors 6a, 6b are provided with lobes 7 and can turn into each other co-operatively, whereby between the lobes 7 a compression chamber 8 is created, the volume of which can be reduced by the rotation of the rotors 6a, 6b, such that the gas that is caught in this compression chamber 8 is compressed. The principle is very similar to the known adjacent co-operating screw rotors.

During the rotation of the rotors 6a, 6b, said compression chamber 8 moves from one end 9a of the rotors 6a, 6b to the other end 9b of the rotors 6a, 6b.

The end 9a will also be referred to as the inlet side 9a of the inner and outer rotor 6a, 6b and the end 9b of the inner and outer rotor 6a, 6b will be referred to as the outlet side 9b in what follows.

In the example shown, the rotors 6a, 6b have a conical shape, whereby the diameter D , D' of the rotors 6a, 6b decreases in the axial direction $X-X'$. However, this is not necessary for the invention; the diameter D , D' of the rotors 6a, 6b can also be constant or vary in another way in the axial direction $X-X'$.

Such design of rotors 6a, 6b is suitable both for a compressor and expander device. Alternatively, the rotors 6a, 6b can also have a cylindrical form with a constant diameter D , D' . They can then either have a variable pitch, such that there is a built-in volume ratio, in the case of

a compressor or expander device, or a constant pitch, in the case the machine 1 relates to a pump device.

5 The axis 10 of the outer rotor 6a and the axis 11 of the inner rotor 6b are fixed axes 10, 11, this means that the axes 10, 11 will not move in relation to the housing 2 of the machine 1, however they do not run parallel, but are located at an angle α in relation to each other, whereby the axes intersect in point P.

10

However, this is not necessary for the invention. For example, if the rotors 6a, 6b have a constant diameter D, D', the axes 10, 11 can nevertheless run parallel.

15 According to the invention the inlet side 9a of the outer rotor 6a is provided with a ventilator 12, to supply air to the compression chamber 8.

20 This means that the ventilator 12 will turn with the outer rotor 6a, such that when the rotors 6a, 6b turn, the ventilator 12 will also start running.

In this case the ventilator 12 is a radial ventilator 12.

25 In the example shown in figures 1 and 2, the outer rotor 6a is provided with an attachment 13 on the inlet side 9a in which the ventilator 12 is built in, which is attached to the outer rotor 6a.

30 In this case, the attachment 13 comprises a hollow cylindrical form, which is placed with its axis in the extension of the axis 10 of the outer rotor 6a.

The attachment 13 has a wall 14 with a certain thickness A, whereby ventilator blades 15 have been mounted in this wall 14.

5

It is not excluded that the height of one or more of the blades 15 decreases axially from the inside to the outside in the radial direction.

10 In this way the reduced contour can be accommodated.

The rotors 6a, 6b are mounted on bearings in the machine 1, whereby the inner rotor 6b on one end 9a is mounted in the machine 1 on a bearing 16 and the other end 9b of the inner
15 rotor 6b is supported or borne by the outer rotor 6a as it were.

In the example shown, the outer rotor 6a is mounted at both ends 9a, 9b in the machine 1 with bearings 17, 18.

20

As shown in figure 1, the outer rotor at the inlet side 9a is mounted rotatably in the housing 2 by means of a bearing 17 on or to said attachment 13.

25 The attachment 13 is provided with a radially inward oriented collar 19, on which said bearing 17 is mounted.

Consequently this bearing 17 can be made much smaller, i.e. with a smaller diameter, compared to the case whereby the
30 bearing 17 is mounted directly on the outer rotor 6a itself.

Further, the machine 1 is also provided with an electric motor 20 which will drive the rotors 6a, 6b. This motor 20 is provided with a motor rotor 21 and a motor stator 22.

- 5 In this case, but not necessarily, the electric motor 20 is mounted around the outer rotor 6a whereby the motor stator 22 directly drives the outer rotor 6a.

10 In the example shown, this is realised because the outer rotor 6a also serves as motor rotor 21.

The electric motor 20 is provided with permanent magnets 23 which are embedded in the outer rotor 6a.

- 15 It is also possible of course that these magnets 23 are not embedded in the outer rotor 6a, but are mounted on the outside thereof for example.

20 Instead of an electric motor 20 with permanent magnets 23 (i.e. a synchronous permanent magnet motor), an asynchronous induction motor can also be applied, whereby the magnets are replaced with a squirrel-cage rotor. Induction from the motor stator generates a current in the squirrel-cage rotor.

25

On the other hand, the motor 20 can also be a reluctance type or induction type or a combination of types.

30 The motor stator 22 is mounted around the outer rotor 6a in a covering way, whereby in this case it is located in the housing 2 of the machine 1.

In this way the lubrication of the motor 20 and the rotors 6a, 6b can be controlled together, as they are located in the same housing 2 and consequently are not closed off from each other.

5

The operation of the device 1 is very simple and as follows.

During the operation of the machine 1, the motor stator 22
10 will drive the motor rotor 21 and therefore drive the outer rotor 6a in the known way.

The outer rotor 6a will help drive the inner rotor 6b, and by the rotation of the outer rotor 6a, the ventilator 12
15 will also turn.

Due to the operation of the ventilator 12 gas will be sucked in via the inlet opening 3. This gas will end up in the compression chamber 8 between the rotors 6a, 6b.
20

Because the ventilator 12 will ensure an active supply or flow of gas, the fill ratio of the compression chamber 8 will be increased.

25 Furthermore, the gas, when the gas is sucked in via the inlet opening 3, will flow past the motor rotor 21 and the motor stator 22. In this way the gas will be able to ensure an active cooling of the motor 20.

30 Due to the rotation this compression chamber 8 moves to the outlet 4 and at the same time will reduce in terms of volume to thus realise a compression of the gas.

The compressed gas can then exit the machine 1 via the outlet opening 4.

- 5 It is not excluded that during the compression, liquid is injected in the machine 1.

Said liquid can both be water and a synthetic or non-synthetic oil.

10

Figure 3 shows an alternative embodiment of the ventilator 12, whereby it is now an axial ventilator 12.

- 15 In this case the attachment 13 is not cylindrical, but more conical. This, however, is not necessary. The axial ventilator 12 is built into the radially inward oriented collar 19.

- 20 In figure 4 the radial ventilator 12 of figure 1 is shown in combination with an additional axial ventilator 12a which are placed in series with each other.

- 25 In this case the additional axial ventilator 12a is placed in front of the radial ventilator 12, seen in the flow direction of the sucked in air. It is also possible of course that the radial ventilator 12 is placed in front of the additional axial ventilator 12a.

- 30 The additional axial ventilator 12a is mounted around the attachment 13.

Figure 5 shows an additional variant whereby in this case the ventilator 12 is a mixed axial-radial ventilator 12, whereby the blades 15 have both an axial and a radial section.

5

The operation of the ventilator 12 in the embodiments of figures 3 to 5 is analogue to the operation of the embodiment in figures 1 and 2.

10 The present invention is by no means limited to the embodiments described as an example and shown in the drawings, but a cylindrical symmetric volumetric machine according to the invention can be realised in all kinds of forms and dimensions, without departing from the scope of
15 the invention.

Claims.

1.- Cylindrical symmetric volumetric machine, which machine
5 (1) comprises a housing (2) with two co-operating rotors
(6a, 6b) therein, namely an outer rotor (6a) mounted
rotatably in the housing (2) and an inner rotor (6b)
mounted rotatably in the outer rotor (6a), whereby a
compression chamber (8) is located between the rotors (6a,
10 6b), which will move by rotation of the rotors (6a, 6b)
from the inlet side (9a) of the rotors (6a, 6b) to the
outlet side (9b) of the rotors (6a, 6b), characterised in
that the inlet side (9a) of the outer rotor (6a) is
provided with a ventilator (12), to supply air to the
15 compression chamber (8).

2.- Cylindrical symmetric volumetric machine according to
claim 1, characterised in that the outer rotor (6a) is
provided with an attachment (13) on its inlet side (9a) in
20 which the ventilator (12) is built in, and which is
attached to the outer rotor (6a).

3.- Cylindrical symmetric volumetric machine according to
claim 2, characterised in that the outer rotor (6a) is
25 mounted rotatably in the housing (2) by means of a bearing
(17) on or to said attachment (13).

4.- Cylindrical symmetric volumetric machine according to
any one of the previous claims, characterised in that the
30 ventilator (12) is a radial ventilator (12).

5.- Cylindrical symmetric volumetric machine according to claim 4, characterised in that an additional axial ventilator (12a) is provided in series with said radial ventilator (12).

5

6.- Cylindrical symmetric volumetric machine according to any one of the previous claims 1 to 3, characterised in that the ventilator (12) is an axial ventilator (12).

10 7.- Cylindrical symmetric volumetric machine according to any one of the previous claims 1 to 3, characterised in that the ventilator (12) is a mixed axial-radial ventilator (12), whereby the blades (15) have both an axial and radial section.

15

8.- Cylindrical symmetric volumetric machine according to any one of the previous claims, characterised in that the ventilator (12) comprises a number of blades (15), the height of which decreases axially from the inside to the
20 outside in the radial direction.

9.- Cylindrical symmetric volumetric machine according to any one of the previous claims, characterised in that the inner rotor (6b) and the outer rotor (6a) have a conical
25 shape.

10.- Cylindrical symmetric volumetric machine according to any one of the previous claims, characterised in that the machine (1) is provided with an electric motor (20) with a
30 motor rotor (21) and motor stator (22) to drive the inner and outer rotor (6a, 6b), whereby the electric motor (20)

is mounted around the outer rotor (6a), whereby the motor stator (22) directly drives the outer rotor (6a).

11.- Cylindrical symmetric volumetric machine according to
5 claim 10, characterised in that the outer rotor (6a) serves as the motor rotor (21).

12.- Cylindrical symmetric volumetric machine according to
claim 11, characterised in that the electric motor (20) is
10 provided with permanent magnets (23) embedded in the outer rotor (6a).

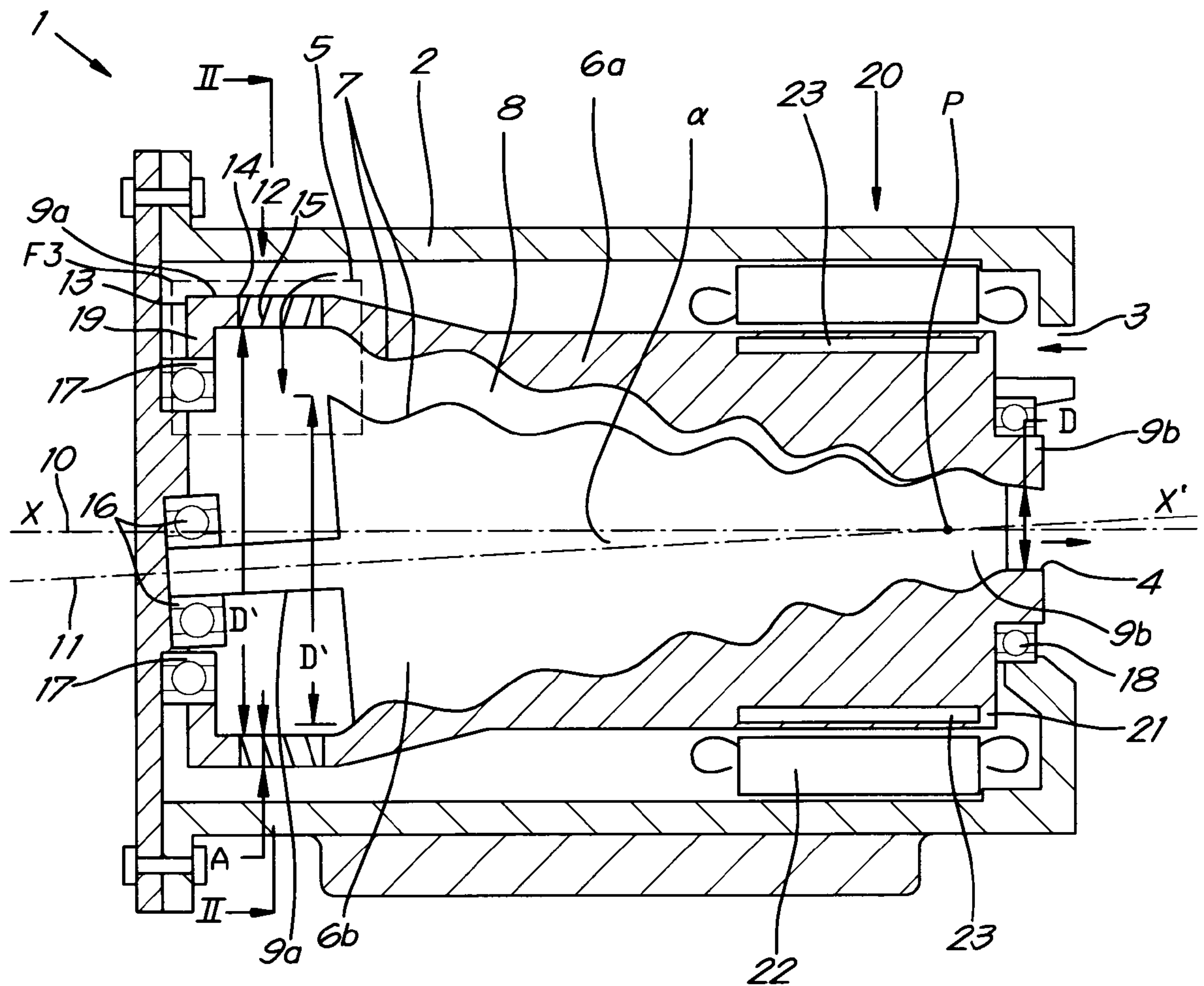
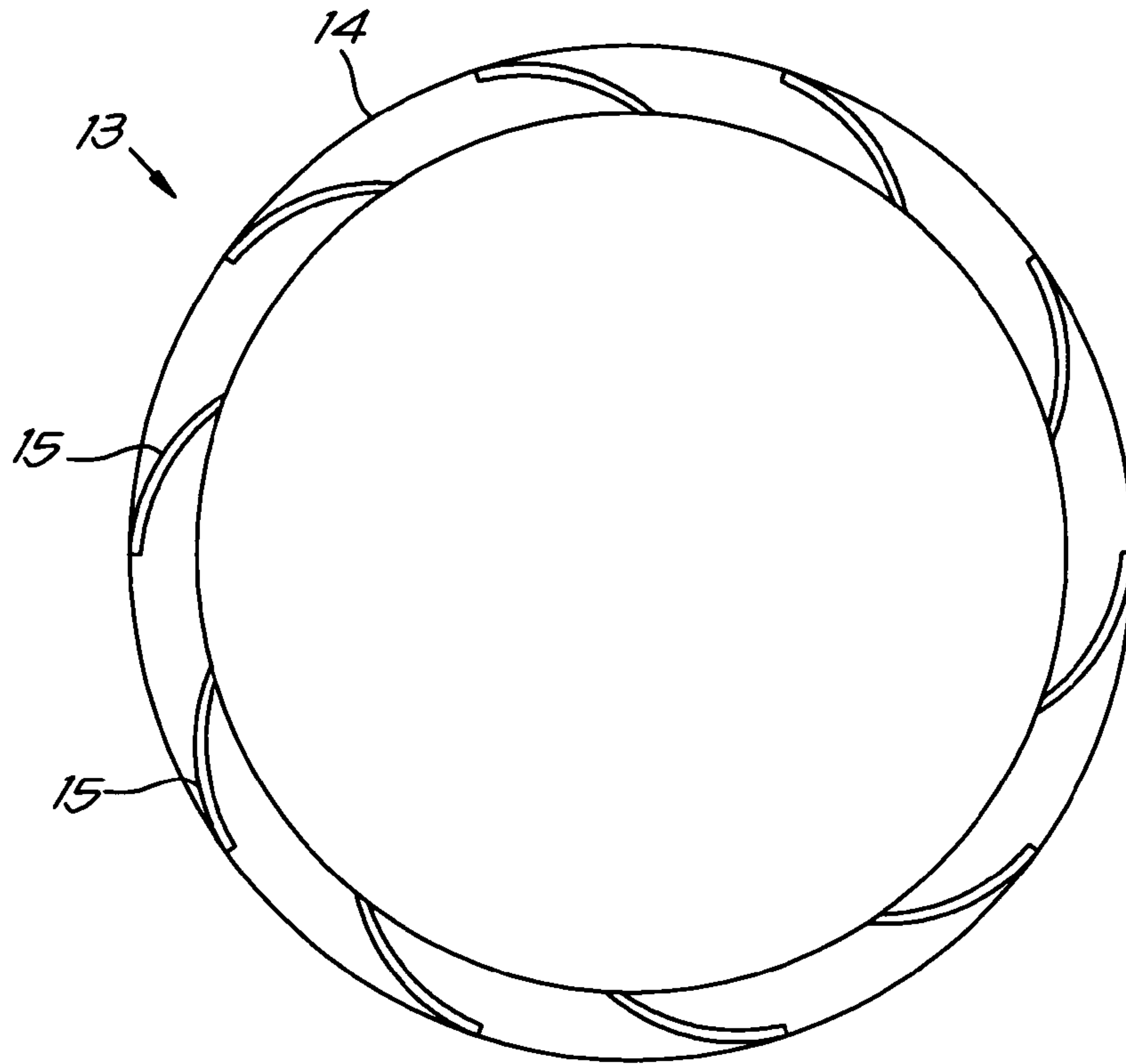
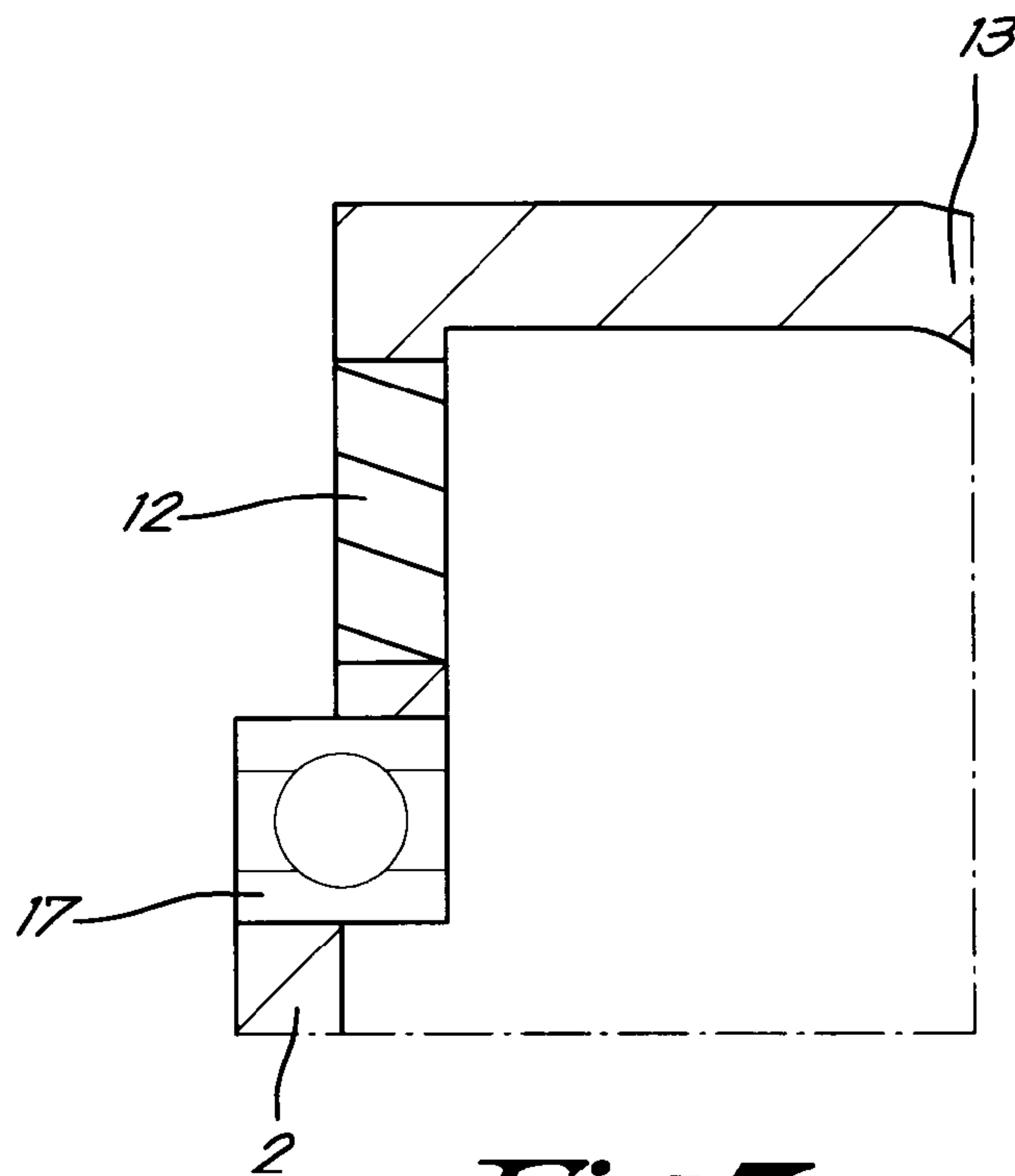
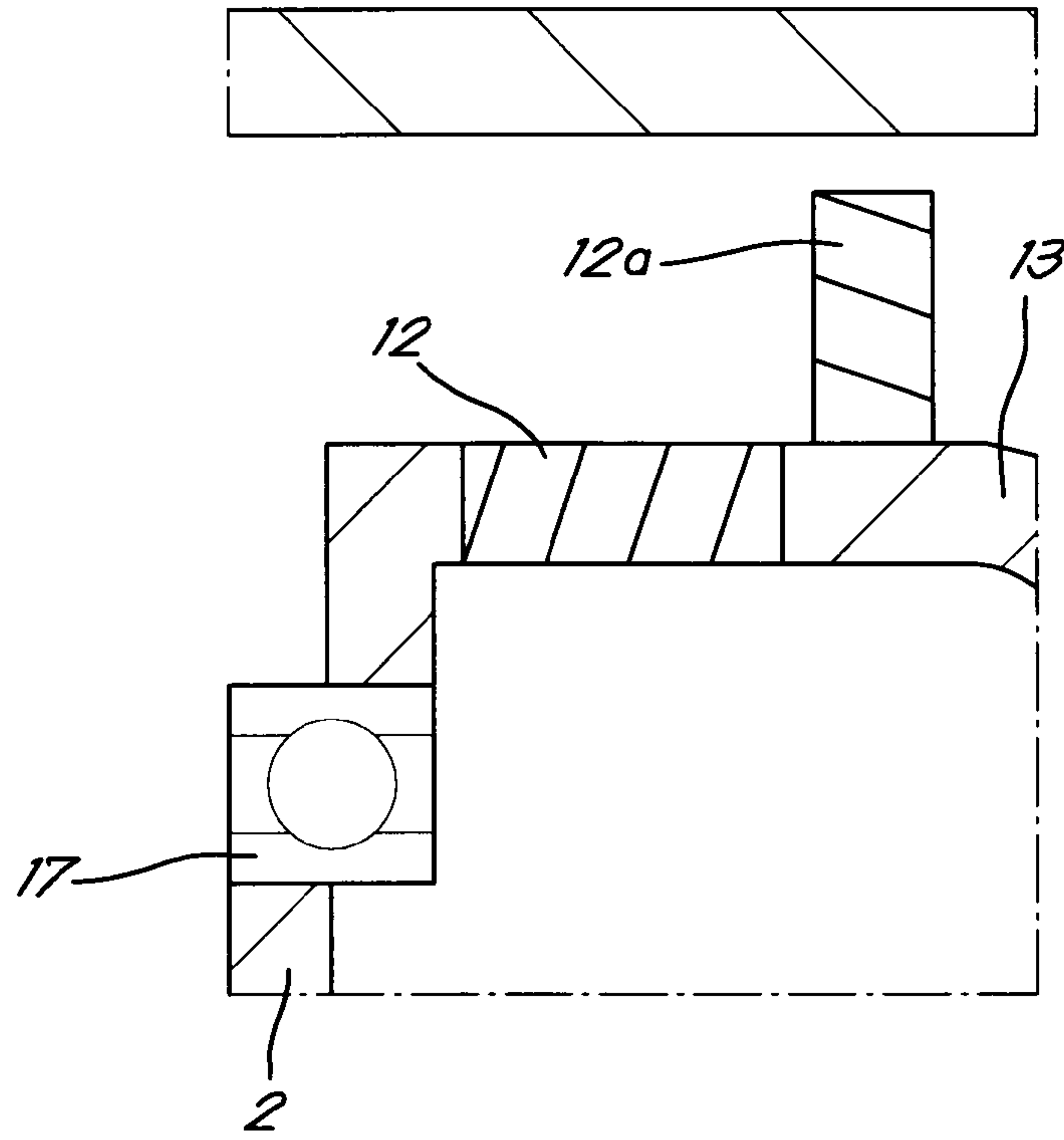
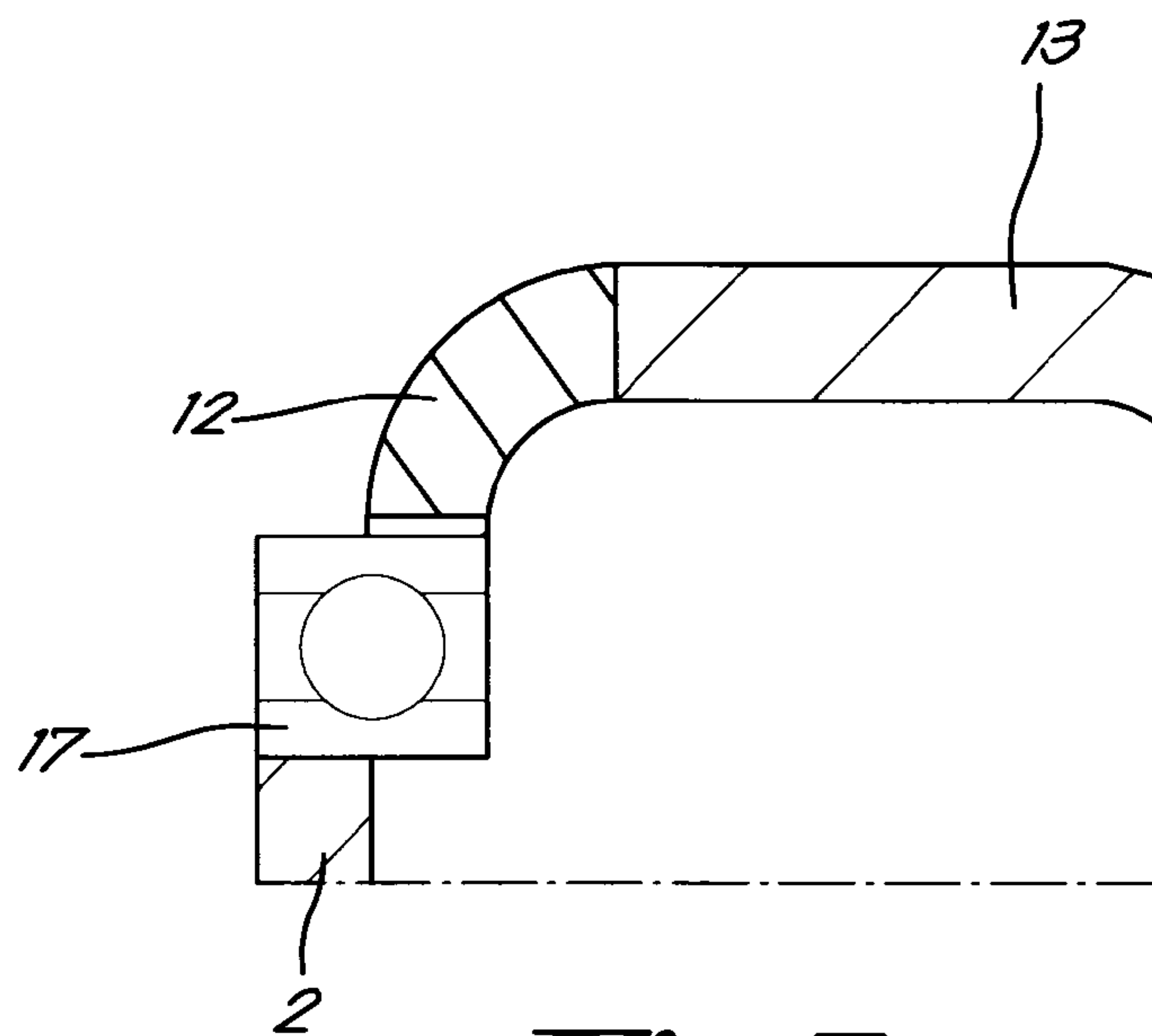


Fig. 1

*Fig. 2**Fig. 3*

*Fig. 4**Fig. 5*

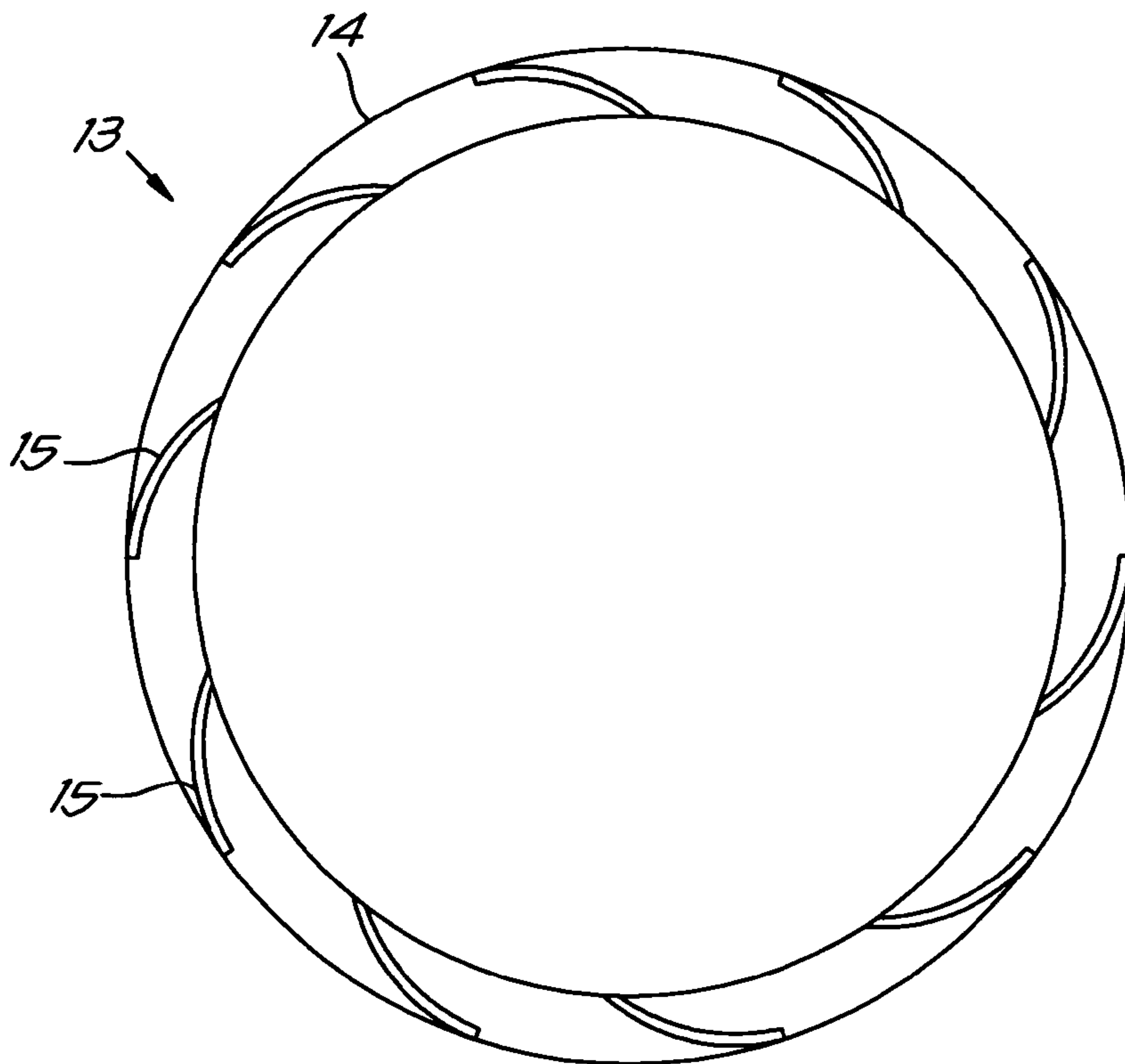


Fig. 2