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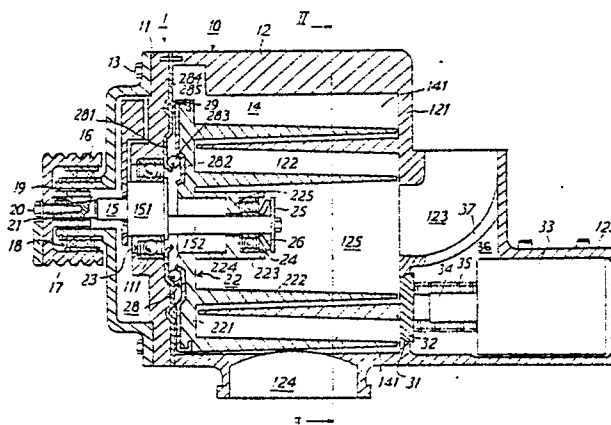
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Scroll type fluid displacement apparatus.

A scroll type fluid displacement apparatus is disclosed which includes a housing (10) having an inlet port (124) and an outlet port (123) connected with the interior (14) thereof, a fixed wrap (122) extending into the interior of the housing (10) from an end plate portion (121) of the housing (10), an orbiting scroll (122) orbitally disposed within the interior (14) with its wrap (222) and the fixed wrap (122) interfitting to form shifting sealed-off fluid pockets. In order to selectively connect between the lower pressure space (141) within the interior (14) and the center space (125) of both wraps, an opening portion (31) is formed through the end plate portion (121) of the housing (10), and a control means (32) is disposed in the opening portion (31) for controlling opening and closing the opening portion (31). Therefore, fluid displacement of the apparatus is controlled by the control means (32).



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SCROLL TYPE FLUID DISPLACEMENT APPARATUS

This invention relates to a fluid displacement apparatus, and more particularly, to a scroll type fluid displacement apparatus for use as a supercharger for a engine or as an air pump.

Scroll type fluid displacement apparatus are well known in the prior art. For example, U.S. Patent No. 801,182 (Creux) discloses a device including two scrolls each having a circular end plate and a spiroidal or involute spiral element. These scrolls are maintained angularly and radially offset so that both spiral elements interfit to make a plurality of line contacts between their spiral curved surfaces to thereby seal off and define at least one pair of fluid pockets. The relative orbital motion of the scrolls shifts the line contacts along the spiral curved surfaces and, as a result, the volume of the fluid pockets changes. Since, the volume of the fluid pockets increases or decreases dependent on the direction of the orbital motion, the scroll type fluid displacement apparatus is applicable to compress, expand or pump fluids.

Scroll type fluid displacement apparatus have been used as a refrigerant compressor in refrigerator or air conditioning apparatus. Such compressors need high efficiency and a high compression ratio, such as 5 to 10 compression ratio. In such a compressor, the re-expansion volume, i.e., the smallest volume of the fluid pockets in a compression cycle, which is located at the center of the scroll members in a scroll type compressor, must be reduced as much as possible. To this end, the inner end portion of the spiral elements are extended inwardly as far as possible to the center of the scroll member.

However, when a scroll type fluid displacement apparatus is used for a supercharger or an air pump which requires a compression ratio of only 1.0 to 1.5, the re-expansion volume needs not be reduced as much as in the high compression ratio application. In an apparatus which requires only a low compression ratio, pressure difference between the high pressure space and the lower pressure space is smaller than in a high compression ratio application, so that 1.5 to 2.0 revolutions of spiral element generally is sufficient. Particularly, the apparatus which is used as the supercharger for engine is carried on the engine and effects the power up of the engine by supercharging air to the engine. The engine with the supercharger is controlled by external environment, for example, in starting or high power driving situation, the engine needs the supercharged air to power up the engine, while, in the constant drive situation, the engine requiring not so much supercharged air. The supercharger must be provided with the control means for the operation of the apparatus.

It is a primary object of this invention to provide an improvement in a scroll type fluid displacement apparatus having a control means for controlling the operation of the apparatus by change of external environment.

It is another object of this invention to provide a scroll type fluid displacement apparatus which is simple to construct and can be simply and reliably manufactured.

A scroll type fluid displacement apparatus according to this invention includes a housing having a fluid inlet port and a fluid outlet port. Fixed scroll member is joined with the housing and has a first end plate from which a first wrap extends into an operative interior area of the housing. An orbiting scroll member has a second end plate from which a second wrap extends. The first and second wraps interfit at an angular and

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radial offset to make a plurality of line contacts to define at least one pair of fluid pockets. A driving mechanism is connected to the orbiting scroll to drive the orbiting scroll in an orbital motion. A rotation preventing device is disposed between the housing and the second end plate for preventing the rotation of the orbiting scroll, thereby the volume of the fluid pockets changes by the orbital motion of the scroll. An opening is formed through the first end plate for connecting between the lower pressure space within the operative area of the housing and a center space of wraps. A control means is disposed in the opening for controlling the opening and closing of the opening.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Fig. 1 is a vertical sectional view of a scroll type fluid displacement apparatus according to an embodiment of this invention;

Figs. 2a-2d are sectional views taken along line II-II in Fig. 1 illustrating the operation of the apparatus;

Fig. 3 is a sectional view taken along the line II-II in Fig. 1 according to another embodiment of this invention; and

Fig. 4 is a partially sectional view of a scroll type fluid displacement apparatus according to another embodiment of this invention.

Referring to Fig. 1, an embodiment of a fluid displacement apparatus in accordance with the present invention, in particular, a scroll type apparatus 1 is shown. Apparatus 1 includes a housing 10 having a front end plate 11 and a cup shaped casing 12, which is attached to one end surface of front end plate 22 by a plurality of bolts 13. An opening in cup shaped casing 12 is covered by front end plate 11 to seal off inner chamber 14 of cup shaped casing 12. An opening 111 is formed in the center

of front end plate 11 for penetration or passage of a drive shaft 15. Front end plate 11 has an annular sleeve 16 projecting from the front end surface thereof which surrounds drive shaft 15. In the embodiment shown in Fig. 1, sleeve 16 is separated from front end plate 11. Therefore, sleeve 16 is fixed to the front end surface of front end plate 11 by bolts 13 with cup shaped casing 12.

A pulley 17 is rotatably supported by a bearing 18 which is carried on the outer surface of sleeve 16. The outer end portion of drive shaft 15, which extends from sleeve 16, is fixed on pulley 17 by a key 19 and bolt 20 through shims 21. Drive shaft 15 is thus driven by an external drive power source through pulley 17.

A fixed spiral element 122 is formed integral with end plate portion 121 of cup shaped casing 12 and extends into inner chamber 14 of cup shaped casing 12. Spiral element 122, which has approximately 1 and 3/4 turns or revolutions, has a trapezoidal shaped as shown in Fig. 1. An outlet port 123 is formed through the end plate portion 121 of cup shaped casing 12 and an inlet port 124 is formed through the outer peripheral surface of cup shaped casing 12.

An orbiting scroll 22 is also located within inner chamber 14 of cup shaped casing 12 and includes a circular end plate 221 and orbital wrap or spiral element 222 affixed to or extending from one side surface of end plate 221. A tubular member 223 projects axially from a generally center area of the side surface of end plate 221. Fixed spiral element 122 and orbiting spiral element 222 interfit at an angular offset of 180° and a predetermined radial offset. At least a pair of fluid pockets are defined between spiral elements 122 and 222. Tubular member 223 has a hollow interior 224 extending through its center.

Drive shaft 15 has a disk shaped rotor 151 at its inner end which is rotatably supported by front end plate 11 through a bearing 23 located within opening 111 of front end plate 11. A crank pin 152 projects axially from an axial end surface of rotor 151 at a position which is radially offset from the center of drive shaft 15. Crank pin 152 is carried in hollow interior 224 of tubular member 223 by a bearing 24. Bearing 24 is held within a ledge in hollow interior 224 by a snap ring 25 and a projection 225 formed on the inner surface of hollow interior 224. Snap ring 25 is attached on the inner end of crank pin 152 and a spring washer 26 is placed between snap ring 25 and bearing 24. Accordingly, orbiting scroll 22 is pushed against front end plate 11 by spring washer 26.

A rotation preventing/thrust bearing device 28 is located between the inner end surface of front end plate 11 and an axial end surface of end plate 221 of orbiting scroll 22. Rotation preventing/thrust bearing device 28 includes a plurality of fixed indentations 281 formed on the inner end surface of front end plate 11, a plurality of orbiting indentations 282 formed on the axial end surface of end plate 221 and, a plurality of bearing elements 283, such as balls. Each ball 283 is placed in facing, generally aligned indentations 281 and 282. The rotation of orbiting scroll 22 is prevented by the interaction between balls 283 and indentations 281 and 282; also the axial thrust load from orbiting scroll 22 is supported by front end plate 11 through balls 283. In the embodiment shown in Fig. 1, front end plate 11 and orbiting scroll 22 are formed of light alloy metal, for example, aluminum alloy, to reduce the weight of the apparatus. As a result, fixed and orbiting cover plate 284 and 285 are disposed on the inner end surface of front end plate 11 and the end surface of end plate 221 to prevent wear of indentations 281 and 282.

A grease seal mechanism 29 is placed between the outer peripheral portion of end plate 221 of orbiting scroll 22 and the inner end surface of front end plate 11. Also, bearing 24 which is located at hollow interior 224 of tubular member 223 and bearing 23 which is located within opening 111 have a grease seal mechanism. Therefore, a space defined by front end plate 11 and axial end surface of end plate 221 is sealed off. Grease, which is enclosed within space, is retained to lubricate rotation preventing thrust bearing device 28.

A connecting hole 31 is formed through end plate portion 121 of cup shaped casing 12. Connecting hole 31 connects between a suction space 141 of inner chamber 14, which is defined between outer side wall of orbiting spiral element 222 and the inner side wall of cup shaped casing 12, and a center space 125 of both spiral elements 122 and 222. Connecting hole 31 is formed in a circular shape as shown in Figs. 2a-2d, however, hole 31 may be formed in an ellipse shape as shown in Fig. 3. A valve member 32 is seated in connecting hole 31 for closing hole 31. Valve member 32 is connected to a solenoid 33 through a plunger 34. A coil spring 35 is placed between valve member 32 and solenoid 33, therefore valve member 32 is usually pushed against hole 31 to close hole 31 and controlled by the operation of solenoid 33. In this embodiment as shown in Fig. 1, solenoid 33 and plunger 34 are located within a housing 125 which is formed integral with cup shaped casing 12. A space 36 in which solenoid 33 and plunger 34 are located is connected to outlet port 123 through a hole 37.

Referring now to Figs. 2a-2d, the operation of the apparatus will be explained below. As shown in Fig. 2a, fixed spiral element 122 and orbiting spiral element 222 interfit at an angular and radial offset with a small radial gap. The fluid, for example, the air introduced through inlet port 124 flows

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into suction space 141 of inner chamber 14 of cup shaped casing 12, and into a space A formed by the inner side wall of orbiting spiral element 222 and the outer side wall of fixed spiral element 122 and a space B formed by the outer side wall of orbiting spiral element 222 and the inner side-wall of fixed spiral element 122. The relative position of the spiral elements after the drive shaft 15 rotates 90° is shown in Fig. 2b. The outer side wall of terminal end of orbiting spiral element 222, now fits against the inner side wall of cup shaped casing 12, since the outer side wall of orbiting spiral element has an annular shape. Thus, the space B is sealed off by the inner side wall of cup shaped casing 12 and the outer side wall of orbiting spiral element 222. However, since the diameter of end plate 221 (the outline of end plate 221 is shown by dotted line in Fig. 2a) is formed smaller than the diameter of cup shaped casing 12 to permit orbital motion of orbiting scroll 22 within cup shaped casing 12, space B is axially connected with the inner chamber 14 of cup shaped casing 12. Accordingly, the pump operation does not start in this stage.

The relative position of the spiral elements after drive shaft 15 further rotates 90° is shown in Fig. 2c. Spaces A and B are still connected axially to the suction space 141 of inner chamber 14. Therefore, this stage is still in a sucking condition. When drive shaft 15 rotates 270° (see Fig. 2d) the inner side wall of orbiting spiral element 222 comes into contact with point P_1 on the outer side wall of fixed spiral element 122 and the outer side wall of orbiting spiral element 222 comes into contact with point P_2 on the inner side wall of fixed spiral element 122 to seal off spaces A and B. Since both spiral elements 122 and 222 have approximately 1 and $3/4$ turns or revolutions, upon passage of the spiral elements from the stage as shown in Fig. 2c to the stage as shown in

Fig. 2d, two spaces A and B are connected to the center space 125 of spiral elements which is connected with outlet port 123. As a result, the fluid within spaces A and B flows into center space 125 and is reduced in the volume. Upon further rotation of drive shaft 15, the fluid within spaces A and B is discharged to an external fluid circuit through outlet port 123 by reduction of volume of spaces A and B.

In the case that the apparatus is used as a supercharger for engine of vehicle, operation of the connecting hole will be described below.

The starting or accelerating situation of vehicle, the engine requires the supercharged air for power up. In this situation, solenoid 33 is not operated, so that connecting hole 31 is closed by valve 32. Therefore, the apparatus is normally operated so as to supply the supercharged air to engine for saving consumption of fuel.

Furthermore, in the case that the vehicle drives at a constant speed, the supercharged air is not required by driving engine. Solenoid 33 is operated through a detecting device (not shown), so that valve 32 is moved to the axial direction by solenoid 33 through plunger 34. Therefore, connecting hole 31 is opened by movement of valve 32. In this situation, the fluid within suction space 141 flows into center space 125 and/or discharge port 123 through connecting hole 31 and/or hole 37. The function of the apparatus is thus stopped. The engine operates at a normal condition.

Fig. 4 shows another embodiment of this invention in which the configuration of the connecting hole and the control mechanism of hole are modified. Similar parts are represented by the same reference numerals as in embodiment shown in Fig. 1. Solenoid 33 is fixed on the outside of cup shaped casing 12. Connecting hole 31 formed through end plate portion 121 has a certain axial length and valve 32 is movably fitted within connecting hole 31.

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Valve 32 is axially moved within connecting hole by operation of solenoid 33, so as to form a fluid passageway connecting between suction space 141 and center space 125 along the inner surface of the valve 32. The fluid passageway for leaking compressed fluid to suction space 141 is controlled by movement of valve 32. The displacement volume of the apparatus is thus controlled.

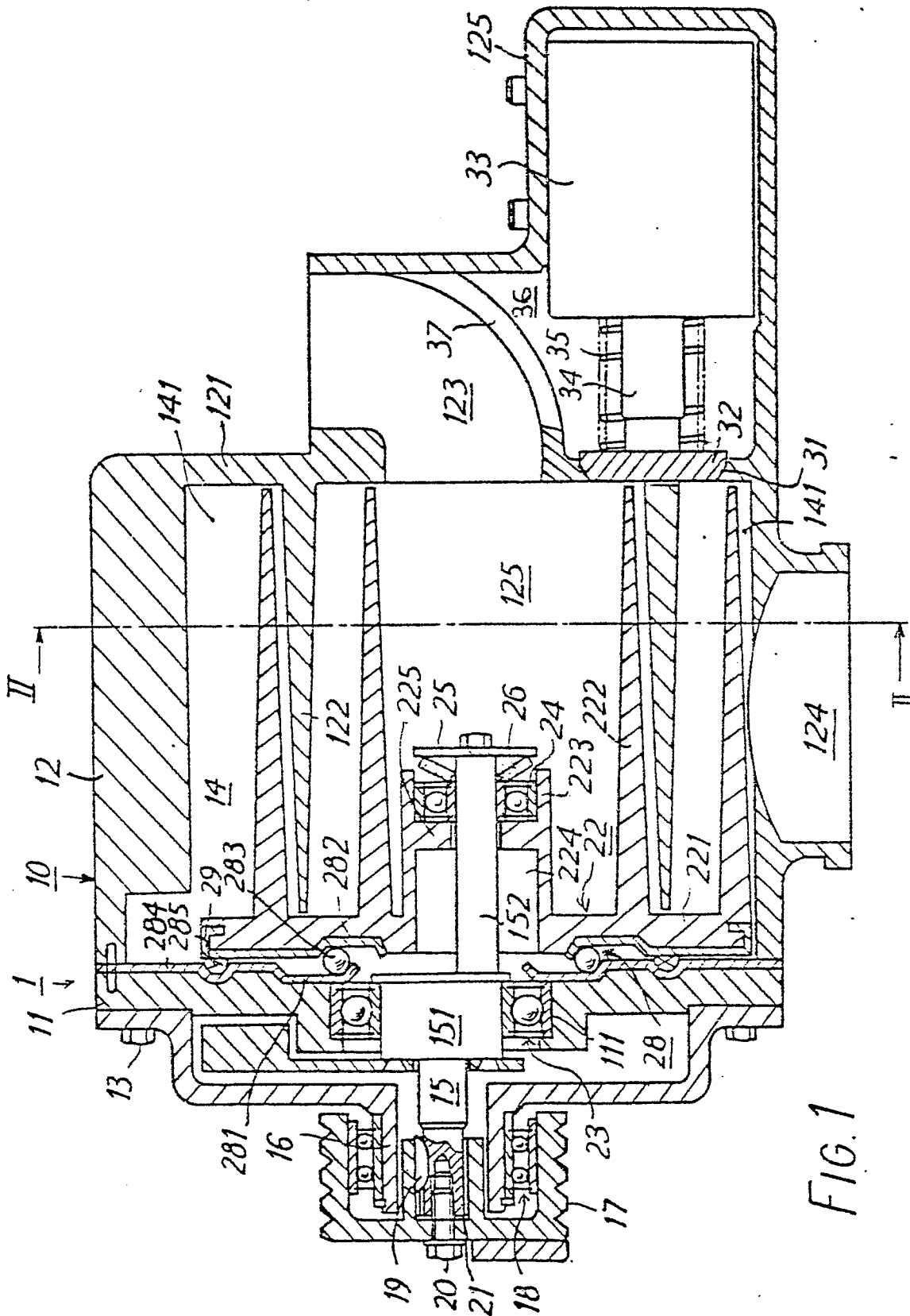
This invention has been described in detail in connection with preferred embodiments, but these are merely examples only and this invention is not limited thereto. It will be easily understood by those skilled in the art that variations and modifications can be easily made within the scope of this invention.

CLAIMS

1. A scroll type fluid displacement apparatus including a housing (10) having an inlet port (124) and an outlet port (123), a fixed scroll (122) joined with said housing (10) and having a first end plate (121) from which a first wrap (122) extends into an operative interior area (14) of said housing (10), an orbiting scroll (22) having a second end plate (221) from which a second wrap (222) extends, said first and second wraps (122, 222) interfitting at an angular and radial offset to make a plurality of line contacts to define at least one pair of fluid pockets within said operative interior area, a driving mechanism (15-151-152) connected to said orbiting scroll (22) to drive said orbiting scroll (22) in an orbital motion, and a rotation preventing means (28) for preventing the rotation of said orbiting scroll (22) so that the volume of fluid pockets changes during the orbital motion of said orbiting scroll (22), characterized by an opening portion (31) formed on said first end plate (121) for connecting with a lower pressure space (141) of the operative interior and a center space (125) of said wraps (122, 222), and a control means (32) for controlling the opening and closing of said opening portion (31) to control the operation of said apparatus.
2. The scroll type fluid displacement apparatus of claim 1 wherein said first end plate (121) is formed integral with an end plate portion of said housing (10).
3. The scroll type fluid displacement apparatus of claim 1 wherein said control means includes a valve member (32) fitted in said opening portion, solenoid (33) controlled by the external environment, and a plunger (34) connected between said valve member (32) and solenoid (33).

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4. The scroll type fluid displacement apparatus of claim 3 wherein said opening portion (31) has an axial length and said valve member is disposed movable within said opening portion (31).



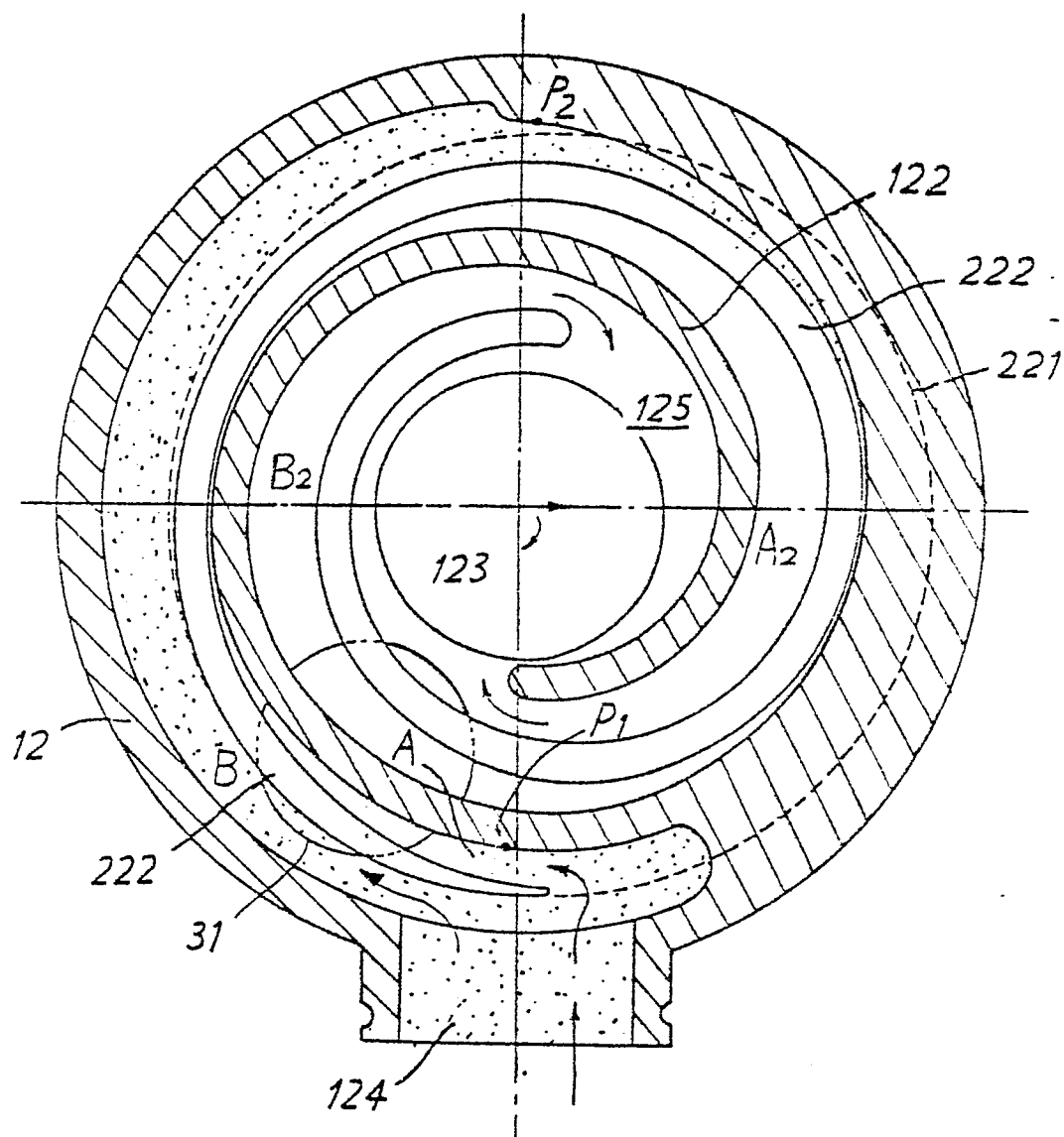


FIG. 2a

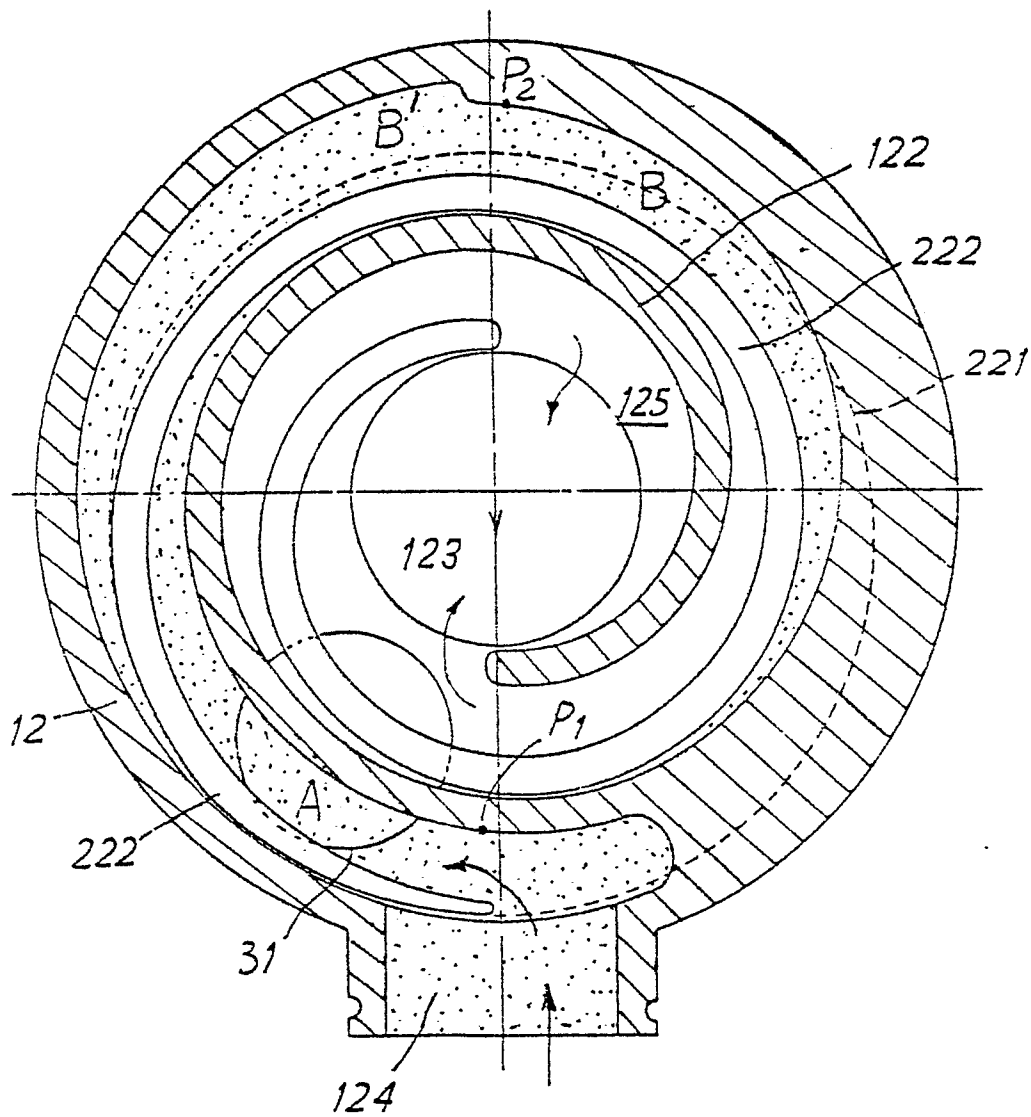


FIG. 2b

FIG. 2c

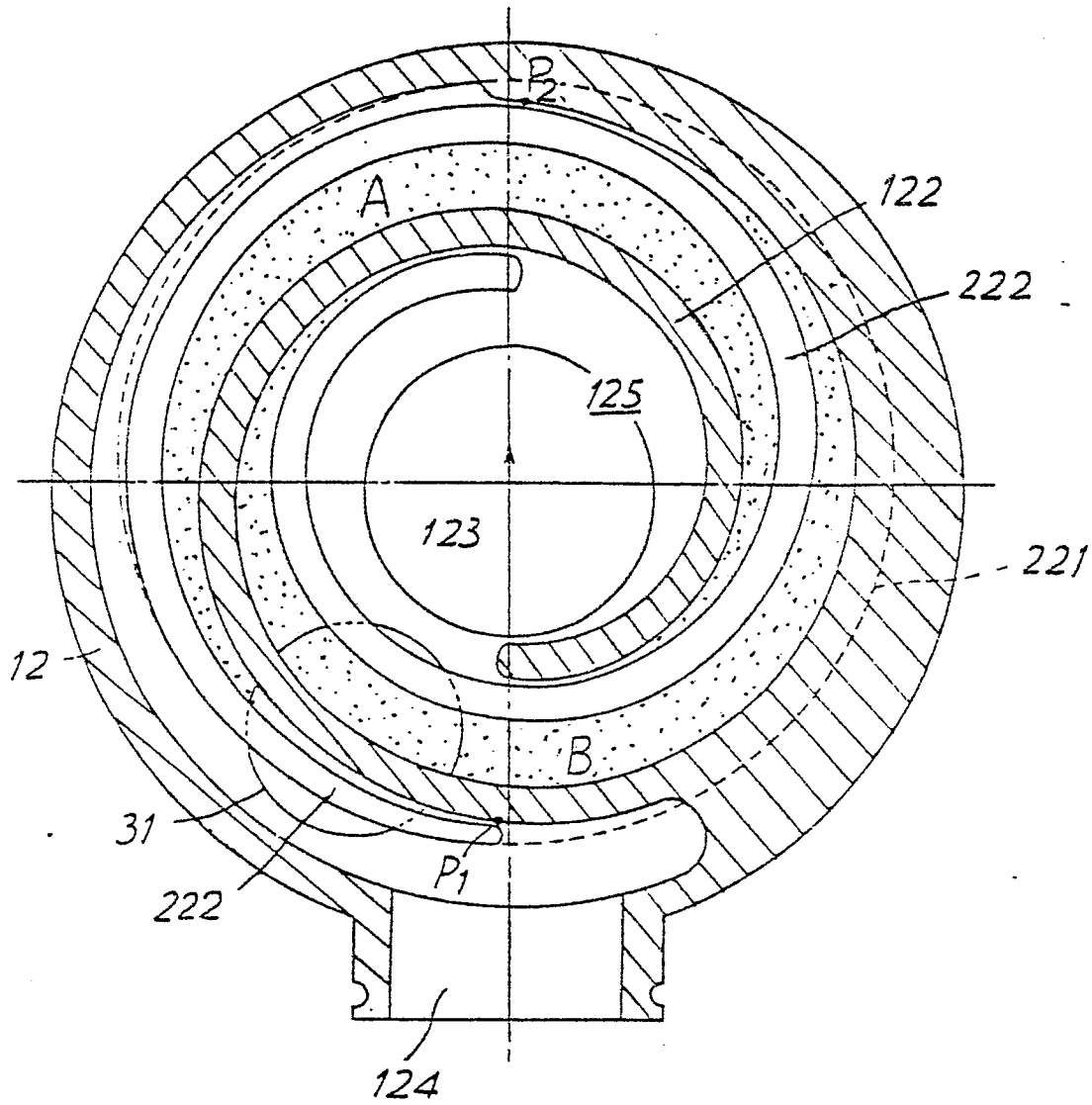


FIG. 2d

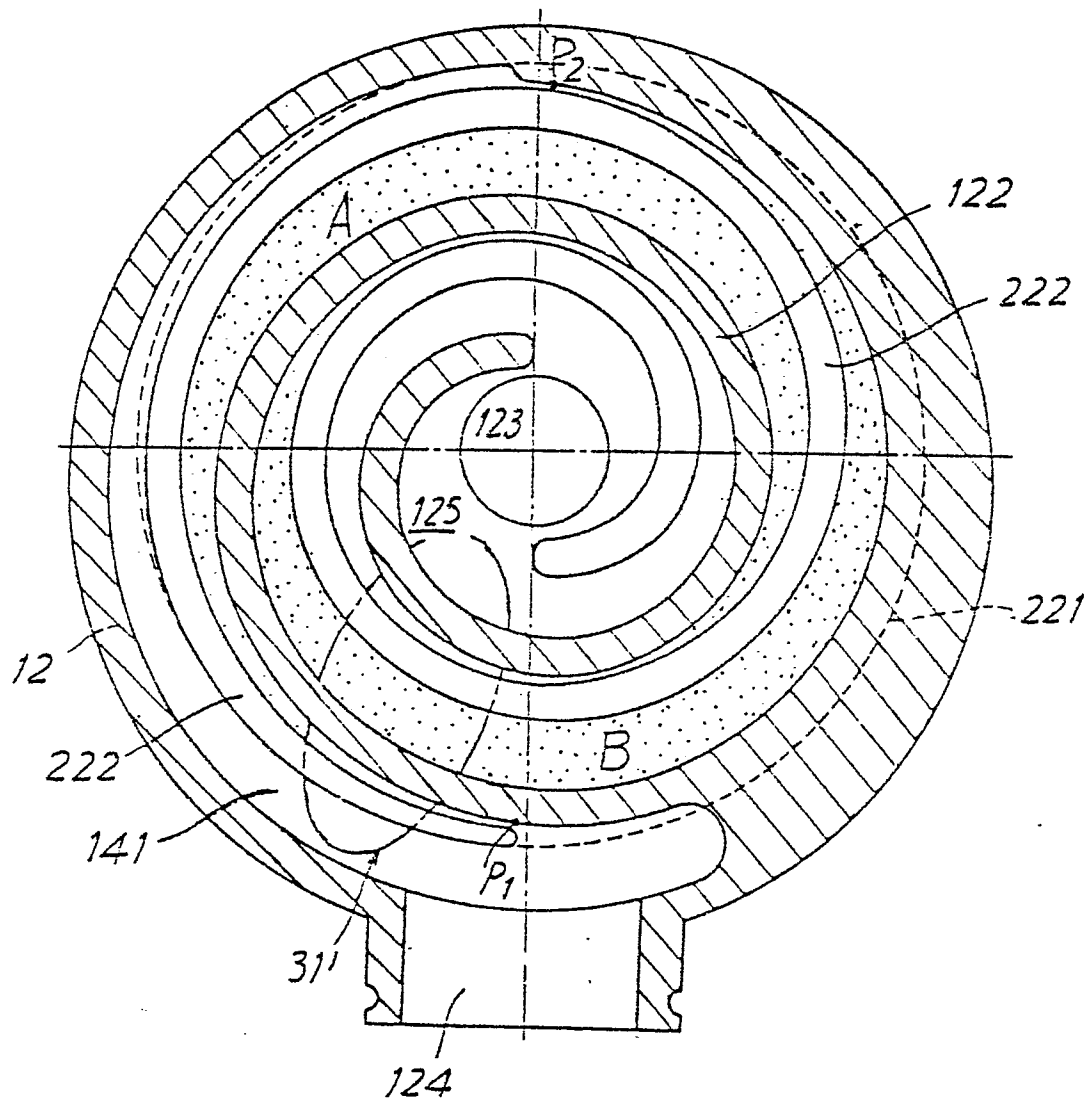


FIG. 3

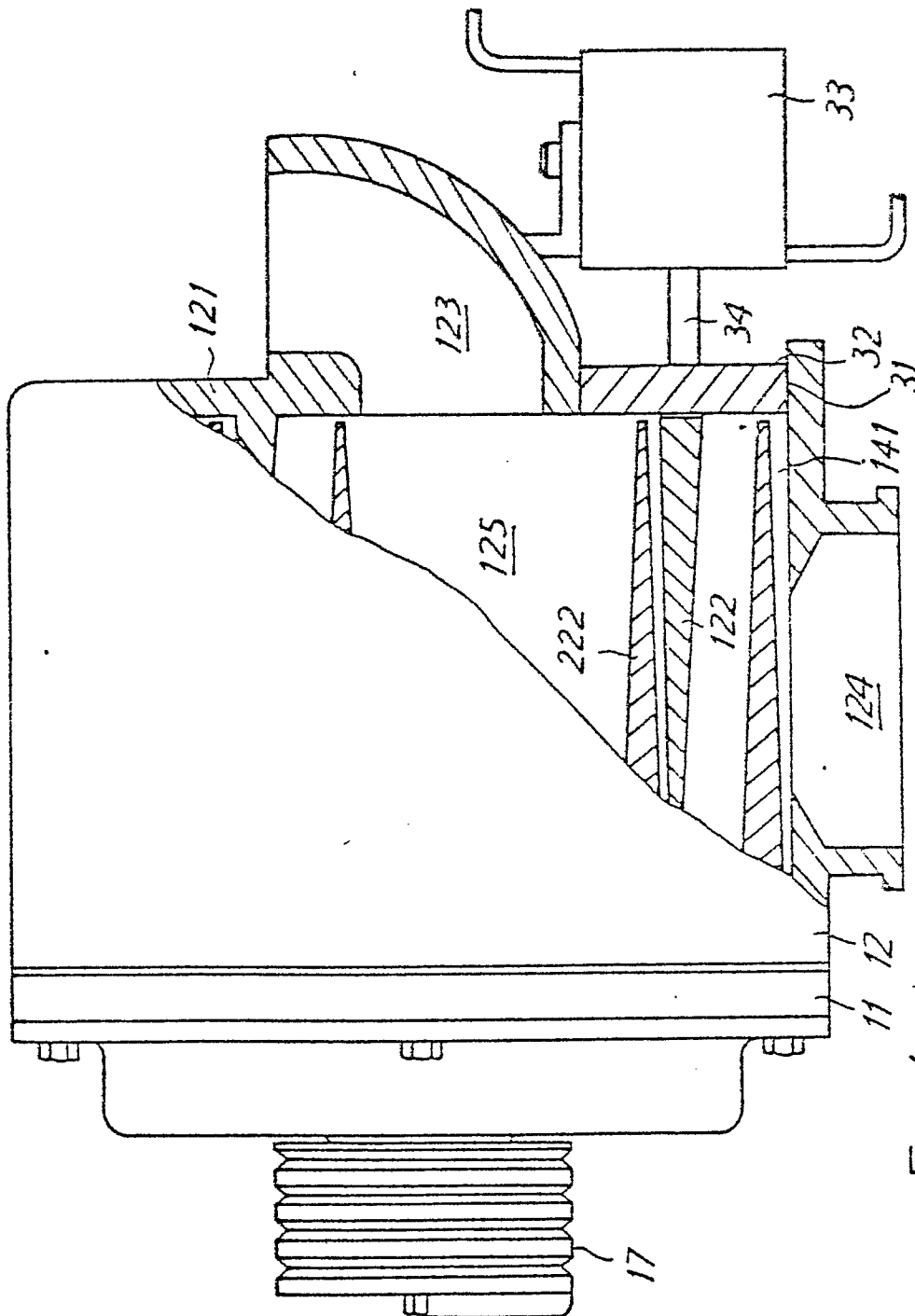


FIG. 4