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(71) **Demandeurs/Applicants:**
PANSOLINI, GIANPIERO, IT;
TOMMASINI, FRANCO, ER
(72) **Inventeur/Inventor:**
TOMMASINI, FRANCO, ER
(74) **Agent:** SHAPIRO COHEN LLP

(54) **Titre : POMPE A ENGRENAGES VOLUMETRIQUE**
(54) **Title: POSITIVE DISPLACEMENT GEAR PUMP**

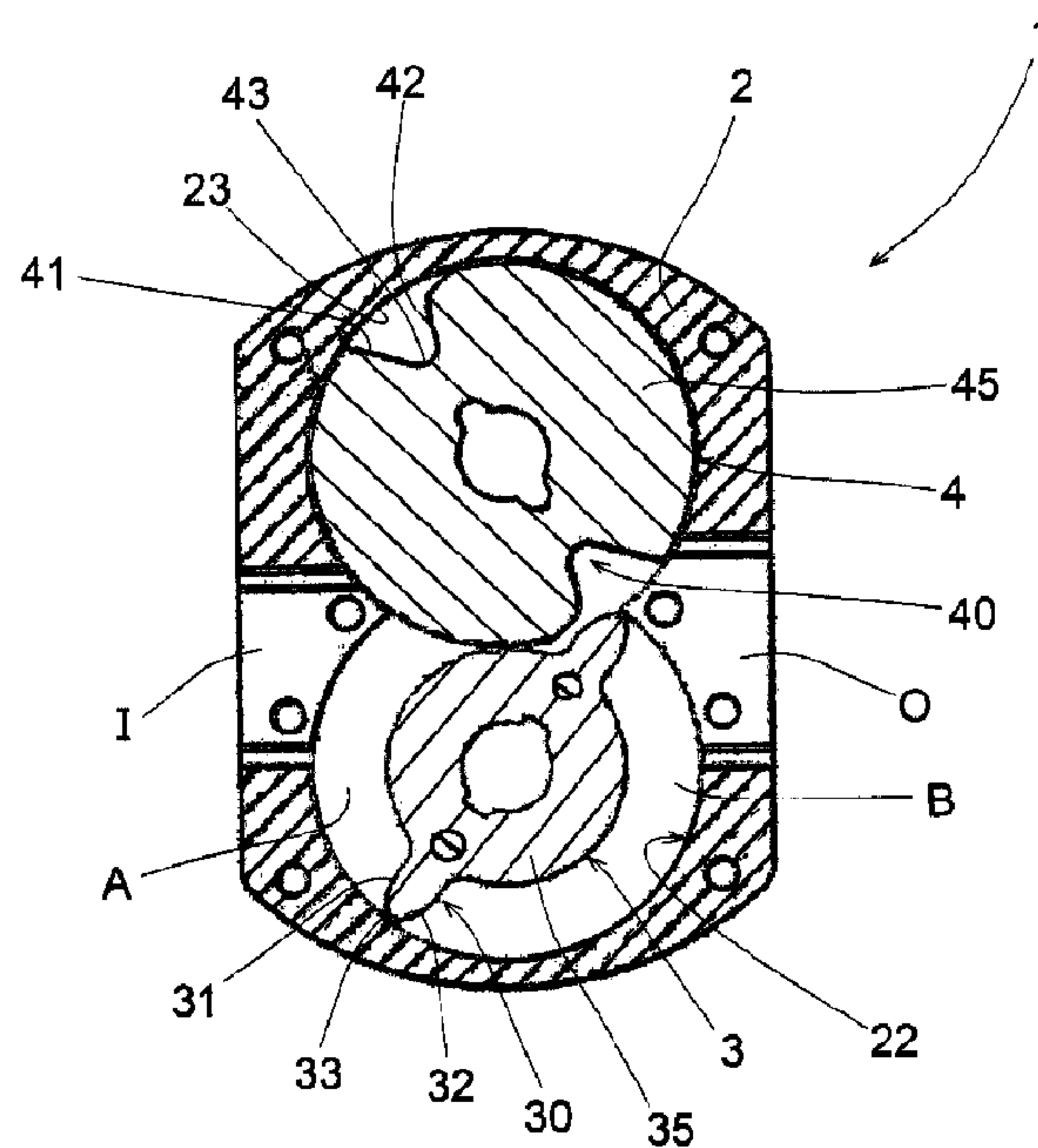


FIG. 3

(57) **Abrégé/Abstract:**

A positive displacement pump (1) comprises a casing with a central body (2) and two closing lids (20), said central body (2) being provided with two cylindrical communicating chambers (22, 23), one suction pipe (I) and one discharge pipe (O), and two rotors (3, 4) revolvingly mounted in said chambers (22, 23) of the central body and supported by shafts (5, 6) revolvingly mounted in said closing lids (20). The two rotors comprise: a male rotor (3) comprising only protuberances (30), not cavities, and a female rotor (4) comprising only cavities (40), not teeth or protuberances.

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- (71) Applicant: PANSOLINI, Gianpiero [IT/IT]; 155, Strada della Civitella, I-05100 Terni (TR) (IT).
- (72) Inventor; and
(71) Applicant : TOMMASINI, Franco [IT/ER]; 5, Shawit, Asmara - Eritrea (ER).
- (74) Agent: BALDI, Claudio; 13, Viale Cavallotti, I-60035 Jesi (AN) (IT).

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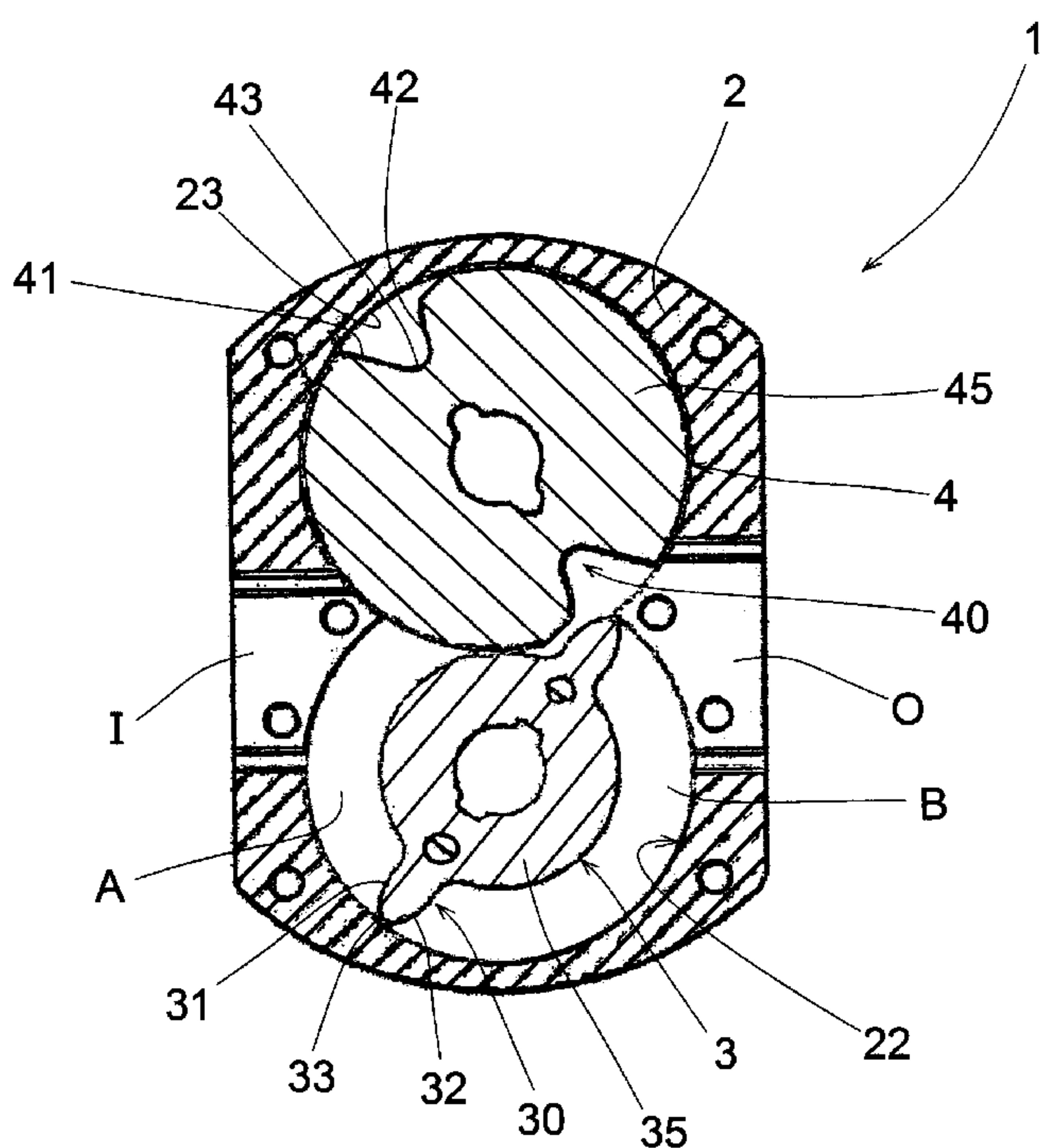


FIG. 3

(57) Abstract: A positive displacement pump (1) comprises a casing with a central body (2) and two closing lids (20), said central body (2) being provided with two cylindrical communicating chambers (22, 23), one suction pipe (I) and one discharge pipe (O), and two rotors (3, 4) revolvingly mounted in said chambers (22, 23) of the central body and supported by shafts (5, 6) revolvingly mounted in said closing lids (20). The two rotors comprise: a male rotor (3) comprising only protuberances (30), not cavities, and a female rotor (4) comprising only cavities (40), not teeth or protuberances.

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Description

Positive displacement gear pump.

The present patent application for industrial invention relates to a positive displacement gear pump.

Various types of positive displacement pumps with internal gears are known on the market, being used to transport liquid or gaseous fluids from a suction pipe to a discharge pipe of the pump.

Fig. 1 shows a positive displacement gear pump according to the prior art, generally indicated with reference numeral (101). The pump (101) comprises a casing (102) with suction pipe (I) and discharge pipe (O). Two identical rotors (103) are mounted inside the casing (102). Each rotor (103) comprises a gear composed of a toothed wheel. Each rotor comprises a plurality of linear or helicoidal teeth (130) that define a plurality of cavities (131) between said teeth (130).

The two gears (103) are engaged in such manner that the teeth (130) of one gear are engaged into the cavities (131) of the other gear, and vice versa. So the fluid enters the suction pipe (I) and comes out of the discharge pipe (O).

This type of positive displacement pumps of the prior art is impaired by drawbacks caused by fluid encapsulation. As a matter of fact, the fluid treated by the pump is trapped in the cavities of the rotor and compressed by the teeth of the other rotor, thus generating micro-explosions. Said micro-explosions considerably reduce the number of rotor revolutions, causing a considerable wear of the rotors and generating failure points in the rotor toothing.

Vane pumps are additionally known, comprising a rotor provided with cavity in which vanes slide radially. The rotor is mounted eccentrically with respect to the seat of the casing where it is housed and the vanes are stressed by springs or by the centrifugal force towards the surface of the rotor housing.

Said vane pumps permit a limited number of revolutions, cause early wear of vanes and require oil lubrication and consequently a separator to separate oil from the fluid treated by the pump.

The purpose of the present invention is to overcome the drawbacks of the prior art, by disclosing a positive displacement gear pump capable of
5 avoiding fluid encapsulation.

Another purpose of the present invention is to obtain such a positive displacement gear pump that is able to operate with a high number of revolutions and is extremely reliable and safe.

10 These purposes are achieved according to the invention with the characteristics claimed in the attached independent claim 1.

Advantageous embodiments appear from the dependent claims.

The positive displacement pump of the invention comprises:

- a casing that comprises a central body and two closing lids, said
15 central body being provided with two communicating cylindrical chambers, one suction pipe and one discharge pipe, and

- two rotors revolvingly mounted in said chambers of the central body and supported by corresponding shafts revolvingly mounted and supported in said closing lids.

20 The two rotors comprise:

- a male rotor that only comprises protuberances, not cavities, and
- a female rotor that only comprises cavities, not protuberances or
teeth.

The male rotor is engaged with the female rotor, i.e. the protuberances
25 of the male rotor are engaged in the cavities of the female rotor without contact between the two rotors.

The provision of male rotor and female rotor avoids fluid encapsulation in the cavities of the female rotor. Consequently, the pump of the invention can be used at a high number of revolutions, with minimum stress for
30 mechanical moving parts.

Additional characteristics of the invention will appear evident from the detailed description below, with reference to the attached drawings, which have an illustrative, not limitative purpose only, wherein:

Fig. 1 is cross-sectional view of a positive displacement gear pump according to the prior art;

Fig. 2 is an exploded perspective view of the positive displacement gear pump according to the invention;

Fig. 3 is a cross-sectional view of the pump of Fig. 2 in assembled condition;

Fig. 4 is an exploded view of a male rotor of the pump shown in Fig. 2; and

Fig. 5 is an exploded perspective view of an additional embodiment of the pump shown in Fig. 2.

Referring now to Figs. 2, 3 and 4, a positive displacement pump according to the invention is disclosed, generally indicated with reference numeral (1).

The pump (1) comprises a casing provided with central body (2) sealed by means of two plate-shaped closing lids (20).

The central body (2) comprises two communicating cylindrical chambers (22; 23) in such manner to form a basically 8-shaped opening that is closed by the two lids (20). The central body is provided with two pipes (I, O) in communication with outside, respectively to suck and discharge the fluid treated by the pump.

A male rotor (3) and a female rotor (4) are disposed in the cylindrical chambers (22, 23) of the central body. The male rotor (3) comprises only protuberances (30), not cavities. Instead, the female rotor (4) comprises only cavities (40), not teeth or protuberances. The male rotor (3) is engaged with the female rotor, i.e. the protuberances (30) of the male rotor are engaged in the cavities (40) of the female rotor without contact between the two rotors.

The male and female rotors (3, 4) are mounted on corresponding shafts (5, 6). The shafts (5, 6) of the rotors are revolvingly supported on supports (bushes or bearings, not shown in the figures) provided in the seats

(24) of the lids (20).

Preferably, the shaft (6) of the female rotor is connected to a drive shaft. Therefore, the female rotor (4) is the driving gear and the male rotor (3) is the driven gear. However, also the shaft (5) of the male rotor can be
5 connected to a drive shaft. Moreover, both shafts (6, 5) of the rotors can be simultaneously connected to two drive shafts in such manner to obtain better torque distribution.

According to the rotation direction of the drive shaft, the pipes (I, O) of the central body can act as suction pipe or discharge pipe.

10 Advantageously, two external gears (7, 8) are disposed outside the casing and keyed to the shafts (5, 6) of the rotors. The external gears (7, 8) are engaging toothed wheels. The external gears allow for phasing the male and female rotors (3, 4), meaning that during the rotation of the two rotors, the protuberances (30) of the male rotor enter the cavities (40) of the female
15 rotor.

As shown in Fig. 3, the male rotor (3) comprises a cylindrical body (35) and a plurality of protuberances (30) radially protruding from the cylindrical body (35). Each protuberance (30) cross-sectionally comprises two involute-shaped sides (31, 32) converging into a rounded head (33). The two sides
20 (31, 32) of a protuberance are symmetrical with respect to a radial axis of symmetry passing through the head (32) of the protuberance.

Advantageously, the male rotor (3) comprises two protuberances (30) in diametrically opposite positions. In such a case, the chamber (22) of the central body of the casing defines a suction area (A) in communication with
25 the suction pipe (I) and a discharge area (B) in communication with the discharge pipe (O).

The female rotor (4) comprises a cylindrical body (45) wherein a plurality of radially extending cavities (40) is obtained. Each cavity (40) cross-sectionally comprises two involute-shaped sides (41, 42) joined into a bottom
30 surface (43) with concave shape. The profiles of the two sides (41, 42) of the cavity are not symmetrical with respect to a radial straight line passing through the bottom of the cavity. The involute-shaped profile of the inlet side

(41) has a higher curvature than the involute-shaped profile of the outlet side (42) of the cavity.

Advantageously, the female rotor (4) comprises two cavities (40) in diametrically opposite positions.

5 The heads (33) of the protuberances of the male rotor are very close to the internal surface of the cylindrical chamber (22). During operation, the heads (33) of the protuberances of the male rotor arrive at a short distance from the bottom (43) of the cavity, thus avoiding the passage of liquid. However, the heads (32) do not touch the internal surface of the cylindrical
10 chamber (22) or the bottom (43) of the cavity.

Moreover, the external surface of the cylindrical body (45) of the female rotor is almost tangent to the internal surface of the cylindrical chamber (23) of the central body of the casing, in such manner to avoid the passage of liquid.

15 Similarly, the external surface of the cylindrical body (45) of the female rotor is almost tangent to the external surface of the cylindrical body (35) of the male rotor.

The male rotor (3) and female rotor (4) are perfectly centered in the corresponding cylindrical chambers (22, 23) in such manner to leave a
20 tolerance space of 0.05 mm, preferably 0.02 mm, between the following parts:

- between the heads (33) of the protuberances of the male rotor and the internal surface of the cylindrical chamber (22) of the central body,

- between the heads (33) of the protuberances of the male rotor and the bottom surface (43) of the cavities of the female rotor,

25 - between the external surface of the cylindrical body (45) of the female rotor and the internal surface of the cylindrical chamber (23) of the central body of the casing,

- between the external surface of the cylindrical body (45) of the female rotor and the external surface of the cylindrical body (35) of the male rotor.

30 Fig. 3 shows an additional embodiment, wherein the head diameter (meaning the distance between the heads (33) of two diametrically opposite protuberances) of the male rotor (3) is identical to the diameter of the

cylindrical body (4) of the female rotor, in such manner to obtain two chambers (22, 23) with identical diameter and make synchronization of the two rotors easier. However, when the diameter of the cylindrical body (35) of the male rotor (3) is smaller than the diameter of the cylindrical body (45) of the female rotor (4), a minimum tolerance must be provided between the two cylindrical bodies (35, 45) because the peripheral speeds of the two cylindrical bodies (35, 45) are different and a contact between them would cause a considerable friction, preventing the rotation of the two rotors.

In order to remedy such a drawback, the diameter of the cylindrical body (35) of the male rotor can be identical to the diameter of the cylindrical body (45) of the female rotor. In this way, the peripheral speed of the two cylindrical bodies (35, 45) of the two rotors is identical and the tolerance between cylindrical bodies (35, 45) of the two rotors may be zero, thus allowing for contact between the cylindrical bodies (35, 45) of the two rotors during rotation. Consequently, losses are minimized and high rotational speeds are allowed. Moreover, in such a case, the chamber (22) that houses the male rotor (3) is larger than the chamber (23) that houses the female rotor (4), thus increasing the delivery capacity of the pump (1), while maintaining the same size of the protuberance module (31).

It must be noted that, because of the special configuration of the cavities (40) of the female rotor and because there are no contact parts between rotors (3, 4) and casing, the fluid is not trapped in the pump (1) and the pump (1) can operate at a high number of revolutions, thus reducing wear and failure of mechanical parts.

As shown in Fig. 4, the male rotor (3) can be made in different parts that are mutually assembled. For instance, seats (36) are obtained in the cylindrical body (35), cross-sectionally having a substantially C-shaped or dovetail profile.

In such a case, the protuberances (30) consist in sectors provided with a substantially parallelepiped base (34) that is engaged into the seat (36). The base (34) of the protuberance can be provided with ribs or grooves (34')

that are engaged with corresponding ribs or grooves (36') provided in the seat (36) of the cylindrical body of the male rotor.

The entire rotors (3, 4) or only the protuberances (30) and/or cavities (40) can undergo thermal and/or chemical treatments and can be coated with
5 suitable materials, such as hard metal, Widia, rubber, plastics, Teflon or ceramic.

As shown in Fig. 5, the pump (1) also comprises two seal gaskets (9) composed of 8-shaped plates made of anti-friction self-lubricating material. The seal gaskets (9) are disposed between the central body (2) and the lids
10 (20). The surface of the lids facing towards the central body is provided with suitable recessed seats (25) adapted to house the seal gaskets (9). Springs (90) are disposed in the seats (25) of the lids in such manner to stress the seal gaskets (9) towards the central body. In such a way, the seal gaskets (9) are stopped against the planar sides of the male and female rotors (3, 4).
15 Such a solution provides for tightness of the chambers (22, 23) obtained inside the central body (20), thus avoiding losses due to construction tolerance. In this way, if the rotors (3, 4) are coated with anti-friction self-lubricating material, the pump (1) can be used at a high number of revolutions, without oil and with minimum wear for mechanical moving parts.

20 Variations and modifications can be made to the present embodiments of the invention, within the reach of an expert of the field, while still falling within the scope of the invention.

Claims

1. A positive displacement pump (1) comprising:

- a casing that comprises a central body (2) and two closing lids (20), said central body (2) being provided with two communicating cylindrical chambers (22, 23), one suction pipe (I) and one discharge pipe (O), and

5 - two rotors (3,4) revolvingly mounted in said chambers (22,23) of the central body and supported by corresponding shafts revolvingly mounted in said closing lids (20),

characterized in that said two rotors (3, 4) comprise:

- a male rotor (3) that only comprises protuberances, not cavities, and

10 - a female rotor (4) that only comprises cavities, not protuberances or teeth,

wherein the male rotor (3) is engaged with the female rotor, i.e. the protuberances (30) of the male rotor are engaged in the cavities (40) of the female rotor without contact between the two rotors.

15 2. The pump (1) of claim 1, wherein said male rotor (3) comprises a cylindrical body (35) and a plurality of protuberances (30) that protrude radially from the cylindrical body and said female rotor (4) comprises a cylindrical body (45) and a plurality of cavities (40) that extend radially inside the cylindrical body.

20 3. The pump (1) of claim 2, wherein

- each protuberance (30) of the male rotor cross-sectionally comprises two involute-shaped sides (31, 32) converging into a rounded head (33), the two sides (31, 32) of a protuberance being symmetrical with respect to a radial axis of symmetry passing through the head (33) of the protuberance,

25 and

- each cavity (40) cross-sectionally comprises two involute-shaped sides (41, 42) joined into a bottom surface (43) with concave shape, wherein the profiles of the two sides (41, 42) of the cavity are not symmetrical with respect to a radial straight line passing through the bottom of the cavity, the

30 involute-shaped profile of the inlet side (41) having a higher curvature than

the involute-shaped profile of the outlet side (42) of the cavity.

4. The pump (1) of claim 3, wherein the male and female rotors (3, 4) are centered in the chambers (22, 23) of the central body in such manner to leave a tolerance space of 0.05 mm, preferably 0.02 mm, between the following parts:

- between the heads (33) of the protuberances of the male rotor and the internal surface of the cylindrical chamber (22) of the central body,
- between the heads (33) of the protuberances of the male rotor and the bottom surface (43) of the cavities of the female rotor,
- between the external surface of the cylindrical body (45) of the female rotor and the internal surface of the cylindrical chamber (23) of the central body of the casing,
- between the external surface of the cylindrical body (45) of the female rotor and the external surface of the cylindrical body (35) of the male rotor.

5. The pump (1) of any one of the preceding claims, wherein the male rotor (3) has two diametrically opposite protuberances (30) and the female rotor (4) has two diametrically opposite cavities (40).

6. The pump (1) of any one of the preceding claims, wherein the protuberances (30) of the male rotor are provided with heads (33) and the head diameter of the male rotor is identical to the diameter of the cylindrical body (4) of the female rotor.

7. The pump (1) of any one of claims 2 to 5, wherein the diameter of the cylindrical body (35) of the male rotor is identical to the diameter of the cylindrical body (45) of the female rotor.

8. The pump (1) of any one of the preceding claims, wherein the male rotor comprises a cylindrical body (35) provided with seats (36) and said protuberances (30) consist in sectors comprising a base (34) that is engaged in the seat (36) of the cylindrical body of the rotor.

9. The pump (1) of any one of the preceding claims, also comprising two external gears (7, 8) composed of toothed wheels keyed onto the shafts (5, 6) of the rotors outside said casing.

10. The pump (1) of any one of the preceding claims, also comprising:

- two plate-shaped seal gaskets (9) disposed between said central body (2) and said lids and

- springs (90) disposed between said lids (20) and seal gaskets (9) in such manner to stress the seal gaskets (9) against the planar sides of the
5 rotors (3, 4).

11. The pump (1) of claim 10, wherein said seal gaskets (9) and said rotors (3, 4) are coated with anti-friction self-lubricating material.

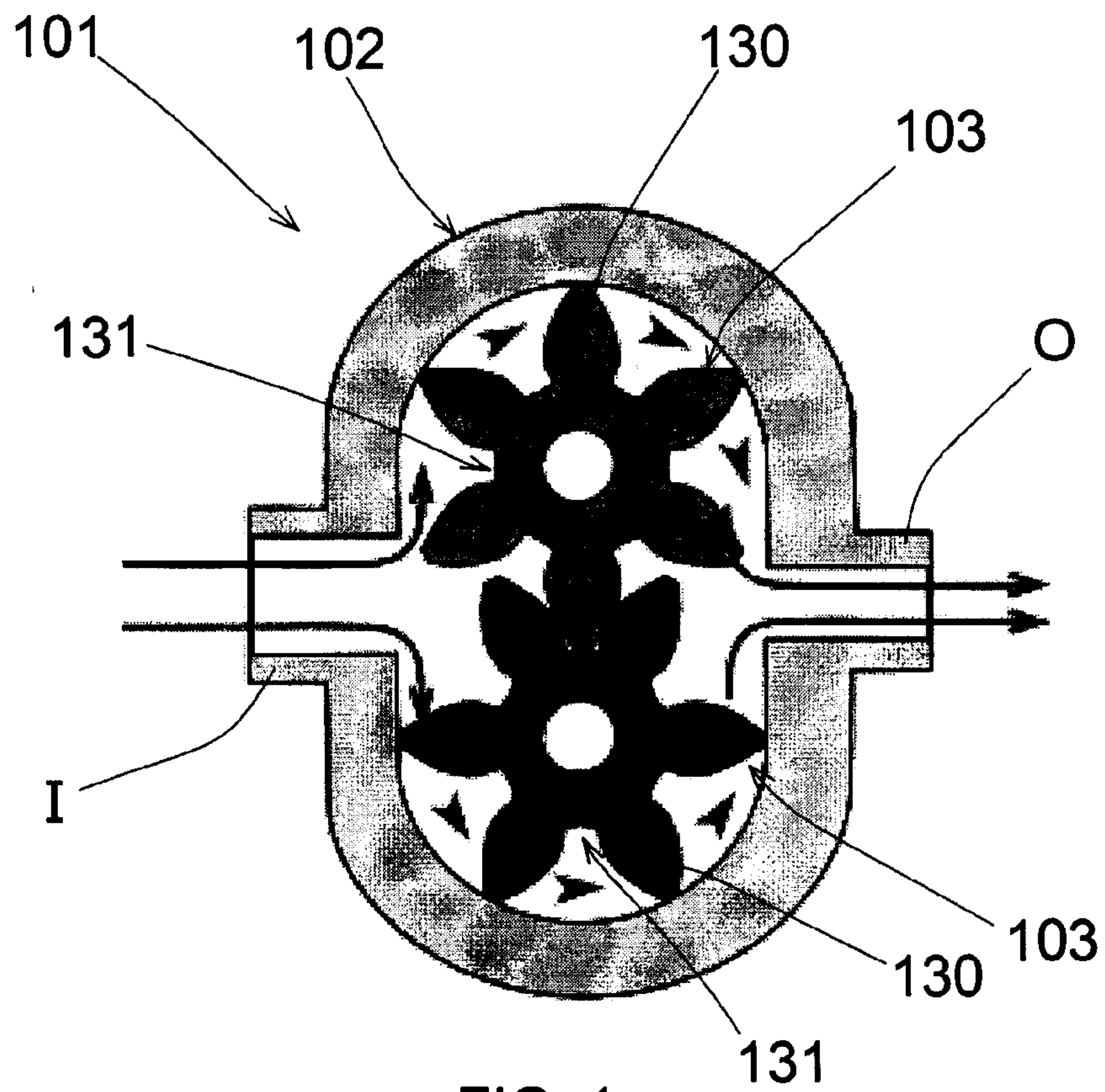


FIG. 1
PRIOR ART

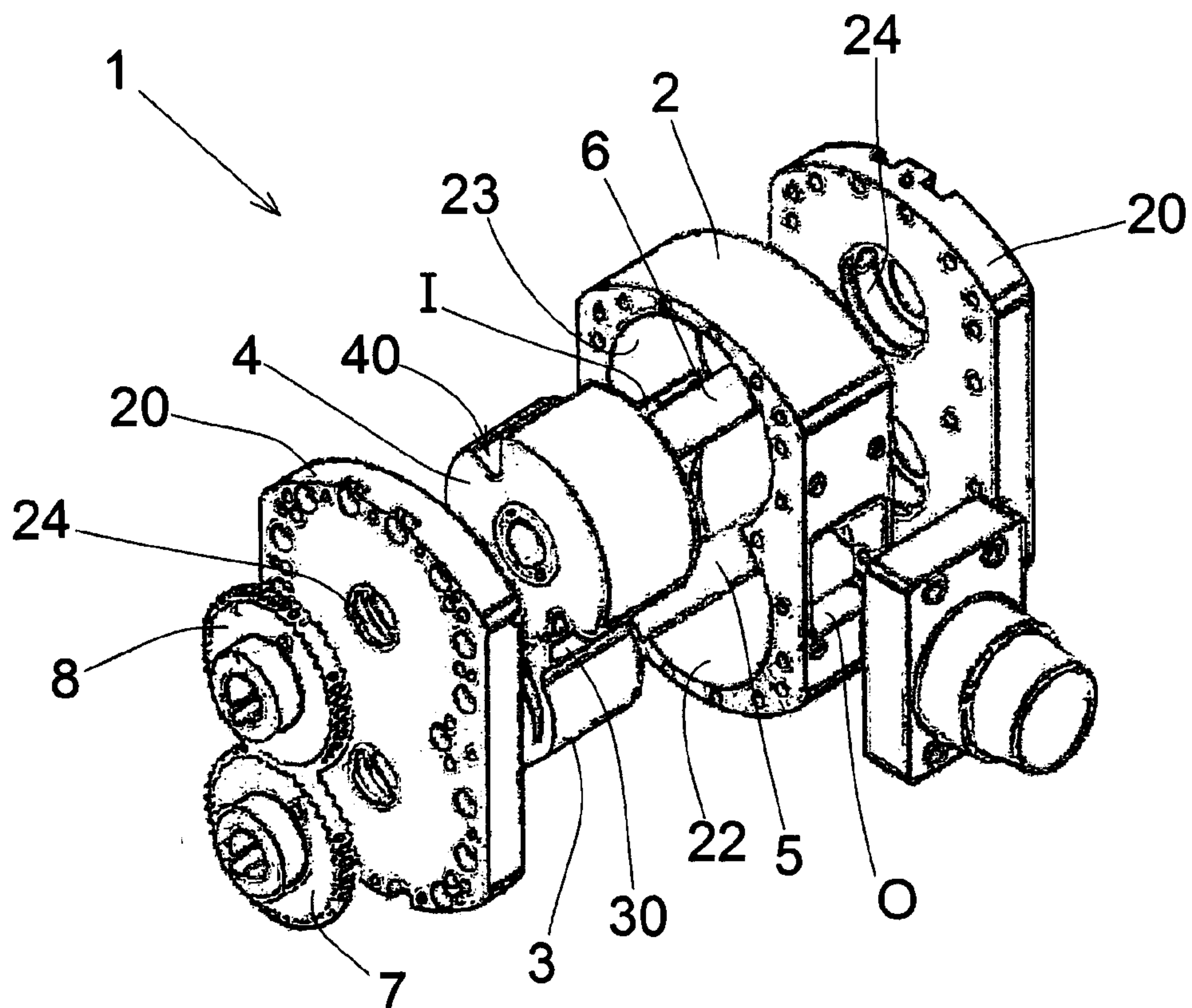


FIG. 2

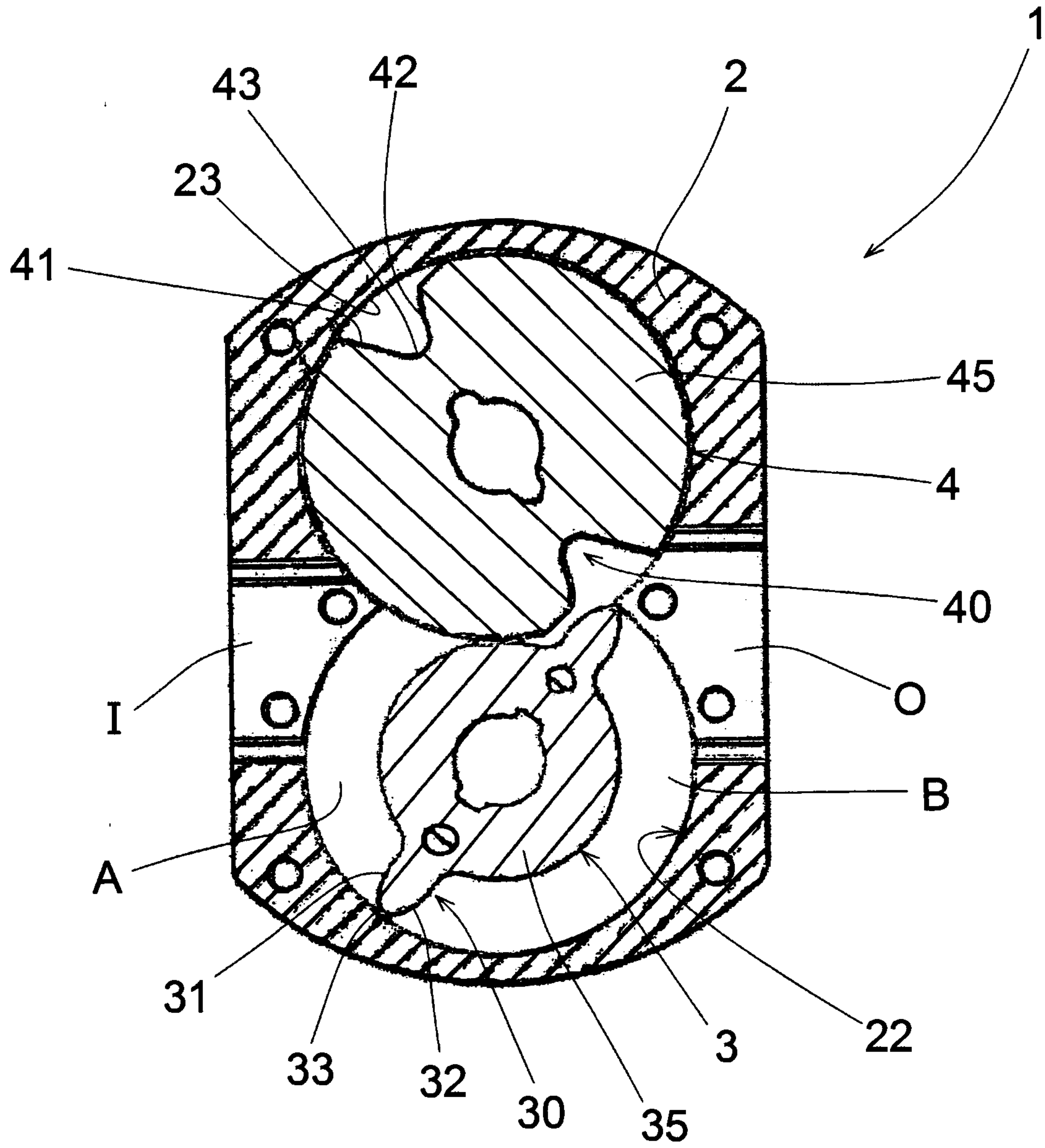


FIG. 3

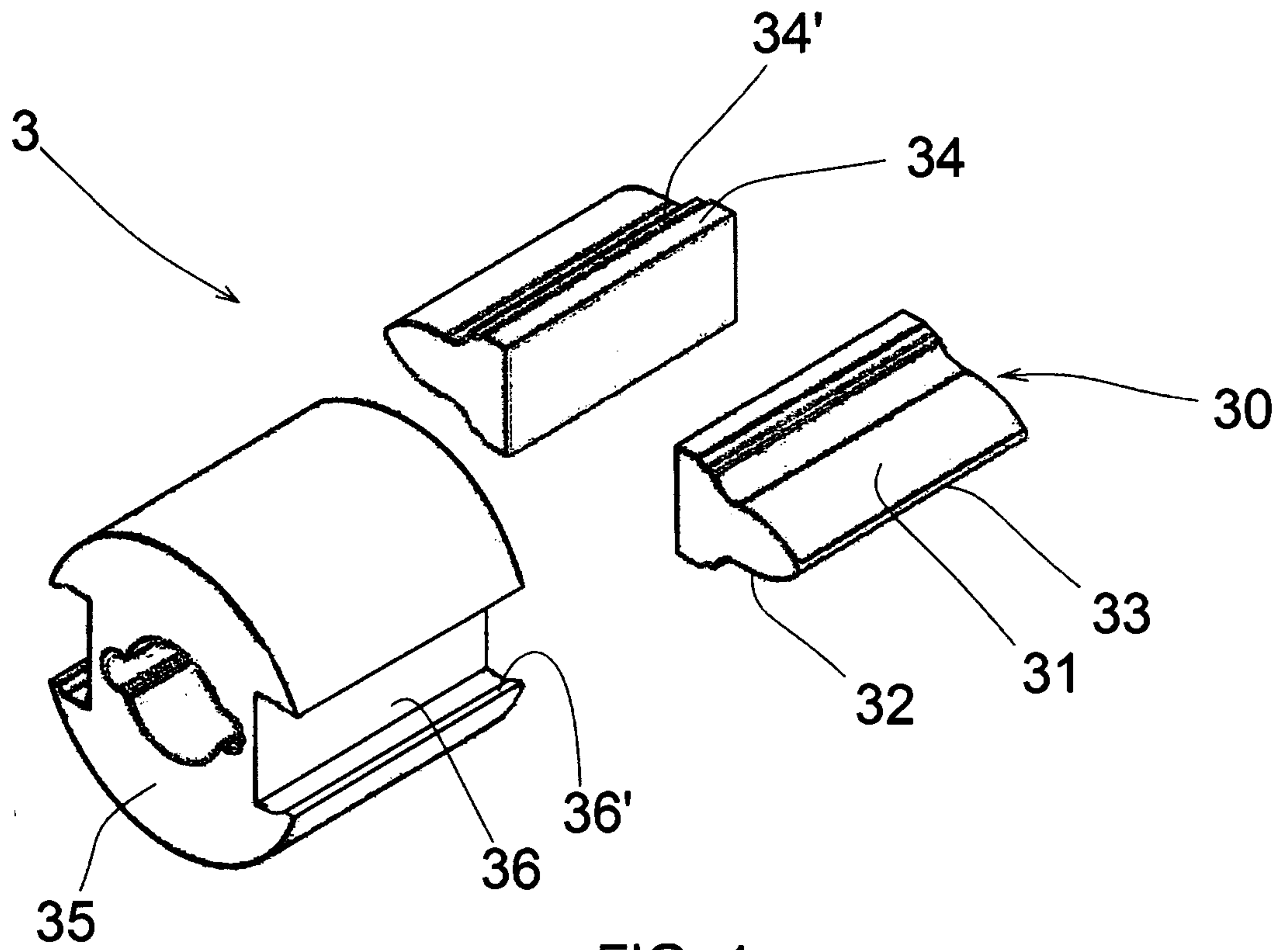


FIG. 4

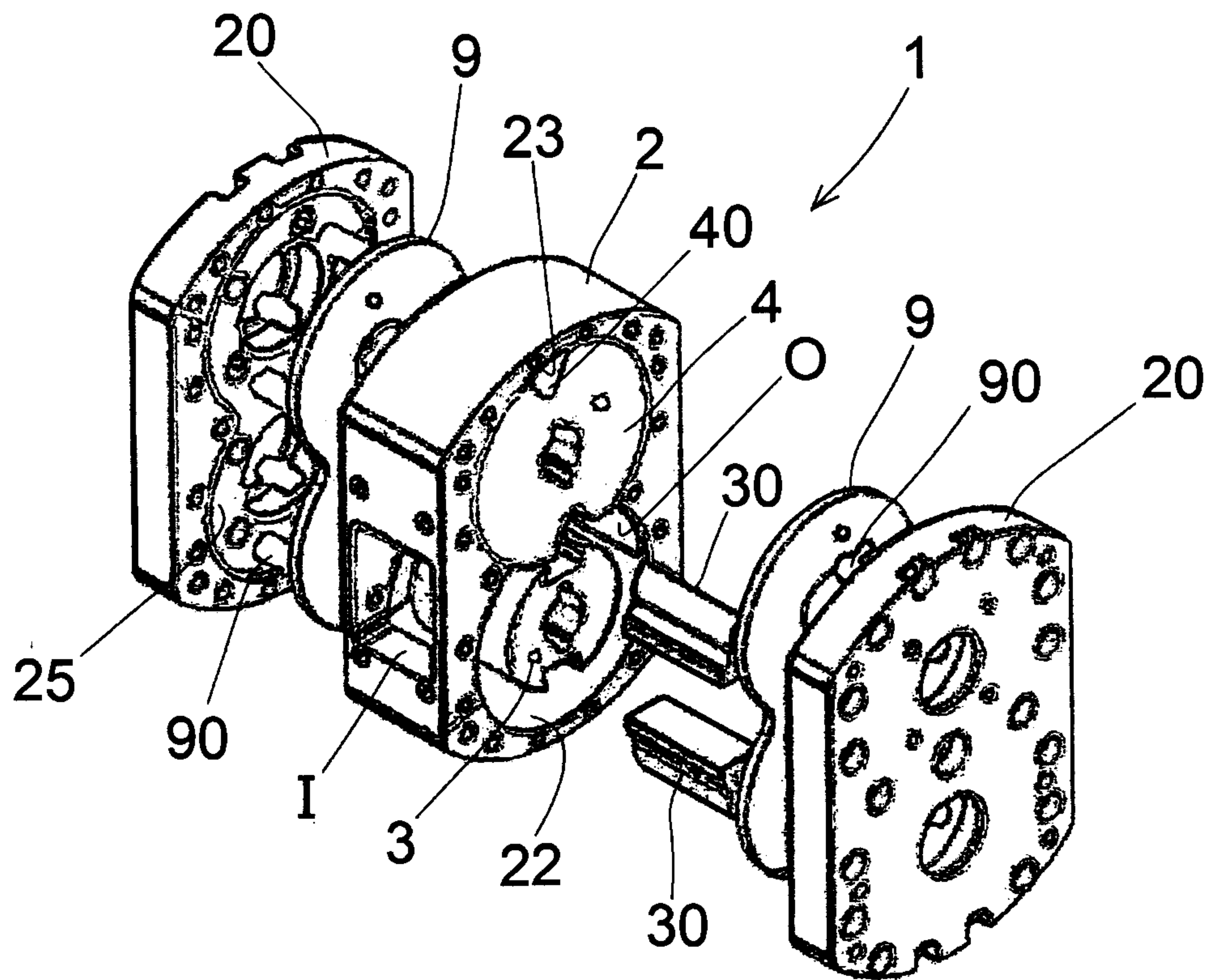


FIG. 5

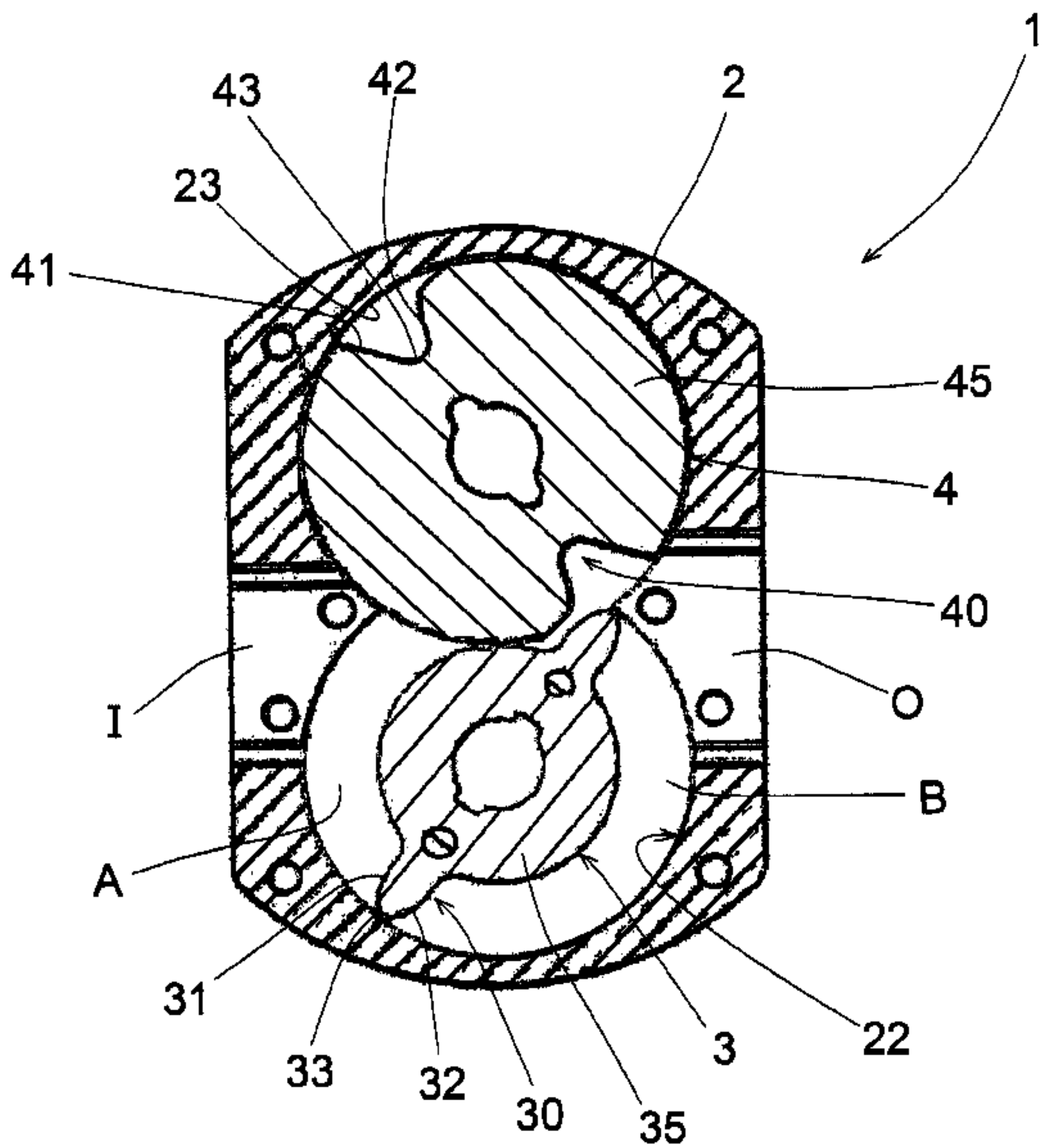


FIG. 3