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(54) Scroll type fluid displacement apparatus with rotation preventing means

(57) In a scroll type fluid displacement apparatus having a rotation preventing mechanism (27) constituted by a combination of a first annular race (27a), a second annular race (27b), and a plurality of balls (27c) arranged between the first and second annular races, the first and the second annular races are formed with radially recessed portions at peripheries thereof and fixed to a movable scroll (26) and a housing with caulking parts of the movable scroll and the housing into the radially recessed portions, respectively. A fixed scroll (25) is fixed to a housing (10). The movable scroll is coupled to the fixed scroll to define fluid pockets in cooperation with the fixed scroll therebetween and is prevented from being rotated relative to the fixed scroll. When the movable scroll is driven to have orbital motion without being rotated, the fluid pockets are displaced between the movable and the fixed scrolls.

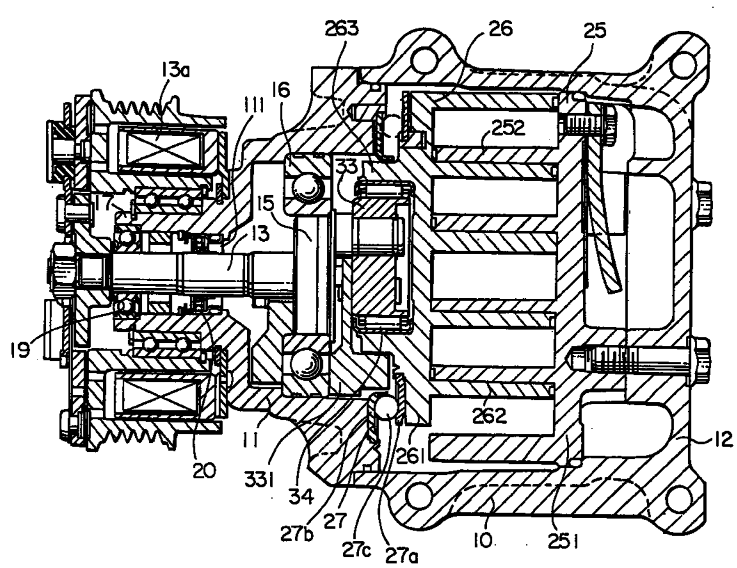

FIG. 1

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Description

Background of the Invention:

The present invention relates to a scroll type fluid displacement apparatus and, in particular, to a mechanism for preventing a movable scroll from being rotated relative to a fixed scroll.

In general, a scroll type fluid displacement apparatus includes a fixed scroll and a movable scroll or orbiting scroll which is coupled to the fixed scroll for defining fluid pockets in cooperation with the fixed scroll therebetween. The movable scroll is prevented from being rotated relative to the fixed scroll while being allowed a circular orbital motion or swing motion thereof. When the movable scroll is caused the orbital motion, the fluid pockets are displaced between the fixed and the movable scrolls. For preventing the movable scroll from being rotated, a rotation preventing mechanism is provided in the fluid displacement apparatus in the manner known in the art.

For such a rotation preventing mechanism, a thrust ball bearing, for example, has been used as disclosed in Japanese First (unexamined) Patent Publication No. 5-33811 or 5-87131.

The thrust ball bearing in the former publication includes a pair of orbit rings or annular races attached to a fixed frame or front housing and a movable scroll, respectively. Each orbit ring is formed with annular orbit grooves, and balls are arranged between the confronting orbit rings with each of the balls received in a corresponding pair of the orbit grooves of the orbit rings. Each orbit ring is fitted in an annular mounting groove formed on the fixed frame or the movable scroll. Then, caulking projections are formed by striking portions of a flange of each orbit ring using a tool such as a punch, thereby preventing the rotation of each orbit ring. As appreciated, recesses are formed in advance at corresponding portions of the fixed frame and the movable scroll so that the caulking is achieved at the positions of the recesses.

Similarly, the thrust ball bearing in the latter publication includes a pair of orbit rings (annular races) attached to a fixed frame (front housing) and a movable scroll, respectively. Each orbit ring is formed with annular orbit grooves, and balls are arranged between the confronting orbit rings with each of the balls received in a corresponding pair of the orbit grooves of the orbit rings. Each orbit ring is fitted in an annular mounting groove formed on the fixed frame or the movable scroll. Each orbit ring is formed at its circumferential portion with a rotation preventing projection. By fitting the projection in a recess formed within the mounting groove, each orbit ring is fixed in angular position relative to the fixed frame or the movable scroll.

In the foregoing former and latter publications, however, since each orbit ring is only fitted in the fixed frame or the movable scroll, that is, each orbit ring is fixed by press fitting, the holding power is not so great. Thus, it is possible that the orbit ring is detached during the high-speed operation.

Further, since each orbit ring is not in contact with the fixed frame or the movable scroll in an axial direction at the inner- and outer-diameter portions thereof, that is, there are clearances therebetween, it is possible that the orbit ring is deformed in a direction to reduce the clearances when performing the foregoing caulking. As a result, the precision of the orbit ring is lowered to not only deteriorate the performance of the fluid displacement apparatus, but also increase the noise.

Further, when assembling the fluid displacement apparatus, it is possible that a ball is dropped in error to the inside of the fixed frame upon trying to put the ball on the orbit ring fixed to the fixed frame. If the fluid displacement apparatus is assembled without taking out the ball, the fluid displacement apparatus may be damaged.

Further, when forming or heat-treating the orbit ring, the orbit ring is subjected to distortion essentially in point symmetry. The distortion of the orbit ring causes a dislocation of a spiral element of the movable scroll relative to that of the fixed scroll, which lowers the performance of the fluid displacement apparatus.

In the latter publication, the orbit ring is formed with the rotation preventing projection. For positioning the projection with accuracy relative to the recess in the mounting groove, the recess should be precisely formed using, for example, the end milling. However, in general, the end milling causes the increase in cost as compared with the lathing.

On the other hand, if forming the recess through molding, such as the die casting, for preventing the cost increase, an unavoidable error is caused within a range of about 0.2mm, thereby lowering the accuracy of the rotation preventing mechanism to induce dispersion in performance of the fluid displacement apparatus. Thus, it is not suitable for the mass production.

Further, in the former and latter publications, it is difficult to adjust a radius of the orbital motion of the movable scroll. This causes dispersion in property of sealing between the spiral elements of the fixed and movable scrolls upon operation of the fluid displacement apparatus, resulting in the low productivity of the fluid displacement apparatus.

Summary of the Invention:

It is therefore an object of the present invention to provide a scroll type fluid displacement apparatus having an improved mechanism for preventing a movable scroll from being rotated relative to a fixed scroll.

It is another object of the present invention to provide a scroll type fluid displacement apparatus of the type described, which is less in price without lowering the performance thereof.

It is still another object of the present invention to provide a scroll type fluid displacement apparatus of the type described, wherein a radius of an orbital motion of a movable scroll can be easily adjusted.

A scroll type fluid displacement apparatus to which this invention is applicable comprises a housing, a fixed scroll fixed to the housing, a movable scroll coupled to the fixed scroll to define fluid pockets in cooperation with the fixed scroll therebetween, a rotation preventing mechanism for preventing the movable scroll from being rotated relative to the fixed scroll, and means for making the movable scroll have an orbital motion with respect to a predetermined axis to displace fluid pockets between the movable and the fixed scrolls.

According to an aspect of this invention, the rotation preventing mechanism comprises a first annular race placed on the movable scroll and extending around the predetermined axis, the first annular race having a first radially recessed portion and being fixed to the movable scroll with caulking a first selected part of the movable scroll into the first radially recessed portion; a second annular race placed on the housing to face the first annular race in a direction parallel to the predetermined axis, the second annular race having a second radially recessed portion and being fixed to the housing with caulking a second selected part of the housing into the second radially recessed portion; and a plurality of balls held between the first and the second annular races for preventing the first annular race from being rotated relative to the second annular race.

According to another aspect of this invention, the rotation preventing mechanism comprises a first annular race placed on the movable scroll and extending around the predetermined axis; a second annular race placed on the housing to face the first annular race in a direction parallel to the predetermined axis; and a plurality of balls held between the first and the second annular races for preventing the first annular race from being rotated relative to the second annular race, each of the first and the second annular races having a given angle between a race surface thereof and a line connecting confronting two points on an outer periphery of each of the first and the second annular races.

Brief Description of the Drawings:

Fig. 1 is a longitudinal sectional view of the scroll type fluid displacement apparatus according to a first embodiment of the present invention;

Figs. 2A through 2C are diagrams for explaining an annular race fixing manner to a movable scroll included in the fluid displacement apparatus of Fig.1, wherein Fig. 2A is a sectional view of a part of a combination of the annular race and the movable scroll, Fig. 2B being a sectional view taken along a line IIB-IIB of Fig. 2A, Fig. 2C being a sectional view taken along a line IIC-IIC of Fig. 2A;

Fig. 2D is a diagram for explaining a modification of the annular race fixing manner shown in Figs. 2A through 2C;

Fig. 3A is a front view of the annular race included in the fluid displacement apparatus of Fig.1;

Fig. 3B is a sectional view taken along line IIIB-O-IIIB of Fig. 3A;

Figs. 4A through 4C are diagrams for explaining an annular race fixing manner to a front end plate included in the fluid displacement apparatus of Fig.1, wherein Fig. 4A is a sectional view of a part of a combination of the annular race and the front end plate, Fig. 4B being a sectional view taken along a line IVB-IVB of Fig. 4A, Fig. 4C being a sectional view taken along a line IVC-IVC of Fig. 4A;

Fig. 4D is a diagram for explaining a modification of the annular race fixing manner shown in Figs. 4A through 4C;

Fig. 5 is a sectional view for explaining assembling of the fluid displacement apparatus of Fig. 1;

Fig. 6 is a diagram for explaining a modification of the fluid displacement apparatus of Fig. 1;

Fig. 7 is a sectional view of a rotation preventing mechanism included in a fluid displacement apparatus according to a second embodiment of the present invention;

Fig. 8 is a sectional view showing a first example of adjustment of a radius of an orbital motion of a movable scroll in the rotation preventing mechanism shown in Fig. 7;

Fig. 9 is a sectional view showing a second example of adjustment of a radius of an orbital motion of a movable scroll by the use of the rotation preventing mechanism shown in Fig. 7;

Fig. 10 is a sectional view showing a third example of adjustment of a radius of the orbital motion of the movable scroll by the use of the rotation preventing mechanism shown in Fig. 7;

Fig. 11 is a diagram showing a fourth example of adjustment of a radius of the orbital motion of the movable scroll by the use of the rotation preventing mechanism shown in Fig. 7; and

Fig. 12 is a sectional view for explaining a modification of the rotation preventing mechanism of Fig. 7.

Description of the Preferred Embodiment:

Referring to Fig. 1, description will be made as regards a scroll type fluid displacement apparatus according to a first embodiment of the present invention. The fluid displacement apparatus is for compressing fluid and therefore will be called hereinafter a scroll type compressor. Such a scroll type compressor includes a rotation preventing mechanism 27 in the manner which will become clear from the following description.

The scroll type compressor includes a compressor housing 10. The compressor housing 10 includes a funnel-shaped front end plate or a front housing 11 and a cup-shaped casing 12. The front end plate 11 is formed at the center thereof with an opening 111 for receiving therethrough a main shaft 13. The main shaft 13 is formed with a main shaft large-diameter portion 15 at its axially inner end. The large-diameter portion 15 is rotatably supported by the front end plate 11 via a ball bearing 16 interposed therebetween. A disc-shaped bushing 33 is coupled to the large-diameter portion 15 so as to be eccentric relative to the main shaft 13.

The front end plate 11 has a sleeve 17 extending forward and encircling the main shaft 13. A ball bearing 19 is disposed at a front end of the sleeve 17 so as to rotatably support the main shaft 13. A shaft seal unit 20 is disposed on the main shaft 13 in the sleeve 17 for sealing. The rotation of an external driving source, such as an automobile engine, is transmitted to the main shaft 13 via an electromagnetic clutch 13a.

Within the cup-shaped casing 12 are disposed a fixed scroll 25, a movable scroll 26 and the rotation preventing mechanism 27. The fixed scroll 25 includes a circular end plate 251 and a spiral element 252 fixed to the end plate 251 at one side thereof. The end plate 251 is fixed to the cup-shaped casing 12. The movable scroll 26 includes a circular end plate 261 and a spiral element 262 fixed to the end plate 261 at one side thereof. An annular boss 263 is provided on the end plate 261 of the movable scroll 26 on a side thereof opposite to the side where the spiral element 262 is provided. The bushing 33 is received in the boss 263 and rotatably supported via a needle bearing 34. A semidisc-shaped balance weight 331 is attached to the bushing 33 so as to extend in a radial direction of the bushing 33.

The spiral element 262 is interfitted or mated with the spiral element 252 with a phase deviation of 180 degrees so as to define fluid pockets therebetween. The movable scroll 26 is coupled to the rotation preventing mechanism 27 so as to be prevented from rotation on its axis. On the other hand, the movable scroll 26 makes an orbital motion on a given circular orbit depending on the rotation of the main shaft 13 on a predetermined axis. The orbital motion of the movable scroll 26 displaces the fluid pockets to thereby compress the introduced fluid as in the known manner.

The rotation preventing mechanism 27 includes first and second annular races 27a and 27b and a plurality of balls 27c arranged between the annular races 27a and 27b at regular intervals in a circumferential direction thereof. The race 27a is fixed to the end plate 261 of the movable scroll 26, while the race 27b is fixed to the front end plate 11. On each of the confronting surfaces of the races 27a and 27b, a plurality of axial recesses are formed at regular intervals in the circumferential direction for receiving therein the corresponding balls 27c, respectively. The balls 27c prevents the race 27a from being rotated relative to the race 27b. Each axial recess has a cross section of a circular shape so that each ball 27s rolls within the corresponding pair of axial recesses of the races 27a and 27b. A diameter of each axial recess is designed taking into consideration of a radius of the orbital motion of the movable scroll 26.

Referring to Figs. 2A through 2C, the description will be directed to a manner of fixing the annular race 27a to the end plate 261 of the movable scroll 26. On the side of the end plate 261 where the boss 263 is provided, an annular portion 26a having a diameter slightly smaller than an inner diameter of the annular race 27a is formed as a first axially projecting portion. The annular race 27a is fitted around the annular portion 26a at its inner periphery or circumference.

In Fig. 2A, the annular race 27a is provided with a plurality of first radially recessed portions or cutout portions 40 (only one cutout portion 40 is shown in Fig. 2A) arranged at regular intervals along the inner periphery of the annular race 27a and each extending a given distance along the inner periphery of the annular race 27a. By positioning a jig having a pawl-shaped projection relative to the cutout portion 40 and then caulking a first selected part of the end plate 261 in the manner known in the art, the end plate 261 is partly gathered to the cutout portion 40 as shown in Figs. 2B and 2C. Through this caulking operation, the annular race 27a is securely fixed to the end plate 261. A caulked portion is designated by a reference numeral 261-1.

The annular race 27a is further formed with a positioning hole 41 at a given position, and the end plate 261 is also formed with a positioning hole (not shown) at a given position. Upon positioning the annular race 27a relative to the end plate 261, a pin is inserted into the positioning holes of the annular race 27a and the end plate 261. Then, the foregoing caulking operation is performed. Alternatively, as shown in Figs. 3A and 3B, it may be arranged that a pin-shaped projection 271 is formed as a positioning projection at a given position on the annular race 27a through burring (in this case, the positioning hole 41 is not formed in the annular race 27a). Then, upon positioning the annular race 27a relative to the end plate 261, the projection 271 is inserted into the positioning hole on the end plate 261.

As shown in Fig. 2D, if the cutout portion 40 is formed deeper in a radial direction of the annular race 27a, the holding power in a rotation direction can be increased after the annular race 27a is fixed to the end plate 261 as in the foregoing manner.

Referring to Figs. 4A through 4C, the description will be made as regards a manner of fixing the annular race 27b to the front end plate 11. On an axially inner end surface of the front end plate 11, an annular portion 11a having an inner diameter slightly greater than an outer diameter of the annular race 27b is formed as a second axially projecting portion. The annular race 27b is fitted in the annular portion 11a at its outer periphery or circumference.

In Fig. 4A, the annular race 27b is provided with a plurality of second radially recessed portions or cutout portions 42 (only one cutout portion 42 is shown in Fig. 4A) arranged at regular intervals along the outer periphery of the annular race 27b and each extending a given distance along the outer periphery of the annular race 27b. By positioning a jig having a pawl-shaped projection relative to the cutout portion 42 and then caulking a second selected part of the front end plate 11, the front end plate 11 is partly gathered to the cutout portion 42 as shown in Figs. 4B and 4C. Through this caulking operation, the annular race 27b is securely fixed to the front end plate 11. A caulked portion is designated by a reference numeral 11-1.

The annular race 27b is further formed with a positioning hole 43 at a given position, and the front end plate 11 is also formed with a positioning hole (not shown) at a given position. Upon positioning the annular race 27b relative to the front end plate 11, a pin is inserted into the positioning holes of the annular race 27b and the front end plate 11. Then, the foregoing caulking operation is performed. Alternatively, it may be arranged that a pin-shaped projection is formed at a given position on the annular race 27b like the annular race 27a without forming the positioning hole 43, and this projection is inserted into the positioning hole on the front end plate 11 so as to achieve positioning of the annular race 27b relative to the front end plate 11.

As shown in Fig. 4D, if the cutout portion 42 is formed deeper in a radial direction of the annular race 27b, the holding power in a rotation direction can be increased after the annular race 27b is fixed to the front end plate 11 as in the foregoing manner.

On the other hand, if the annular race 27a, 27b is small in thickness, it may be arranged to form no cutout portions on the corresponding annular race. In this case, if the height of the corresponding annular portion 26a, 11a is set greater than the thickness of the annular race, the annular race can be securely fixed.

Referring to Fig. 5 shortly, when assembling the rotation preventing mechanism 27 as described above, a rotation preventing mechanism assembling pedestal 44 is used. The pedestal 44 has a through bore 45 at the center thereof. The front end plate 11 with the main shaft 13 mounted thereto is placed on the pedestal 44. In this case, the main shaft 13 is inserted into the through bore 45 as shown in Fig. 5.

The annular races 27a and 27b are fixed to the movable scroll 26 and the front end plate 11, respectively, as described with reference to Figs. 2A through 2C and 4A through 4C. In this case, it may be arranged that an inner periphery of the annular race 27b is bent toward the annular race 27a so as to form a flange 271 along the whole inner periphery or flanges 271 at portions of the inner periphery. By providing the flange or flanges 271, the ball 27c disposed on the annular race 27b is prevented from falling to the inside of the front end plate 11 when assembling the compressor.

The annular races 27a and 27b are produced in the same facilities and processes and have the same shape. In general, a member having symmetry, such as the annular race, is subjected to symmetric distortion during the heat treatment such that it becomes convex or concave at the center thereof, that is, it has the shape of conical surface of an extremely large obtuse angle. When these races are arranged to confront each other, the distortions are offset or canceled so that the movable scroll 26 is unchanged in distance from the front end plate 11 to achieve the smooth orbital motion thereof.

Referring back to Fig. 5, when the axial recesses are formed on the annular races 27a and 27b for receiving therein the balls 27c as described before, corresponding convex portions are formed on the backsides of the annular races 27a and 27b. On the other hand, at the root portions of the annular portions 26a and 11a, first and second stepped portions 26b and 11b are formed, respectively. A height (step magnitude) of the stepped portion 26b, 11b, that is, a distance from a step of the stepped portion 26a, 11b to the root of the annular portion 26a, 11a in the axial direction of the main shaft 13 in Fig. 5, is set equal to a projecting magnitude of the convex portion formed on the backside of the annular race 27a, 27b and thus is set small. Since the annular race 27a, 27b is received by the step of the stepped portion 26b, 11b, the annular race 27a, 27b is prevented from distortion when the annular race 27a, 27b is fixed to the end plate 261 of the movable scroll 26 or the front end plate 11 by means of caulking.

On the other hand, as shown in Fig. 6, if, for example, the root portion of the annular portion 26a of the end plate 261 is tapered to have a first tapering surface as shown by the broken line, the inner edge of the annular race 27a cuts into the tapered root portion upon caulking the end plate 261 so that the tapered root portion is deformed as shown by the solid line to ensure the fixation of the annular race 27a more securely. Similarly, the root portion of the annular portion 11a of the front end plate 11 may be tapered to have a second tapering surface which is similar to the first tapering surface.

Referring to Figs. 7 through 11, the description will now be directed to a scroll type fluid displacement apparatus or compressor according to a second embodiment of the present invention.

In Fig. 7, annular races 27a and 27b are made of an elastic material and fixed to the end plate 261 of the movable scroll 26 and the front end plate 11, respectively.

As described above, each of the annular races 27a and 27b may be subjected to the distortion during the heat treatment so as to be convex or concave at the center thereof, that is, it may have the shape of conical surface of an extremely large obtuse angle. Fig. 7 shows the state wherein each of the annular races 27a and 27b is concave at the center thereof.

Assuming that a radius of the orbital motion of the movable scroll 26 is R0, a radius of the ball 27c is r, a diameter of the ball 27c is D, a distortion angle of each of the annular races 27a and 27b, that is, a taper angle thereof, is ϕ, a distance from the center of the ball 27c to the highest portion of the annular race 27b is H1, a distance from the center of the ball 27c to the highest portion of the annular race 27a is H2, and a thickness of each of the annular races 27a and 27b is t, the orbital motion radius R0 is given by the following equation (1):

$$R0 = 2 \cdot r \cdot \cos\phi \qquad (1)$$

The distances H1 and H2 are given by the following equations (2) and (3), respectively:

$$H1 = t + D/2 + r \cdot \sin\phi \cdot (1 + \sin(\theta + \pi/2)) \quad (2)$$

$$H2 = t + D/2 + r \cdot \sin\phi \cdot (1 - \sin(\theta + \pi/2)) \quad (3)$$

In the foregoing equations, θ represents a swing phase angle of the rotation preventing mechanism 27. In Fig. 7, $\theta = \pi/2$ (rad) on the stationary side, that is, on the side of the annular race 27b, and $\theta = \pi/2$ (rad) on the swing side, that is, on the side of the annular race 27a.

Thus, the sum of the distances H1 and H2 is given by the following equation (4):

$$H1 + H2 = 2 \cdot t + D + 2 \cdot r \cdot \sin\phi \quad (4)$$

As clear from the equation (3), the movable scroll 26 is constant in distance from the front end plate 11 regardless of the swing phase angle θ. That is, the orbital motion radius R0 can be easily adjusted by adjusting the taper angle ϕ.

Referring to Fig. 8, the adjustment of the orbital motion radius R0 will be described hereinbelow.

For example, a tapering surface having a taper angle ϕ' (ϕ' differs from ϕ) is formed on a race receiving surface 111 of the front end plate 11, and the annular race 27b is fixed to the front end plate 11 such that the taper angle ϕ of the annular race 27b becomes the taper angle ϕ' of the race receiving surface 111. It may be arranged that a tapering surface is formed likewise on a race receiving surface of the end plate 261 of the movable scroll 26 so as to adjust the taper angle of the annular race 27a.

As shown in Fig. 9, it may be arranged that a spacer 112 having a given taper angle (for example, ϕ') is disposed on a race receiving surface 111 of the front end plate 11, and the annular race 27b is mounted on the spacer 112. In this regard, it may be further arranged that a plurality of spacers having different taper angles are provided and one of them is selected depending on the orbital motion radius R0. It may be arranged that a spacer is disposed likewise on a race receiving surface of the end plate 261 of the movable scroll 26 so as to adjust the taper angle of the annular race 27a.

As shown in Fig. 10, it may be arranged to form a stepped portion 113 on a race receiving surface 111 of the front end plate 11. The stepped portion 113 is set to have a height such that the inclination angle (taper angle) of the annular race 27b becomes, for example, ϕ' when the annular race 27b is disposed on the race receiving surface 111. It may be arranged that a stepped portion is formed likewise on a race receiving surface of the end plate 261 of the movable scroll 26 so as to adjust the taper angle of the annular race 27a.

As shown in Fig. 11, it may be arranged that a spacer 114 having a rectangular shape in cross-section is disposed on a race receiving surface 111 of the front end plate 11 so as to form a stepped portion on the race receiving surface 111. Like the stepped portion 113, the spacer 114 is set to have a height such that the inclination angle (taper angle) of the annular race 27b becomes, for example, ϕ' when the annular race 27b is disposed on the race receiving surface 111. It may be further arranged that a plurality of spacers having different heights (step magnitudes) are provided and one of them is selected depending on the orbital motion radius R0. It may be arranged that a spacer is disposed likewise on a race receiving surface of the end plate 261 of the movable scroll 26 so as to adjust the taper angle of the annular race 27a.

Referring to Fig. 12, the description will be made as regards a modification of the rotation preventing mechanism 27. On each of the confronting surfaces of the races 27a and 27b, a plurality of annular grooves are formed at regular intervals in the circumferential direction for receiving therein the corresponding balls 27c, respectively. Each groove has a cross section of a circular arc having a radius of curvature slightly greater than that of the ball 27c so that each ball 27c rolls along the corresponding pair of grooves of the races 27a and 27b. A diameter of a circular orbit along a bottom of each groove is set substantially equal to a radius of the orbital motion of the movable scroll 26. With this structure, it becomes possible to adjust the orbital motion radius R0. Japanese Laid-open (Unexamined) Patent Publication No. 33811/1993 (JP-A-5-33811), the disclosure of which is herein incorporated by reference, discloses a thrust ball bearing corresponding to the modification of the rotation preventing mechanism 27.

As described above, the annular races 27a and 27b can be fixed easily and reliably. This can prevent the cost increase and further prevent lowering of the compressor performance owing to improvement in durability. Further, the radius of the orbital motion of the movable scroll can be easily adjusted only by adjusting the taper angles of the annular races 27a and 27b.

While the present invention has thus far been described in conjunction with a few embodiments, it will readily be understood for those skilled in the art to put this invention into practice in various other manners.

Claims

1. A scroll type fluid displacement apparatus comprising a housing, a fixed scroll fixed to said housing, a movable scroll coupled to said fixed scroll to define fluid pockets in cooperation with said fixed scroll therebetween, a rotation preventing mechanism for preventing said movable scroll from being rotated relative to said fixed scroll, and means for making said movable scroll have an orbital motion with respect to a predetermined axis to displace fluid pockets between said movable and said fixed scrolls, said rotation preventing mechanism comprising:

   a first annular race placed on said movable scroll and extending around said predetermined axis, said first annular race having a first radially recessed portion and being fixed to said movable scroll with caulking a first selected part of said movable scroll into said first radially recessed portion;

a second annular race placed on said housing to face said first annular race in a direction parallel to said predetermined axis, said second annular race having a second radially recessed portion and being fixed to said housing with caulking a second selected part of said housing into said second radially recessed portion; and

a plurality of balls held between said first and said second annular races for preventing said first annular race from being rotated relative to said second annular race.

2. A scroll type fluid displacement apparatus as claimed in claim 1, wherein said first radially recessed portion is made at an inner periphery of said first annular race, said second radially recessed portion being made at an outer periphery of said second annular race.

3. A scroll type fluid displacement apparatus as claimed in claim 1, wherein said second annular race has a flange extending towards said first annular race.

4. A scroll type fluid displacement apparatus as claimed in claim 1, wherein said movable scroll has a first axially projecting portion, said first selected part being a part of said first axially projecting portion, said housing having a second axially projecting portion, said second selected part being a part of said second axially projecting portion.

5. A scroll type fluid displacement apparatus as claimed in claim 4, wherein said movable scroll has a first stepped portion adjacent to said first axially projecting portion, said housing having a second stepped portion adjacent to said second axially projecting portion, said first and said second stepped portions receiving said first and said second annular races, respectively.

6. A scroll type fluid displacement apparatus as claimed in claim 4, wherein each of said first and said second projecting portions has a height greater than a thickness of the corresponding one of said first and said second annular races.

7. A scroll type fluid displacement apparatus as claimed in claim 4, wherein each of said movable scroll and said housing has a tapering surface adjacent to each of said first and said second axially projecting portions.

8. A scroll type fluid displacement apparatus as claimed in claim 1, wherein each of said first and said second annular races has a positioning projection, each of said movable scroll and said housing having a positioning hole for receiving said positioning projection therein, and wherein positioning of said first and said second annular race relative to said movable scroll and said housing is performed using said positioning projections and said positioning holes when said first and said second annular races are fixed to said movable scroll and said housing.

9. A scroll type fluid displacement apparatus comprising a housing, a fixed scroll fixed to said housing, a movable scroll coupled to said fixed scroll to define fluid pockets in cooperation with said fixed scroll therebetween, a rotation preventing mechanism for preventing said movable scroll from being rotated relative to said fixed scroll, and means for making said movable scroll have an orbital motion with respect to a predetermined axis to displace fluid pockets between said movable and said fixed scrolls, said rotation preventing mechanism comprising:

a first annular race placed on said movable scroll and extending around said predetermined axis;

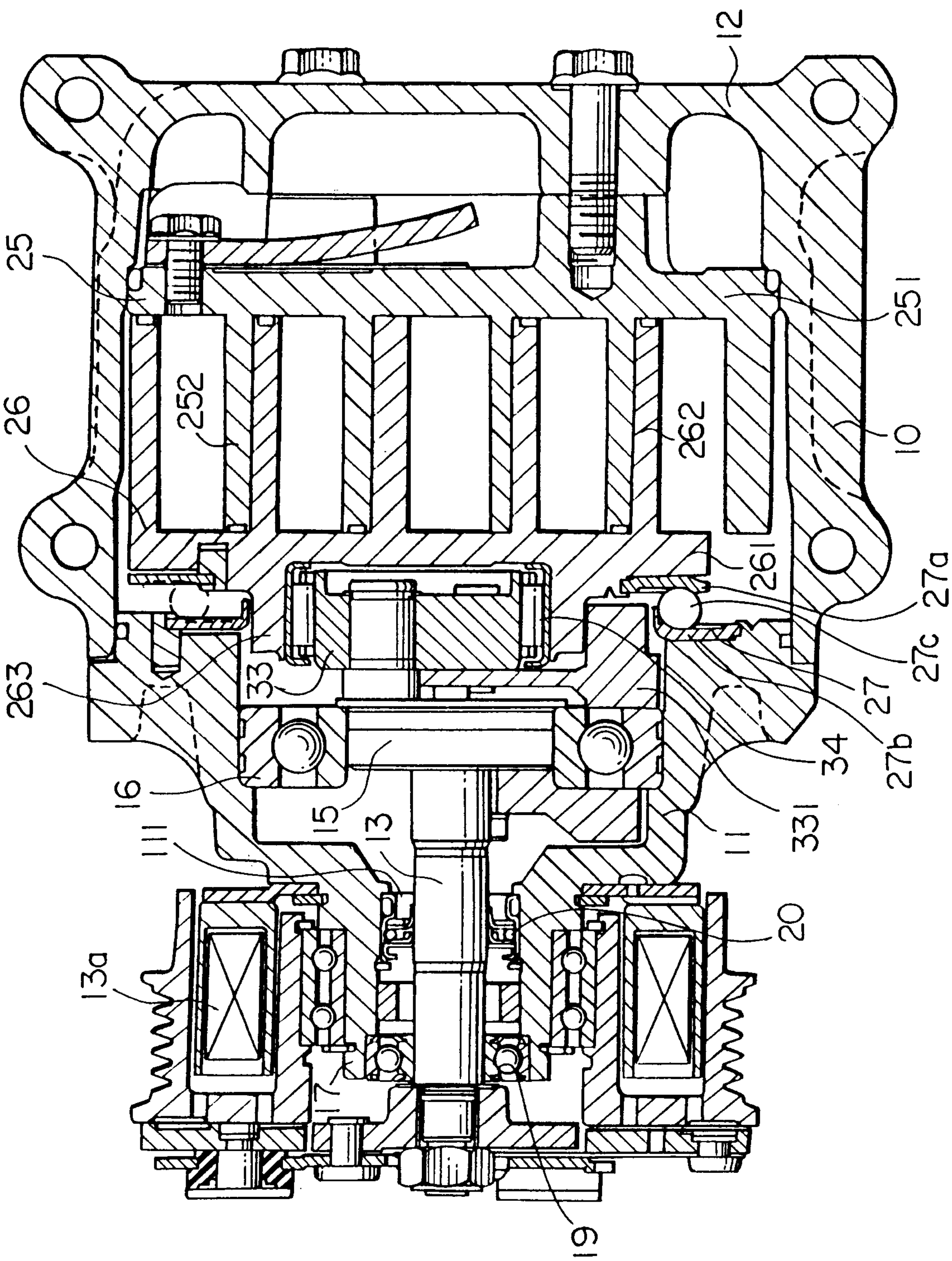
a second annular race placed on said housing to face said first annular race in a direction parallel to said predetermined axis; and

a plurality of balls held between said first and said second annular races for preventing said first annular race from being rotated relative to said second annular race;

each of said first and said second annular races having a given angle between a race surface thereof and a line connecting confronting two points on an outer periphery of each of said first and said second annular races.

10. A scroll type fluid displacement apparatus as claimed in claim 9, wherein said given angle is an acute angle.

11. A scroll type fluid displacement apparatus as claimed in claim 10, wherein each of said movable scroll and said housing has means for adjusting said given angle of the corresponding one of said first and said second annular races.


12
25
251
252
26
262
261
263
27a
27c
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27b
33
34
331
15
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111
20
13a
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19
10

FIG. 1

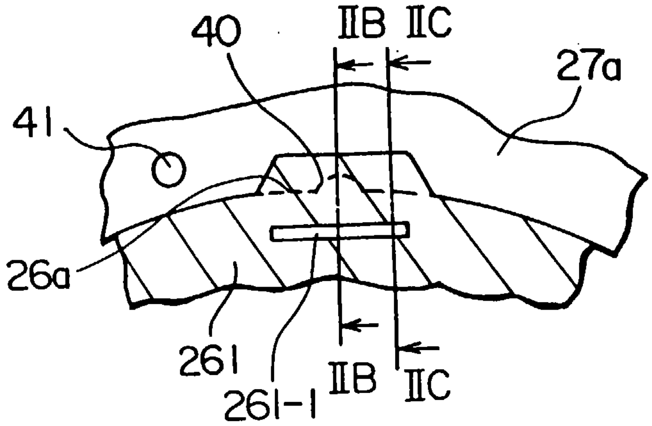

FIG. 2A

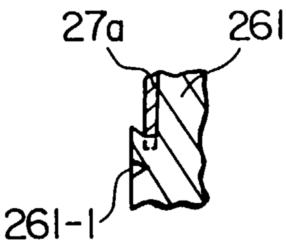

FIG. 2B

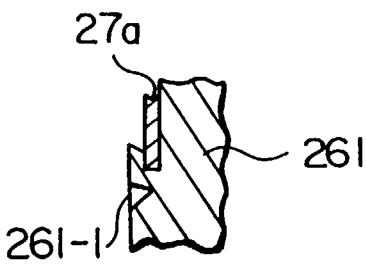

FIG. 2C

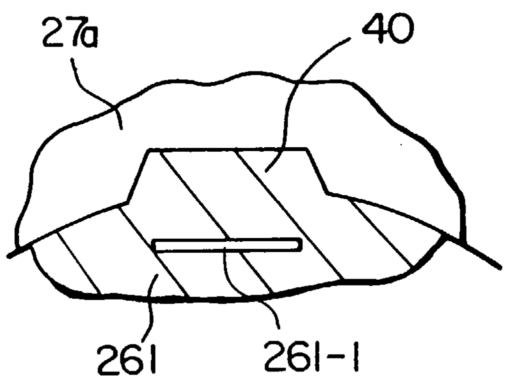

FIG. 2D

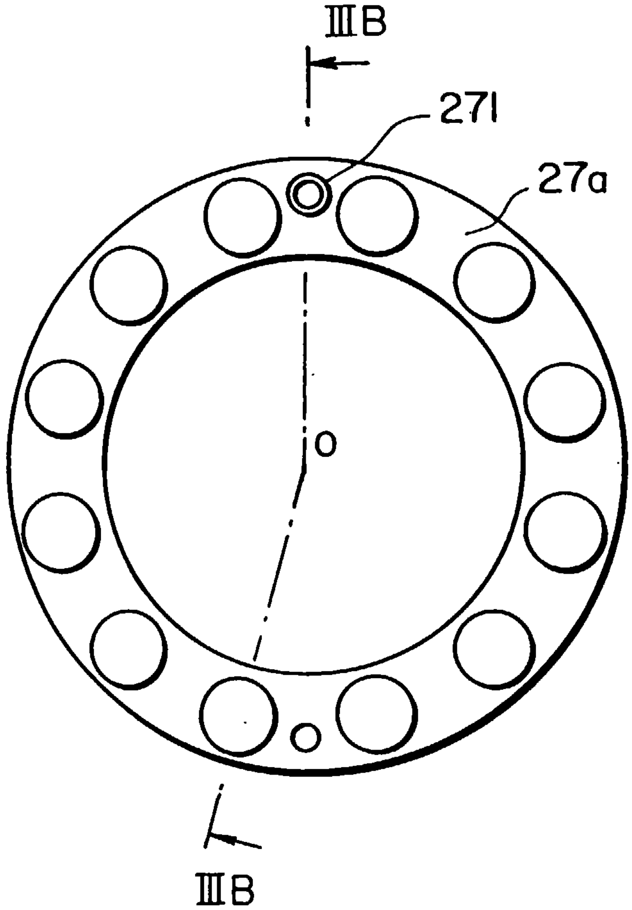

FIG. 3A

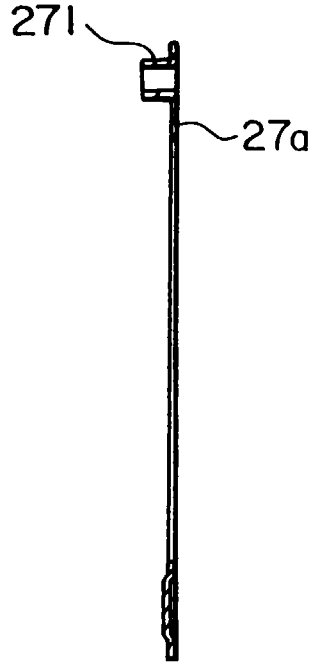

FIG. 3B

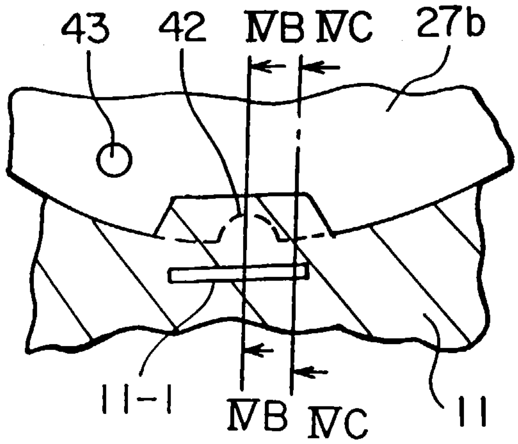

FIG. 4A

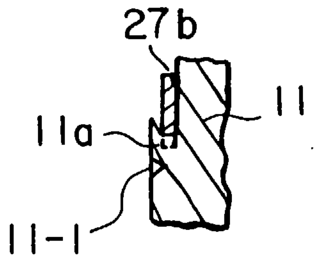

FIG. 4B

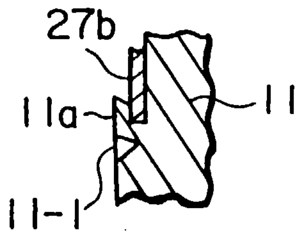

FIG. 4C

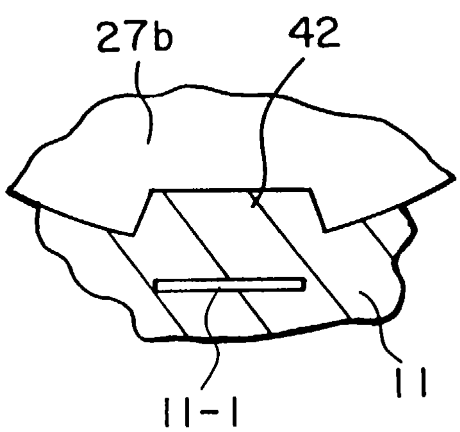

FIG. 4D

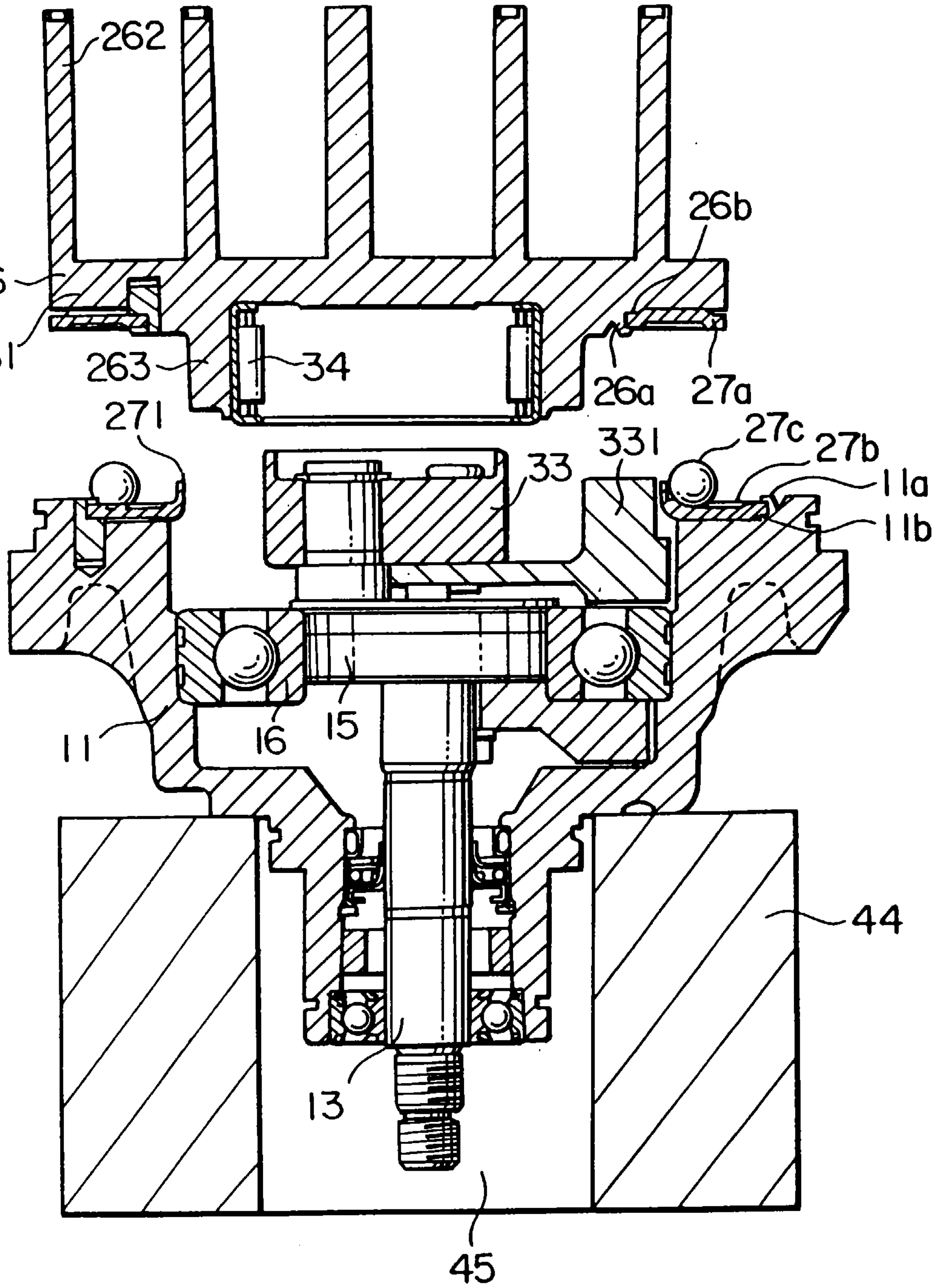
262
26b
26
261
263
34
26a
27a
271
27c
27b
331
33
11a
11b
11
16
15
44
13
45

FIG. 5

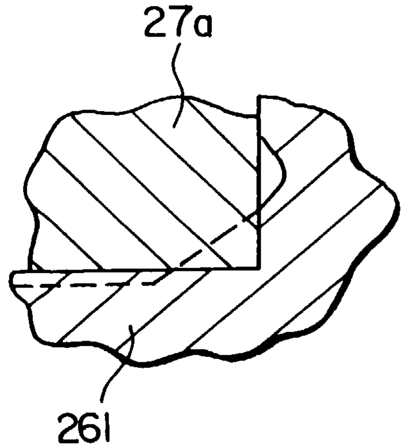
27a
261

FIG. 6

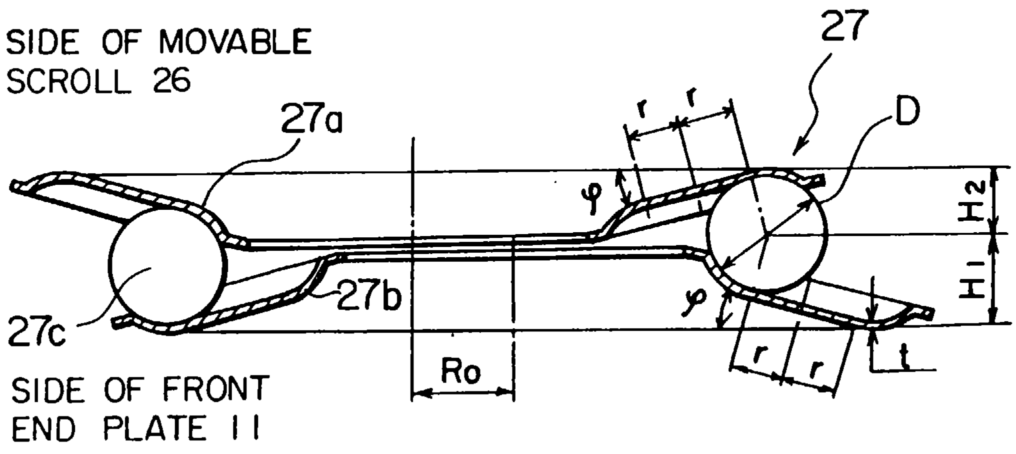
SIDE OF MOVABLE
SCROLL 26
27
27a
r
r
D
φ
H2
H1
27b
27c
φ
r
r
t
Ro
SIDE OF FRONT
END PLATE 11

FIG. 7

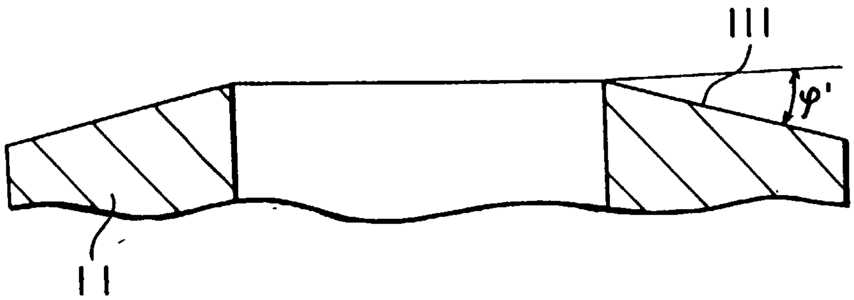

FIG. 8

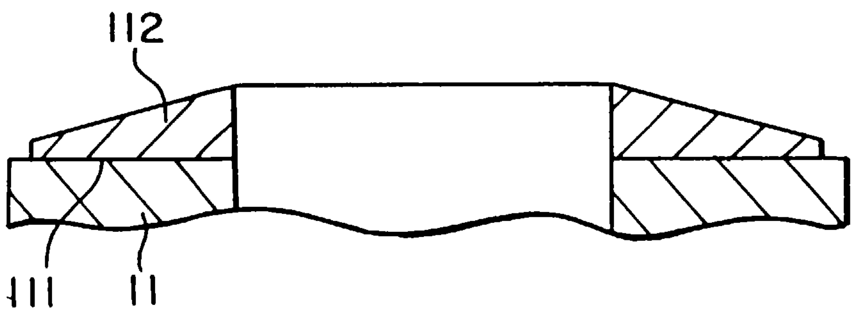

FIG. 9

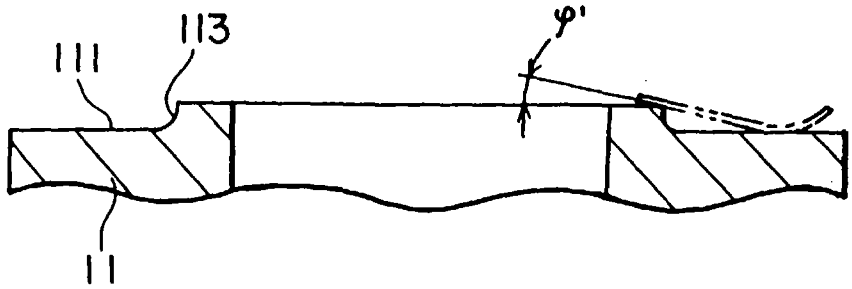

FIG. 10

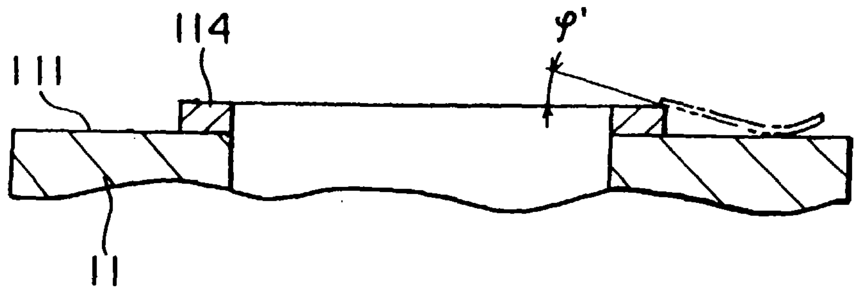

FIG. 11

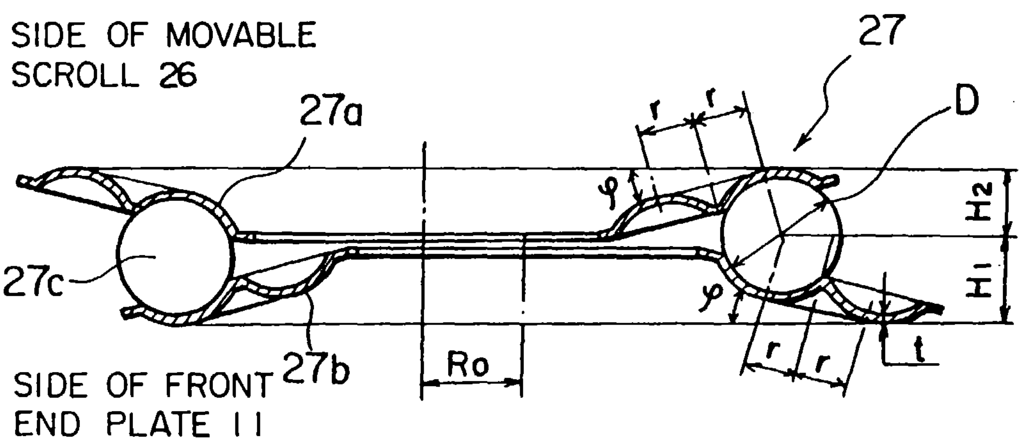

FIG. 12

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 10 8151

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.6)
Y	PATENT ABSTRACTS OF JAPAN vol. 9, no. 42 (M-359) [1765] , 22 February 1985 & JP 59 183090 A (TOSHIBA), 18 October 1984, * abstract *	1,2,4-6, 8	F04C18/02 F01C17/06
Y	EP 0 123 407 A (SANDEN CORP.) * page 11, line 18 - page 13, line 26; figures 4-7 *	1,2,4-6, 8	
A	PATENT ABSTRACTS OF JAPAN vol. 14, no. 39 (M-924), 24 January 1990 & JP 01 271679 A (SANDEN CORP.), 30 October 1989, * abstract *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
F04C
F01C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	25 June 1997	Kapoulas, T

CATEGORY OF CITED DOCUMENTS

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