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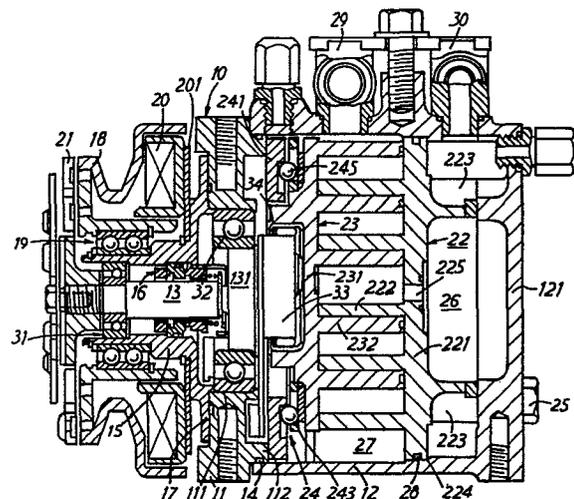
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**Scroll type fluid displacement apparatus.**

A scroll type fluid displacement apparatus including a housing (12) with a fluid inlet port and fluid outlet port is disclosed. A fixed scroll (22) is joined with the housing and has a first circular end plate (221) from which a first wrap extends. An orbiting scroll (23) has a second circular end plate (231) from which a second wrap extends. The first and second wraps interfit at an angular and radial offset to make a plurality of line contacts to define at least one pair of sealed off fluid pockets. A driving mechanism, which includes a drive shaft (13), is operatively connected to the orbiting scroll to effect the orbital motion of the orbiting scroll at radius  $R_{or}$ , while the rotation of the orbiting scroll is prevented by a rotation preventing/thrust bearing device (24), whereby the fluid in the fluid pockets moves inwardly or outwardly and changes in volume. The center of the first circular end plate is aligned with the center line of the housing and the center of the first wrap is radially offset from the center of the first circular end plate by the distance  $\frac{1}{2} R_{or}$ . The center of the second wrap is radially offset from the center of the second circular end plate by the distance  $\frac{1}{2} R_{or}$ . The drive shaft has a center line, which is aligned with the center line of the housing, and also has a crank pin, the center line of which is aligned with the center of the second circular end plate.



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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.

5 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 scroll members each having a circular end plate and a spiroidal or involute spiral element. These scroll members are maintained angularly and radially offset so that both spiral elements interfit to make a plurality of line  
10 contacts between their spiral curved surfaces to thereby seal off and define at least a pair of fluid pockets. The relative orbital motion of the two scroll members shifts the line contacts along the spiral curved surfaces and, therefore, the fluid pockets change in volume. Since the volume of the pockets increases  
15 or decreases dependent on the direction of the orbital motion, the scroll type fluid displacement apparatus is applicable to compress, expand or pump fluids.

It is a primary object of this invention to provide an improvement in a scroll type fluid displacement apparatus  
20 wherein the diameter and weight of the housing of the apparatus are reduced.

It is another object of this invention to provide a scroll type fluid displacement apparatus wherein the relationship between the parts of the apparatus is precisely maintained  
25 and the efficiency of the mass production of the apparatus is improved.

It is still another object of this invention to provide a scroll type fluid displacement apparatus wherein the manufacturing technique and productivity of the parts of the apparatus  
30 are improved.

A scroll type fluid displacement apparatus according to this invention includes a housing having a fluid inlet port and fluid outlet port. A fixed scroll is joined with the housing and has a first circular end plate from which a first wrap extends. An orbiting scroll has a second circular end plate from which a second wrap extends. The first and second wraps interfit at an angular and radial offset to make a plurality of line contacts to define at least one pair of sealed off fluid pockets. A driving mechanism, which includes a drive shaft, is operatively connected to the orbiting scroll to effect the orbital motion of the orbiting scroll at radius  $R_{or}$ , while the rotation of the orbiting scroll is prevented by a rotation preventing/thrust bearing means, whereby the fluid in the fluid pockets moves inwardly or outwardly and changes in volume. The center of the first circular end plate is aligned with the center line of the housing and the center of the first wrap is radially offset from the center of the first circular end plate by the distance  $1/2 R_{or}$ . The center of the second wrap is radially offset from the center of the second circular end plate by the distance  $1/2 R_{or}$ . The drive shaft has a center line, which is aligned with the center line of the housing, and also has a crank pin, the center line of which is aligned with the center of the second circular end plate.

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

25

Figs. 1a-1d are schematic views illustrating the relative movement of interfitting spiral elements to compress fluid;

Fig. 2 is a schematic view illustrating the dimensional relationship between the cylindrical compressor housing and the end plate of an orbiting scroll in known compressor;

30

Fig. 3 is a schematic end view of the end plate of fixed scroll used in the compressor of Fig. 2, illustrating its dimensional requirements;

5 Fig. 4 is a schematic view illustrating the relationships between the centers of orbiting scroll, fixed scroll and driving mechanism in the known compressor;

Fig. 5 is a vertical sectional view of the scroll type compressor using the relationship of Fig. 4;

Fig. 6 is a vertical sectional view of a scroll type compressor according to one embodiment of this invention;

10 Fig. 7 is an exploded perspective view of the driving mechanism used in the compressor of Fig. 6;

Fig. 8 is an exploded perspective view of the rotation preventing/thrust bearing device used in the compressor of Fig. 6;

15 Fig. 9 is a schematic view illustrating the relationships between the centers of the scrolls and driving mechanism used in the compressor of Fig. 6; and

Fig. 10 is a diagrammatic sectional view illustrating the spiral elements of the fixed and orbiting scrolls.

20 Referring to Figs. 1a-1d, the principle of operation of scroll type fluid apparatus, particularly the compression operation, will be described.

25 Figs. 1a-1d may be considered end views of a compressor wherein the end plates are removed and only spiral elements are shown at orbital angular positions spaced  $90^\circ$  from one another. Two spiral elements 1 and 2 are angularly offset and interfitted with one another. As shown in Fig. 1a, the orbiting spiral element 1 and fixed spiral element 2 make four line contacts as shown at four points A-D. A pair of fluid pockets 3a and 3b are defined between

line contacts D, C and line contacts A, B as shown by the dotted regions. The fluid pockets are defined not only by the wall of spiral elements 1 and 2, but also by the end plates from which these spiral elements 1 and 2 extend.

5           Orbiting spiral element 1 is moved in relation to fixed spiral element 2 so that the center 0' of orbiting spiral element 1 revolves around the center 0 of fixed spiral element 2 at a radius of 0-0', while the rotation of orbiting spiral element 1 is prevented. This motion angularly and radially shifts fluid pockets 3a and 3b toward  
10           the center of the interfitted spiral elements, to gradually reduce the volume of each fluid pocket 3a and 3b, as shown in Fig. 1a-1d, thereby, compressing the fluid in each pocket.

          In typical operation, fluid pockets 3a, 3b are initially formed when the ends of spiral elements 1,2 contact with the outer surface  
15           of the other spiral elements, as shown in Fig. 1a. Further rotation of orbiting spiral element 1 causes the pockets 3a, 3b to reduce in volume, as shown in Figs. 1b, 1c. Thereafter, the pair of fluid pockets 3a, 3b become connected to one another, as shown in Fig. 1d, and the single pocket is further reduced in volume, as shown by the  
20           undotted central area in Figs. 1a, 1b and 1c. During the reduction in volume of pockets 3a, 3b, the ends of the spiral elements leave contact with the outer surface of the other spiral elements, as shown in Figs. 1b, 1c, 1d, until contact is reestablished, as shown in Fig. 1a to form a new pair of fluid pockets 3a, 3b.

25           This operation results in compression of the fluid in the pockets, since circular end plates are affixed to the axial facing ends of spiral elements 1 and 2. Discharge of the compressed fluid occurs through a centrally located discharge port in one of the end plates, shown diagrammatically as 4 in Figs. 1a, 1b and 1c.

30           In comparison with conventional fluid displacement apparatus of the piston type, a scroll type fluid displacement apparatus has several advantages, such as continuous transfer of the fluid, volume

efficiency, and relatively silent operation.

5 However, in order to increase the compressive capacity and  
compression ratio, the number of turns, or revolutions of each spiral  
element must be increased. Consequently the diameter of the  
apparatus also must be increased. This becomes a problem in a  
scroll type fluid displacement apparatus which is used as a  
refrigerant compressor of an automotive air conditioner, because  
the diameter of compressor housing must be kept as small as  
possible in order to fit the compressor within the typically very  
10 narrow space of an engine compartment. Furthermore, both scroll  
members must be maintained angularly and radially offset, and  
the dimensional accuracy of the compressor parts must be maintained,  
or the total dimensional error of the assembled compressor parts must  
be minimized in order to assure the stability and efficiency of the  
15 apparatus.

A cylindrical housing is an advantageous configuration for con-  
taining a pair of scroll members each of which have a wall thickness  $t$   
and involute angle  $\phi$ . An optimal disposition of the end plate and  
spiral element to reduce the diameter of the housing is disclosed in  
20 U. S. Patent No. 4,304,535 (Terauchi), the disclosure of which is  
incorporated herein. Accordingly, as shown in Figs. 2 and 3 herein,  
orbiting scroll 231 orbits at radius  $R_{or}$  while maintaining its angular  
orientation with fixed scroll 221. The sectional area of the housing  
needed to permit the orbital motion of orbiting scroll 231 at radius  
25  $R_{or}$  will be made up by adding the spiral or snail shaped area on  
which fixed spiral element is held (area D in Fig. 3) to the space  
(area B in Fig. 3) over which orbiting spiral element 232 slides.  
Therefore, the inner diameter of the cylindrical housing in which the  
pair of scrolls are contained will be given by  $2\phi r_g + t + R_{or}$ , where  $r_g$   
30 is involute generating circle radius. In this construction, the center  
of inner wall of cylindrical housing is radially offset from the center  
of involute generating circle of fixed spiral element and the

maximum diameter of orbiting end plate to permit the orbital motion within the above cylindrical housing will be given by  $2\phi rg + t + R_{or}$ .

5 A suitable drive point of the orbiting scroll is the involute generating circle center of the orbiting spiral element, since the relation between the center of tangential gas force in the high pressure fluid pocket defined by both scroll centers and the drive point does not change at any rotational angle of the drive shaft. Accordingly, in the Fig. 2 the center of drive shaft is concentric with the involute generating circle center  $O_F$  of fixed spiral element 10 222' and the drive point  $O_D$  of orbiting scroll 231 is disposed on the involute generating circle center  $O_o$  of orbiting spiral element 232'. Orbiting scroll 231 therefore revolves at a radius  $O_F - O_o$  and this radial spacing does not change during the operation of the apparatus.

15 Fig. 4 illustrates the relationship between the center of each end plate and the centers of the involute generating circles of the spiral elements. In this figure, the center  $O_E$  of orbiting end plate 231' is radially offset from the involute generating circle center  $O_o$  of orbiting spiral element 232' to the right by a distance  $1/2 R_{or}$ . Also, the center  $O_c$  of fixed end plate 221', i.e., the center of the 20 compressor housing is radially offset from the involute generating circle center  $O_F$  of fixed spiral element 222' to the right by a distance  $1/2 R_{or}$ . The center  $O_c$  is also radially offset from the center  $O_o$  by a distance  $1/2 R_{or}$ . The drive point  $O_D$  is disposed on the center  $O_o$  and the center  $O_d$  of drive shaft 13 is concentric with 25 center  $O_F$ , whereby the orbital motion of the orbiting scroll 231 is shown as the locus of the center  $O_o$ . The locus of the center  $O_o$  is shown by the circle C with its center at center  $O_F$  of drive shaft, as shown in Fig. 4.

30 Fig. 5 is a vertical sectional view of a scroll type compressor which utilizes the above mentioned disposition of scroll members. In this construction, the center  $O_F$  of the drive shaft 13' is radially

offset from the center  $O_c$  of housing 10' and also the center  $O_o$  of the drive point is radially offset from the center  $O_E$  of orbiting end plate 231'. Therefore, a tubular boss 233' projecting axially from one end surface of end plate 231' and rotatably supported on a drive pin of the driving mechanism is radially offset from the center of end plate 231'. Tubular boss 233' therefore must be formed at an offset position. The forming of these scrolls is complicated, and hence, it is difficult to form the scrolls with high dimensional accuracy. Furthermore, a coupling mechanism 24' is required to maintain the angular orientation between both scrolls and to carry the radial force from the orbiting scroll. However in this construction, the coupling mechanism, such as a ball coupling/thrust bearing device, must be disposed within the housing 10' at a radially offset position. Ring member 241' which is concentric with the ball coupling/thrust bearing device is fitted on the inner end surface of the housing 10' at a radially offset position, thereby requiring a dead space A on which the outer peripheral portion of ring member 241' is placed. Hence, the diameter of housing 10' is increased, as shown in Fig. 5.

Referring to Fig. 6, a scroll type fluid displacement apparatus in accordance with the present invention, in particular, a scroll type compressor is shown. The compressor includes a compressor housing 10 having a front end plate 11 and a cup shaped casing 12 fastened to an end surface of front end plate 11. An opening 111, the center of which is concentric with the center line of cup shaped casing 12 is formed in the center of front end plate 11 for supporting a drive shaft 13. The center line of drive shaft 13 is thus concentric or aligned with the center line of cup shaped casing 12, ie. with the center line of the housing. An annular

projection 112, concentric with opening 111, is formed on the rear surface of front end plate 11 and faces cup shaped casing 12. An outer peripheral surface of annular projection 112 contacts an inner wall of the opening of cup shaped casing 12. Cup shaped casing 12 is fixed on the rear end surface of front end plate 11 by a fastening device, such as bolts and nuts (not shown), so that the opening of cup shaped casing 12 is covered by front end plate 11. An O-ring 14 is placed between the outer peripheral surface of annular projection 112 and the inner wall of cup shaped casing 12 to seal the mating surfaces between front end plate 11 and cup shaped casing 11.

Front end plate 11 has an annular sleeve 15 projecting from its front end surface. Sleeve 15 surrounds drive shaft 13 to define a shaft seal cavity. A shaft seal assembly 16 is assembled on drive shaft 13 within the shaft seal cavity. Sleeve 15 is attached to the front end surface of front end plate 11 by screws (not shown). An O-ring 17 is placed between the front end surface of front end plate 11 and an end surface of sleeve 15 to seal the mating surfaces of front end plate 11 and annular sleeve 15. Alternatively sleeve 15 may be formed integral with front end plate 11.

A pulley 18 is rotatably supported by a bearing 19 on the outer surface of sleeve 15. An electromagnetic coil 20, which is received in an annular cavity of pulley 18, is mounted on the outer surface of sleeve 15 by a support plate 201. An armature plate 21 is elastically supported on the outer end of drive shaft 13 which extends from sleeve 15. A magnetic clutch is formed by pulley 18, magnetic coil 20 and armature plate 21. Drive shaft 13 is thus driven by an external power source, for example, an engine of vehicle, through a rotation transmitting device, such as the above described magnetic clutch.

A number of elements are located within the inner chamber

of cup shaped casing 12 including a fixed scroll 22, an orbiting scroll 23, a driving mechanism for orbiting scroll 23 and a rotation preventing/thrust bearing device 24 for orbiting scroll 23. The inner chamber of cup shaped casing 12 is formed between the inner wall of cup shaped casing 12 and the rear end surface of front  
5 end plate 11.

Fixed scroll 22 includes a circular end plate 221, and a wrap or spiral element 222 affixed to or extending from one end surface of end plate 221. A plurality of internal bosses 223 axially  
10 project from the end surface of end plate 221 on the side opposite spiral element 222. The center of spiral element 222 (the center of its involute generating circle) is radially offset from the center of end plate 221 by a distance  $R_{or}/2$  wherein  $R_{or}$  is the radius at which orbiting scroll 23 orbits. The end surface of each boss 223  
15 is seated on the inner surface of end plate portion 121 of cup shaped casing 12 and is fixed to end plate portion 121 by a plurality of bolts 25, one of which is shown in Fig. 6. Circular end plate 221 of fixed scroll 22 partitions the inner chamber of cup shaped casing 12 into a discharge chamber 26 having bosses 223, and a  
20 suction chamber 27, in which spiral element 222 of fixed scroll 22 is located. A sealing member 28 is disposed within a circumferential groove 224 of circular end plate 221 to form a seal between the inner wall of cup shaped casing 12 and the outer wall of circular end plate 221.

25 Orbiting scroll 23, which is located in suction chamber 27, includes a circular end plate 231 and a wrap or spiral element 232 affixed to or extending from one end surface of end plate 231. The center of spiral element 232 (the center of its involute generating circle ) is radially offset from the center of end plate 231 by a  
30 distance of  $R_{or}/2$ . The spiral elements 222 and 232 interfit at angular offset of  $180^{\circ}$  and predetermined radial offset. The spiral elements define at least a pair of fluid pockets between their

interfitting surfaces. Orbiting scroll 23 is connected to the driving mechanism and rotation preventing/thrust bearing device 24 to effect the orbital motion at a circular radius  $R_{or}$  by the rotation of drive shaft 13 to thereby compress fluid passing through the compressor.

5 Generally, radius  $R_{or}$  of orbital motion given by:  
(the pitch of the spiral element)-2(the wall thickness of the spiral element)

2

As seen in Fig. 10, the pitch ( $p$ ) of the spiral elements can be defined by  $2\pi r_g$ , where  $r_g$  is the involute generating circle radius.  
10 The radius  $R_{or}$  of orbital motion is also illustrated in Fig. 10, as a locus of an arbitrary point  $Q$  on orbiting scroll 23. The center of spiral element 232 is placed radially offset from the center of spiral element 222 by the distance  $R_{or}$ . Thereby, orbiting scroll 23 is allowed to undergo orbital motion at a radius  $R_{or}$  by the rota-  
15 tion of drive shaft 13. As orbiting scroll 23 orbits, line contacts between both spiral elements 222 and 232 shift to the center of the spiral elements along the surface of the spiral elements: The fluid pockets defined between spiral elements 222 and 232 move to the center of the spiral elements with consequent reduction of the  
20 volume, to thereby compress the fluid in the pockets. Fluid or refrigerant gas, introduced into suction chamber 27 through a fluid inlet port 29 on cup shaped casing 12, is taken into fluid pockets formed between both spiral elements 222 and 232 from outer end portion of both the spiral elements. As orbiting scroll 23 orbits,  
25 fluid in the fluid pockets is compressed and the compressed fluid is discharged into discharge chamber 26 from the fluid pocket at the spiral elements center through a hole 225, and therefrom, discharged through fluid outlet port 30 on cup shaped casing 12 to an external fluid circuit, for example, a cooling circuit.

30 Referring to Fig. 6 and Fig. 7, the driving mechanism of orbiting scroll 23 will be described. Drive shaft 13 is formed with a

disk shaped rotor 131 at its inner end portion and is rotatably supported by sleeve 15 through a bearing 31 which is disposed within sleeve 15. Disk shaped rotor 131 is also rotatably supported by front end plate 11 through a bearing 32 located within opening 111 of front end plate 11. A crank pin or drive pin 132 projects axially from an axial end surface of disk shaped rotor 131 and is radially offset from the center of drive shaft 13. Circular end plate 231 of orbiting scroll 23 has tubular boss 233 axially projecting from the end surface opposite to the end surface from which spiral element 232 extends. A discoid or short axial bushing 33 fits into boss 233, and is rotatably supported therein by a bearing, such as needle bearing 34. An eccentric hole 35 is formed on bushing 33; eccentric hole 35 is radially offset from the center of bushing 33. Drive pin 132, which is surrounded by a bearing 36, fits into eccentric hole 35. Therefore, bushing 33 is driven by the revolution of drive pin 132 to thereby rotate within bearing 34. The spiral element 232 of orbiting scroll 23 is pushed against the spiral element 222 of fixed scroll 22 due to the moment created between the driving point and the reaction force acting point of the pressurized gas to secure the line contacts and effect radial sealing.

Referring to Figs. 6 and 8, the rotation preventing/thrust bearing device 24 will be described. Rotation preventing/thrust bearing device 24 is placed between the inner end surface of front end plate 11 and the end surface of circular end plate 231 which faces the inner end surface of front end plate 11. Rotation preventing/thrust bearing device 24 includes a fixed ring 241, which is fastened against the inner end surface of front end plate 11 by a fastening device, such as pins 242, an orbiting ring 243 which is fastened against the end surface of circular end plate 231 by a fastening device, such as pins 244, and a bearing element, such as a plurality of spherical balls 245. Both rings 241 and 243 have a plurality of circular indentations 246 and 247 and one of the spherical balls 245 is retained

between each of these indentations 246 and 247. The rotation of orbiting scroll 23 is prevented by balls 245, which interact with the edges of indentations 246 and 247 to prevent rotation. Also, balls 245 carry the axial thrust load from orbiting scroll 23. Therefore, orbiting scroll 23 orbits while maintaining its angular orientation to fixed scroll 22. As shown in Fig. 8, orbiting ring 243 preferably consists of a ring member 243A and plate member 243B. Both members 243A and B are fastened against end plate 231 of orbiting scroll 23 by pins 244. Alternatively, orbiting ring 243 may be formed of a single integral piece of material.

The relative locations of the centers of the spiral elements 222 and 232, circular end plates 221 and 231, housing 10, drive shaft 13 and drive pin 132, in accordance with the present invention, are illustrated in Fig. 9. As seen therein, the center  $O_c$  of the end plate 221 of fixed scroll 22 is concentric or aligned with the center line  $O_S$  of the housing 10, which is also the center line of drive shaft 13. The drive point  $O_D$  of orbiting scroll 23 is placed on the center  $O_E$  of the end plate 231 of orbiting scroll 23. Therefore, tubular boss 233 which projects axially from the axial end surface of end plate 231 of orbiting scroll 23 to operatively connect it to the driving mechanism can be formed concentric with end plate 231 of orbiting scroll 23, and the ring elements 241, 233 of rotation preventing/thrust bearing device 24 can be located on the end surfaces of the housing and orbiting scroll concentric with the center of the housing, orbiting scroll and boss.

The dead space which is caused by the eccentric disposition (shown as A in Fig. 5) can be eliminated and the diameter of the housing can be reduced. Since, the disposition of the driving mechanism or the rotation preventing/thrust bearing devices is concentric to the connected parts, the manufacturing of the parts, for example the orbiting scroll and the front end plate, can be done by simple working of the parts to a high dimensional accuracy. Furthermore, the assembly of the apparatus utilizing such concentric parts is simple.

This invention has been described in detail in connection with the preferred embodiment, but this is an example only and the invention is not restricted thereto. It will be easily understood by those skilled in the art that other variations and modifications can be easily made within the scope of the invention.

5

## WHAT IS CLAIMED IS:

1. In a scroll type fluid displacement apparatus including a housing, a fluid inlet port and a fluid outlet port, a fixed scroll joined with said housing and having a first circular end plate from which a first wrap extends into the interior of said housing, an  
5 orbiting scroll having a second circular end plate from which a second wrap extends, said first and second wraps interfitting at an angular and radial offset to make a plurality of line contacts to define at least one pair of sealed off fluid pockets, a driving  
10 mechanism including a drive shaft operatively connected to said orbiting scroll to effect the orbital motion of said orbiting scroll at radius  $R_{or}$ , and a rotation preventing means for preventing the rotation of said orbiting scroll so that the volume of the fluid  
15 pockets changes during the orbital motion of said orbiting scroll, the improvement comprising the center of said first circular end plate being aligned with the center line of said housing, the center of said first wrap being radially offset from the center of said  
20 first circular end plate by the distance  $1/2 R_{or}$ , the center of said second wrap being radially offset from the center of said second circular end plate by the distance  $R_{or}$ , said drive shaft having a center line aligned with the center line of said housing and, said drive shaft having a crank portion at its inner end portion operatively  
connected to said orbiting scroll at the center of said second end  
plate.

25 2. The scroll type fluid displacement apparatus of claim 1 wherein said driving mechanism comprises said drive shaft which has said crank pin projecting axially from the inner end surface thereof and radially offset from the center line of said drive shaft, a  
30 tubular boss axially projecting from the axial end surface of said second end plate and, a bushing which is rotatably supported within said tubular boss and connected to said crank pin.

pressure in fluid path 24 will be suitable to break the pressure seal at crease 26 and thereby permit the communication of fluid therepast to strip 22.

As is best shown in FIG. 3, receptacle tampering indicator 12 comprises top and bottom halves 28 and 30. Each half of indicator 12 is preferably fabricated from a thin and opaque, heat and/or pressure sensitive material, such as a plastic, a foil, or the like. Primary fluid reservoir 14 is stamped or pressed into the bottom half 30 of indicator 12. Thus, primary reservoir 14 extends downwardly from bottom half 30 so as to be able to receive a suitable supply of fluid (e.g. water). Top and bottom indicator halves 28 and 30 are sealed together by means of a controlled application of heat and pressure thereto. However, prior to sealing, a strip of litmus paper 22 is positioned at the tab portion 10 of indicator 12 between the top and bottom halves 28 and 30 thereof. Moreover, a suitably sized portion of string 20 is positioned along the bottom half 30 of indicator 12 so as to define a region at which fluid path 18 will be formed between primary and secondary fluid reservoirs 14 and 16. During the manufacturing and sealing

process by which the receptacle tampering indicator 12 is formed, dies can be utilized, so that voids will be created in the seal between top and bottom indicator halves 28 and 30. These voids (not shown) are suitably shaped and dimensioned so as to define secondary fluid reservoir 16 and fluid paths 18 and 24 at the interface between indicator halves 28 and 30. The fluid passageway including reservoirs 14 and 16 and paths 18 and 24 forms a closed system to prevent the escape of fluid therefrom.

As is best shown in FIG. 2, the tab portion 10 of tampering indicator 12 includes a window member 32 formed therethrough. Window member 32 is positioned at tab portion 10 so as to be in alignment with indicator strip 22. During the manufacturing and sealing process, pieces of transparent (e.g. plastic) covering material are positioned over the top and bottom of indicator strip 22, so that when indicator halves 28 and 30 are sealed together, the color of indicator strip 22 will be visible to the consumer or store merchant through window member 32. In the alternative, the top half 28 of indicator 12 may be fabricated from a transparent material, so that indicator strip 22 is

visible therethrough. Hence, the need for window member 32 and the transparent coverings thereover would be advantageously eliminated.

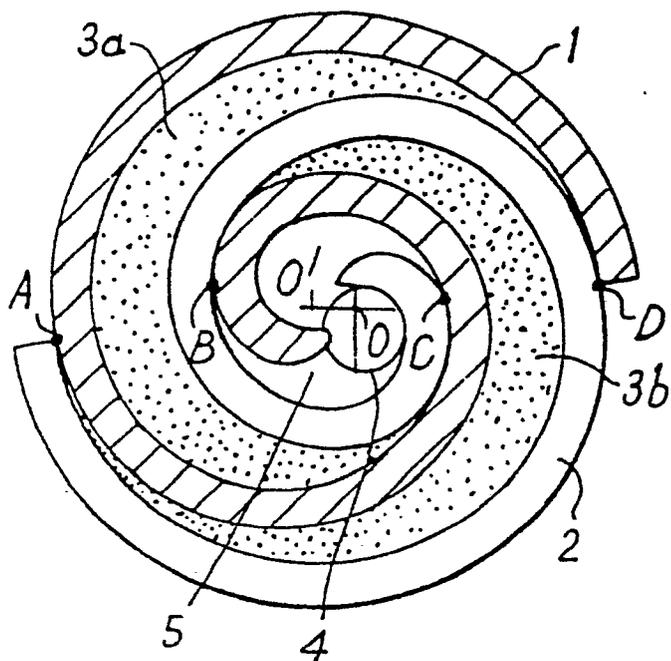
When in the assembled relationship, the receptacle tampering indicator 12 of the present invention is positioned beneath the cap 8 of the receptacle in which a plurality of dosage forms are packaged by the manufacturer thereof. According to the first preferred embodiment of the present invention, a thin layer 34 of adhesive is disposed along the top indicator half 30. Accordingly, by applying suitable pressure, the manufacturer of the dosage forms may affix indicator 12 to the underside 38 of a receptacle cap 8 at a (e.g. paper or plastic) seal 36 that is frequently attached thereat. In the event that receptacle cap 8 does not have such a seal 36 associated therewith, receptacle tampering indicator 12 may be affixed directly to the underside 38 of receptacle cap 8. In a second preferred embodiment of the present invention, the seal 36 may include indicator 12 as an integral part thereof. Thus, the need to fabricate a separate seal 36 and receptacle tampering indicator 12 is eliminated by forming seal 36 with fluid reservoirs 14 and 16,

fluid paths 18 and 24, and chemically treated fluid indicator strip 22 therein, as previously disclosed. However, such an integral seal-indicator structure would also include a tab (such as that designated by reference numeral 10) extending outwardly therefrom on which fluid indicator strip 22 would be disposed. Of course, it is to be understood that the sizes of receptacle tampering indicator 12 and the reservoirs 14 and 16 thereof are dependent upon the corresponding size of seal 36 and the area available beneath the receptacle cap 8.

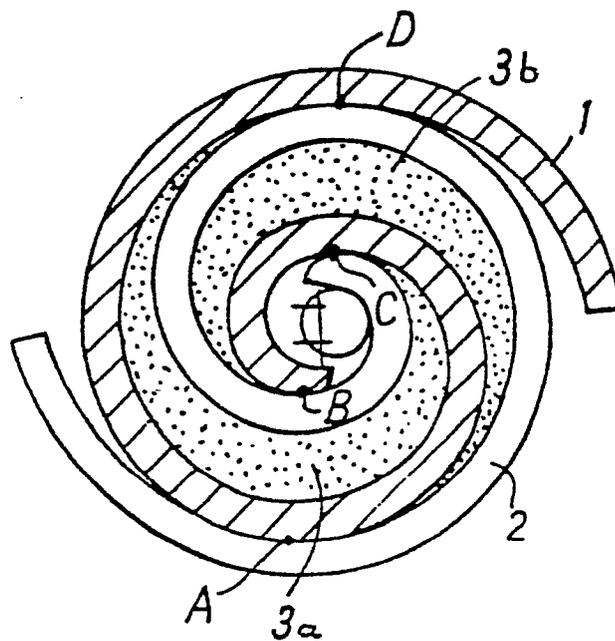
The operation of the presently disclosed receptacle tampering indicator 12 is best disclosed while referring to FIG. 4 of the drawings. As previously disclosed, indicator 12 is attached beneath the receptacle cap 8. In accordance with the present invention, the primary fluid reservoir 14 and the additional fluid path 24 are particularly located so as to be engaged by the rim 40 which is formed at the mouth of the receptacle (designated 1 in FIG. 1), through which a supply of dosage forms may be withdrawn from or loaded within the receptacle. More particularly, when the manufacturer has loaded

FIG. 1

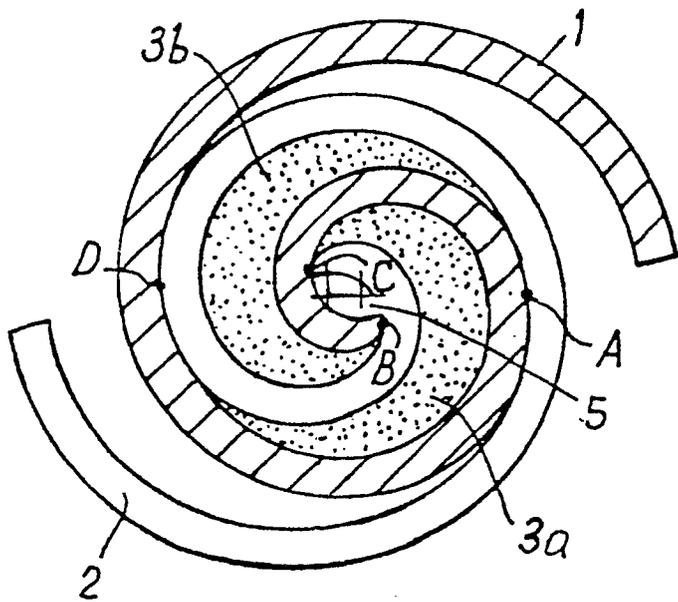
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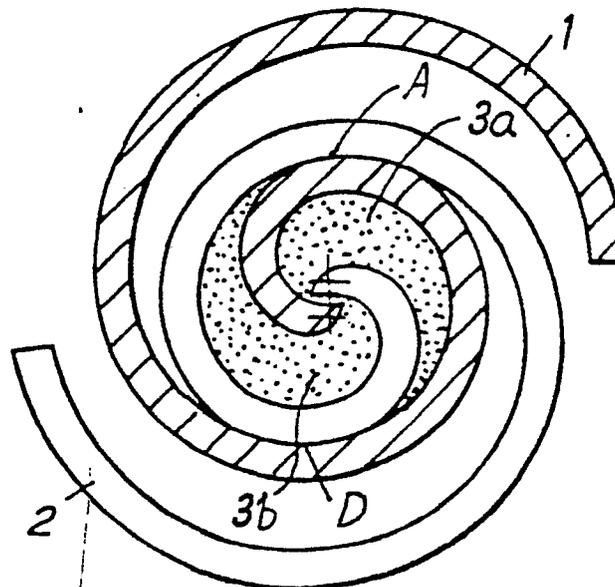
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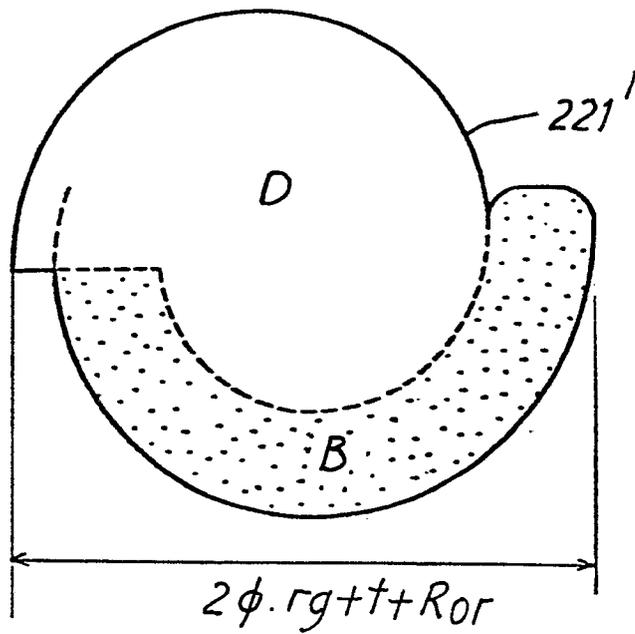
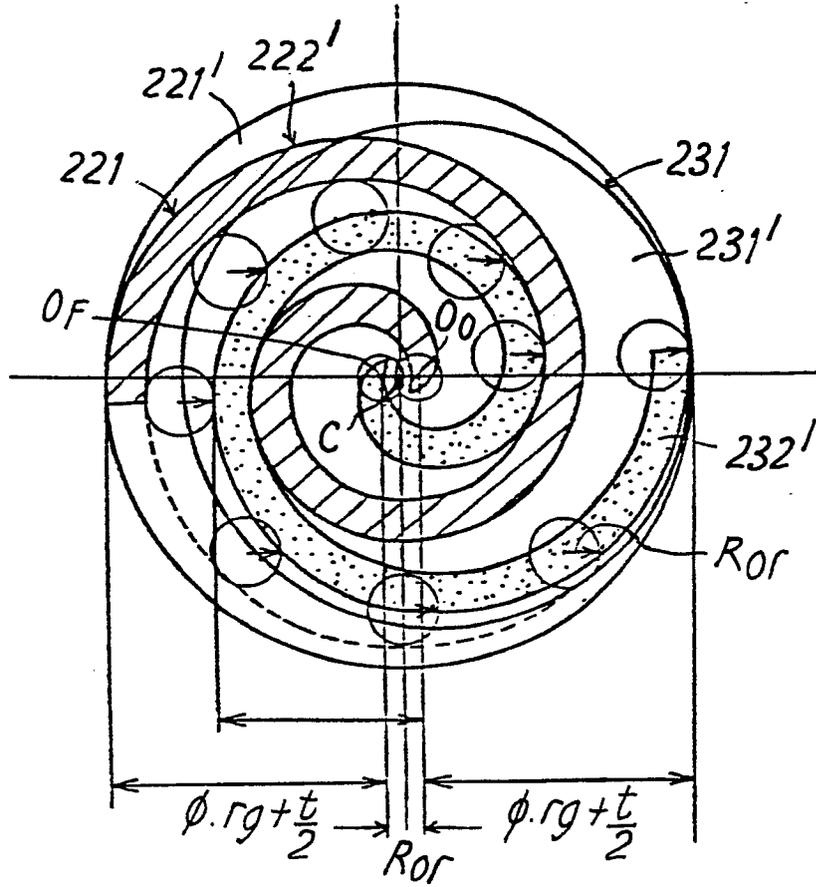


(c)



(d)





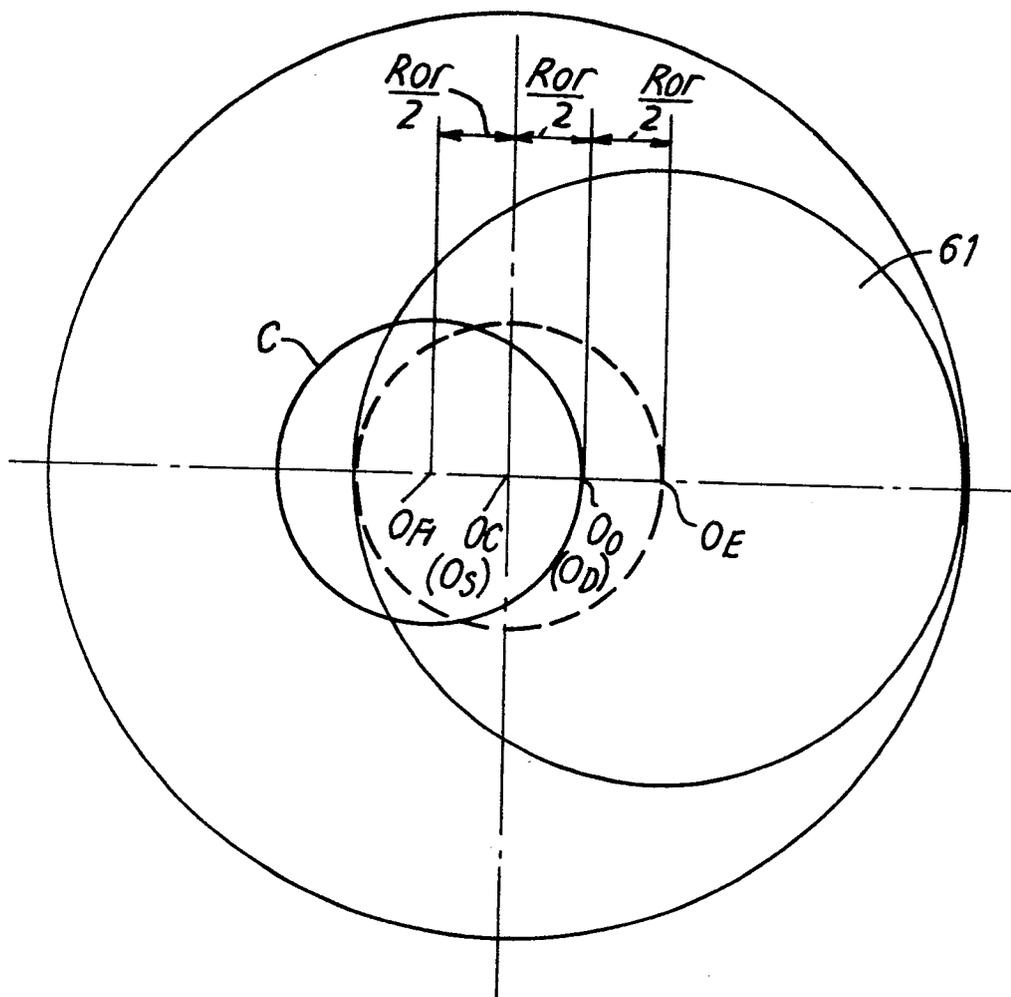
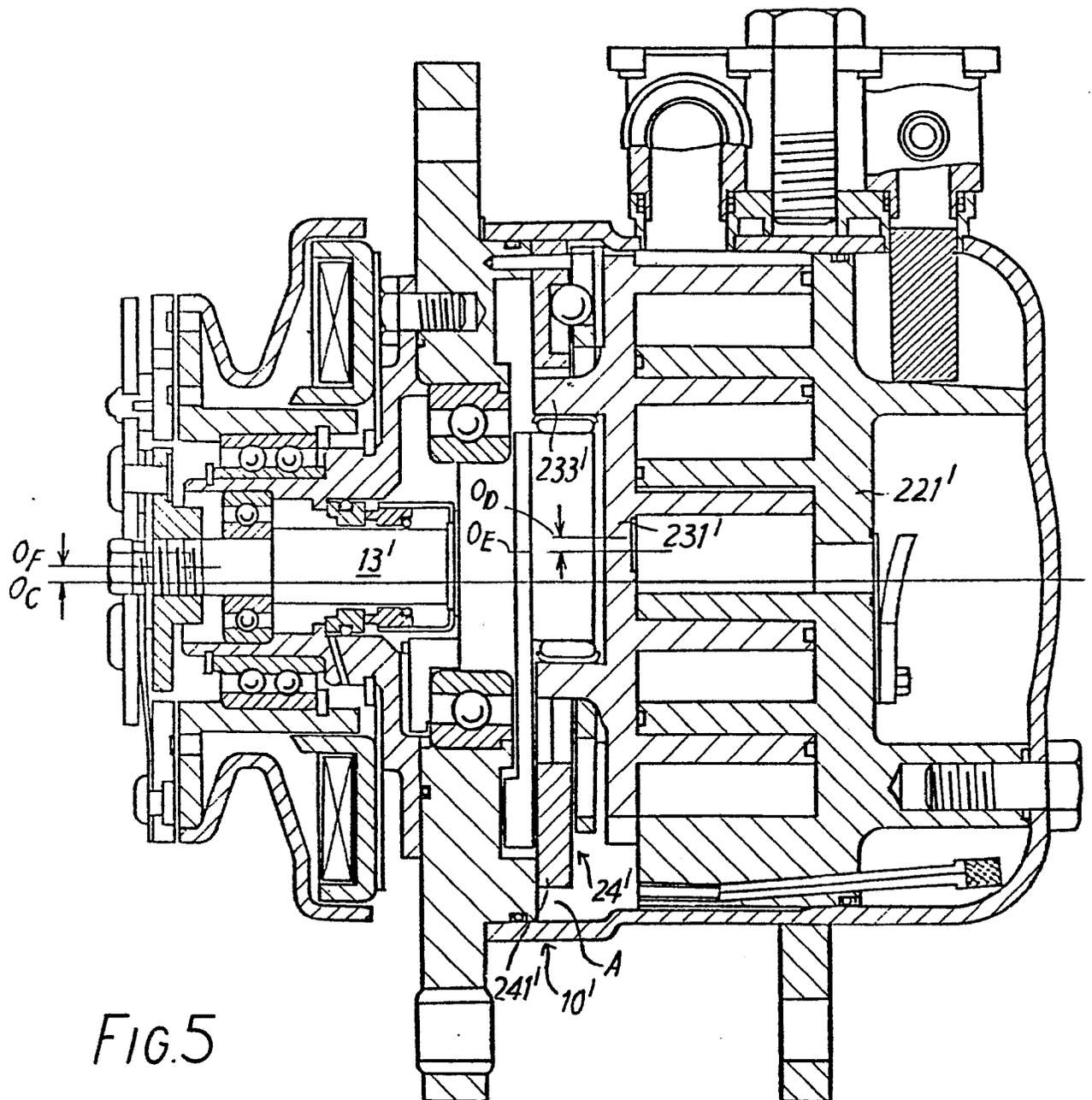


FIG.4



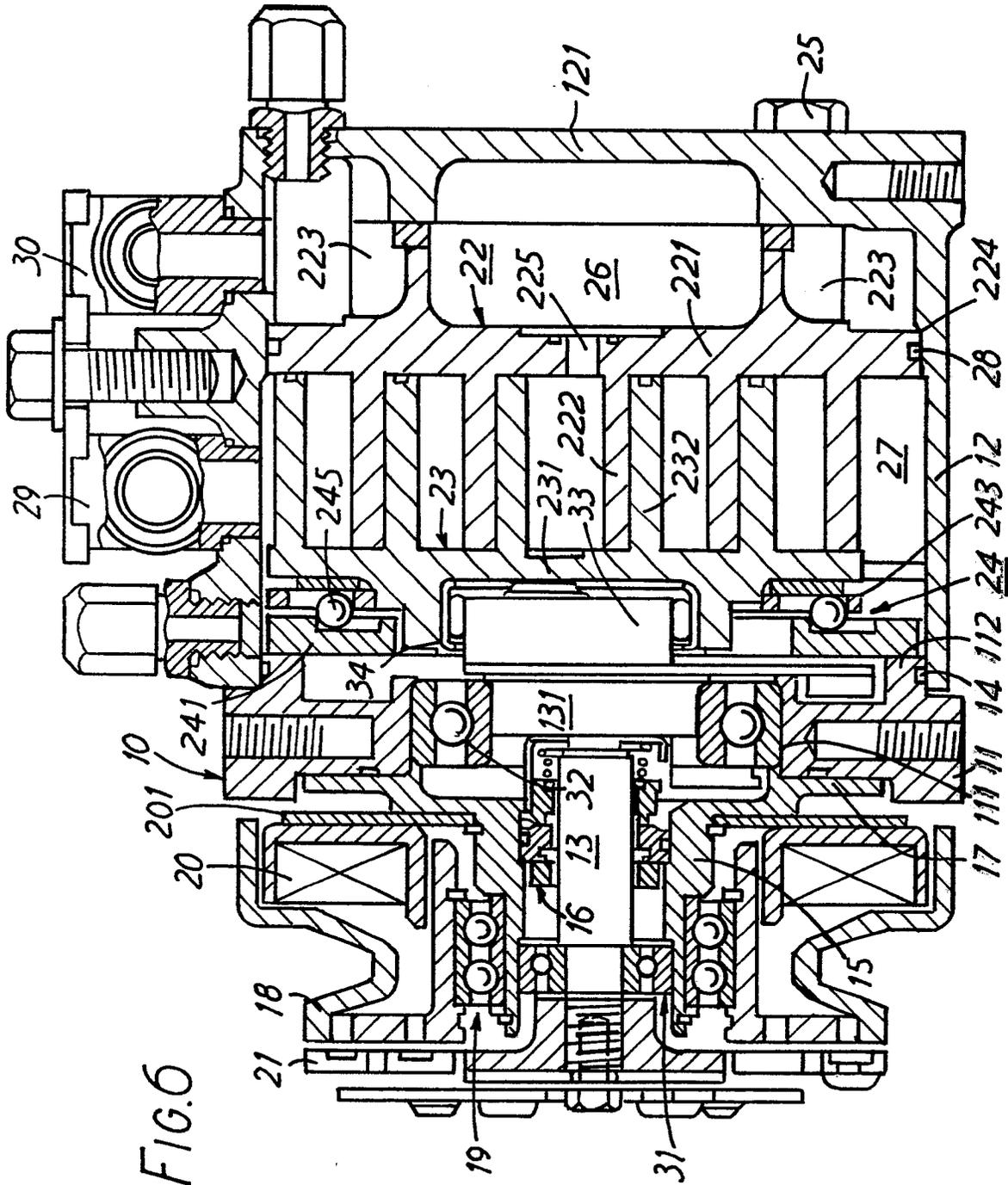
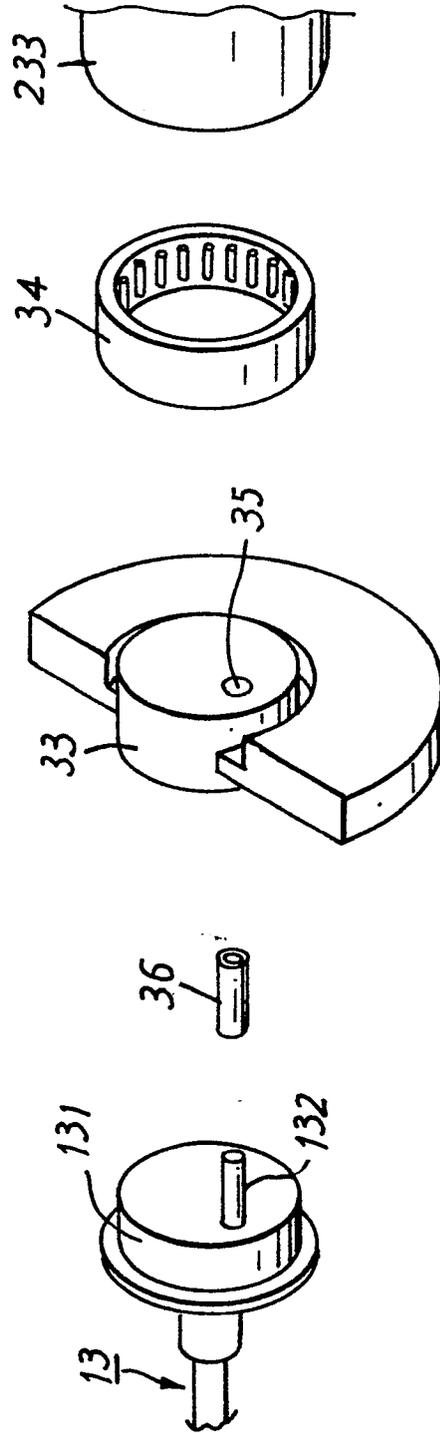


FIG. 6

FIG. 7



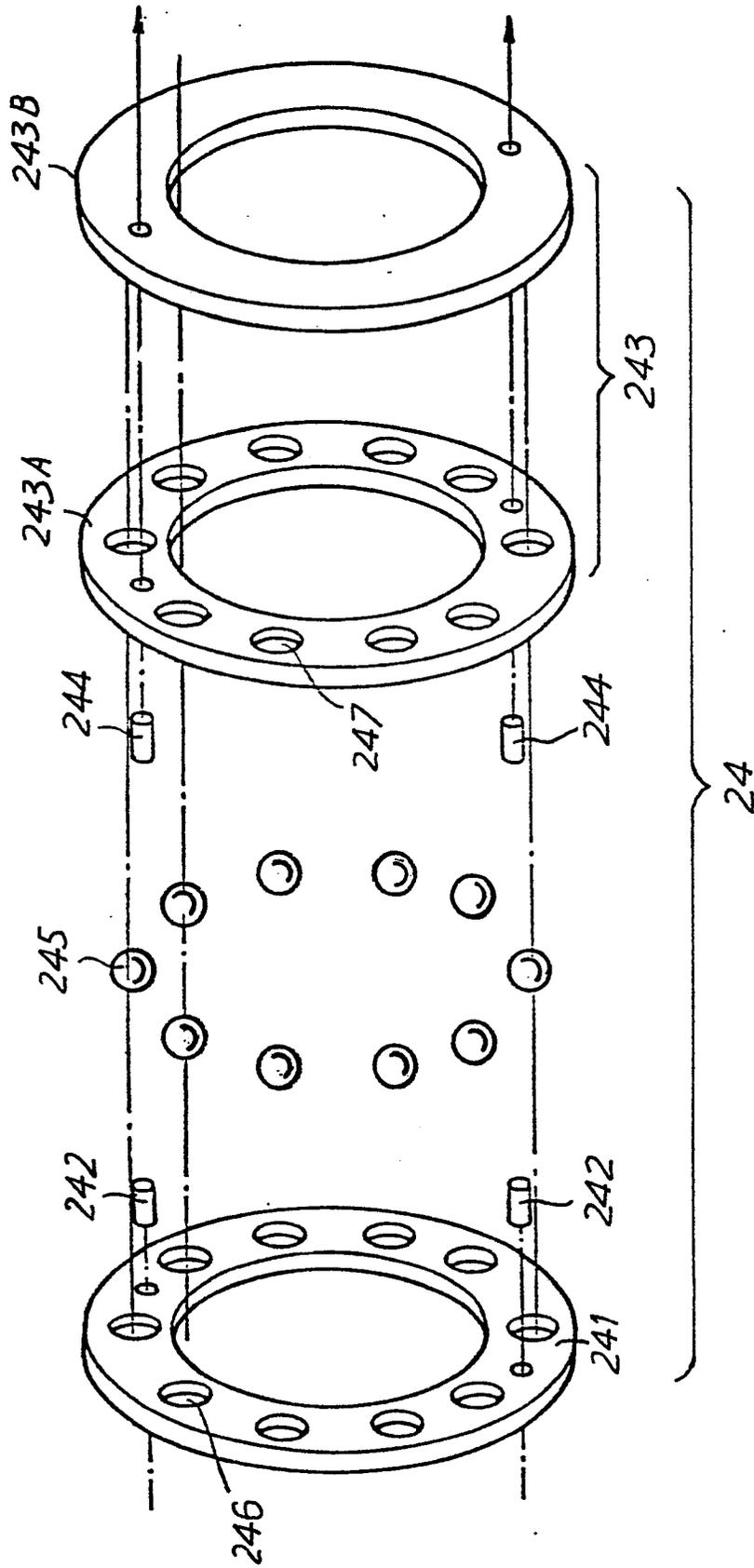


FIG. 8

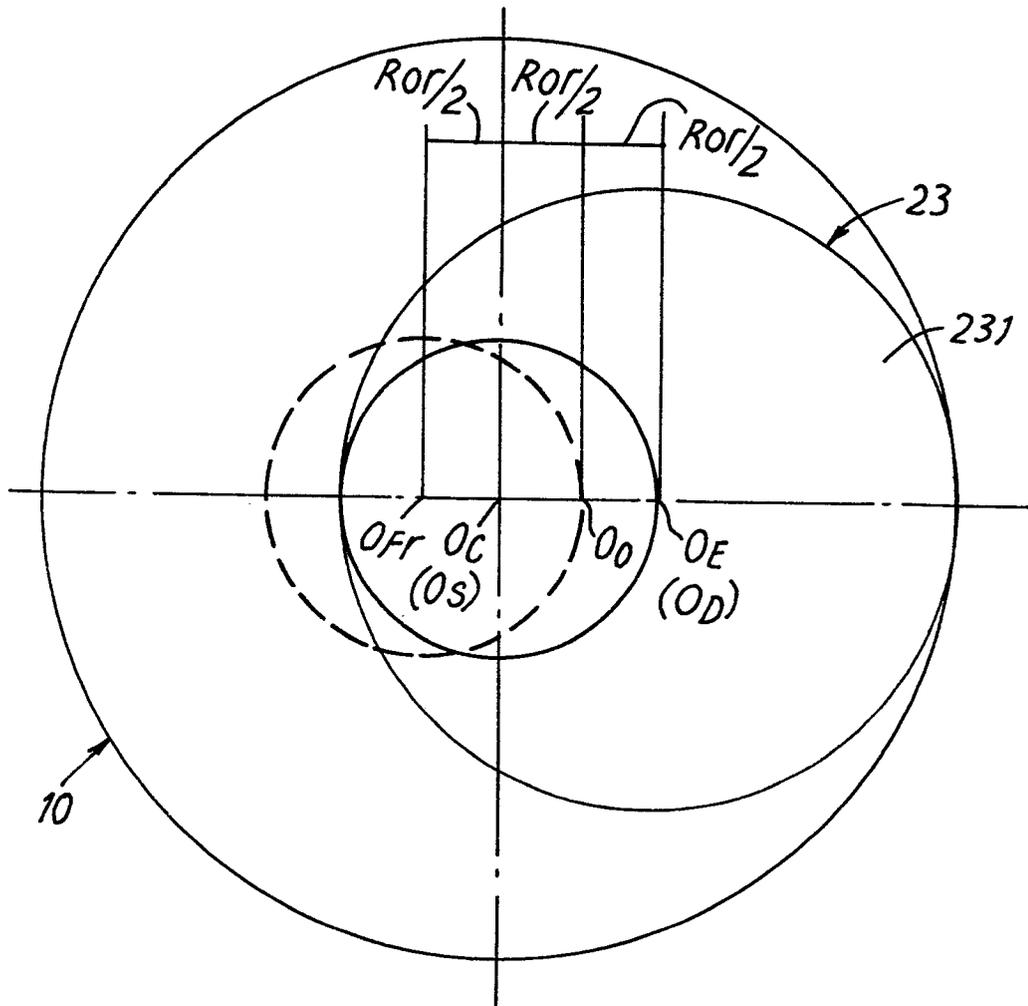


FIG. 9

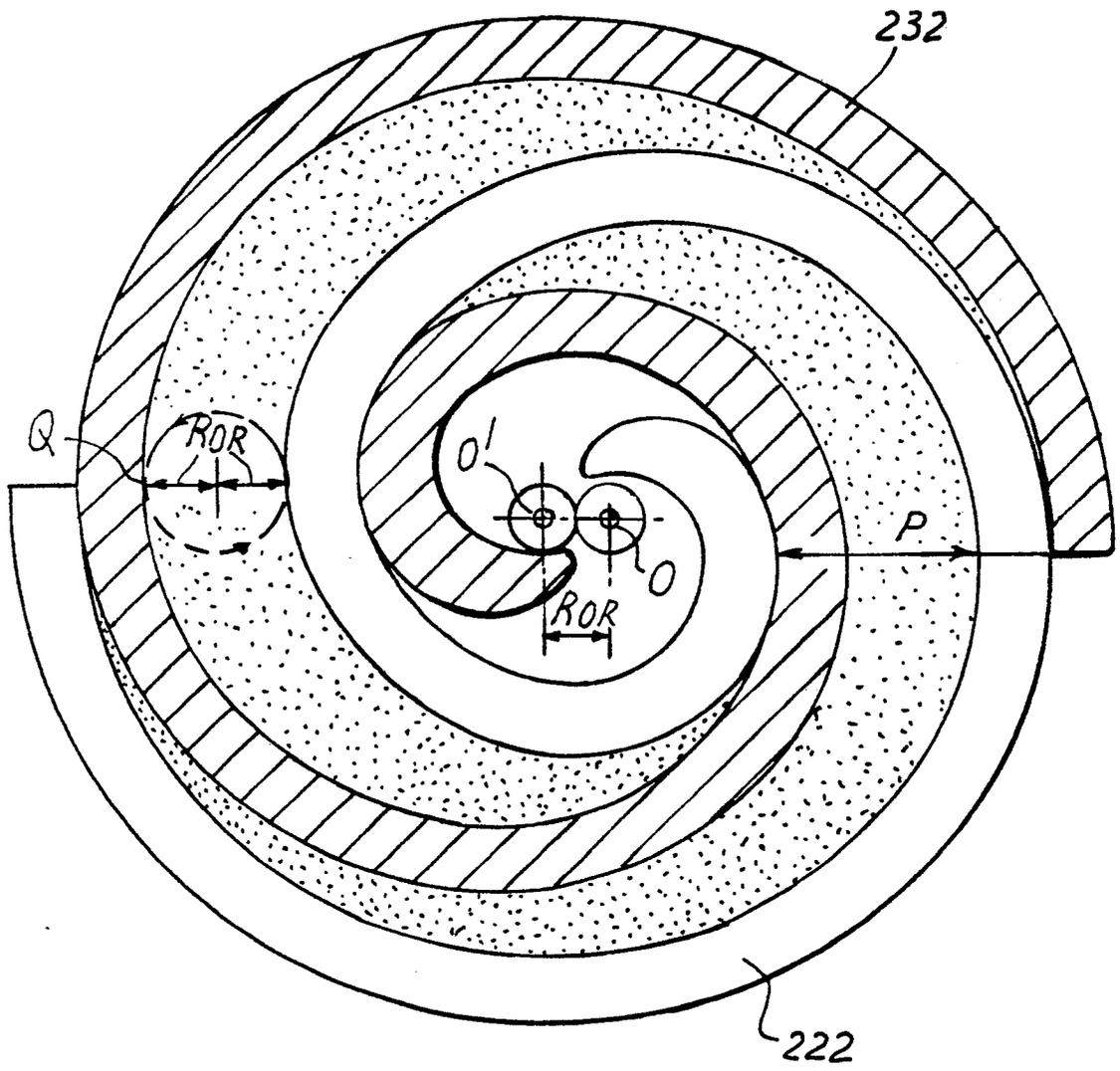


FIG.10



European Patent  
Office

**EUROPEAN SEARCH REPORT**

0105981

Application number

EP 82 30 5402

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Y	EP-A-0 010 402 (SANKYO) * Page 15, last paragraph; page 16; page 17, in particular last paragraph; page 18, two last paragraphs; page 19, lines 1-21; page 22, last paragraph; page 23, first paragraph; figures 4,5,6 *	1,4	F 01 C 1/02
Y	--- EP-A-0 009 355 (SANKYO) * Page 14, line 16 to the end; page 15,16; page 17, first paragraph; page 18, second paragraph; figures 1,4,5 *	1,4	
Y	--- EP-A-0 039 622 (SANKYO) * Page 11, line 15 to the end; page 12, line 24 - page 13, line 10; figures 3,4 *	2,4	
Y	--- DE-A-3 013 785 (HITACHI)  * Page 10, last paragraph; page 11; page 13, second paragraph; figures 1,2 *	1,2,3 4	TECHNICAL FIELDS SEARCHED (Int. Cl. 3)  F 01 C F 04 C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 06-06-1983	Examiner KAPOULAS T.
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			