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(71) Applicant: **SANKYO ELECTRIC COMPANY LIMITED, 20 Kotobuki-cho, Isesaki-shi, Gunma-ken (JP)**

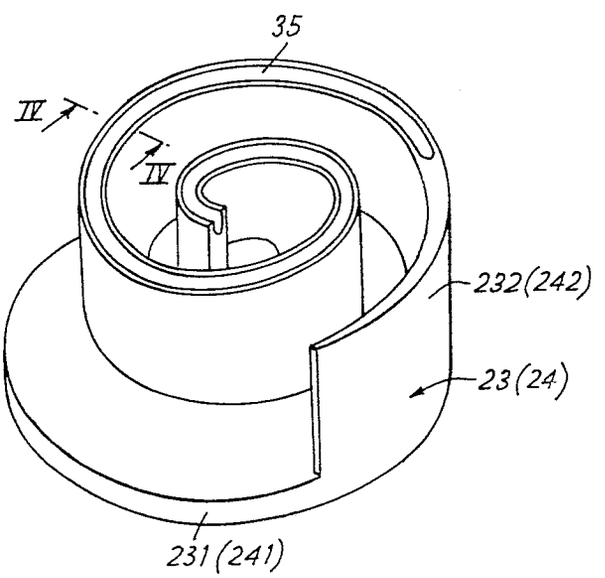
(72) Inventor: **Terauchi, Kiyoshi, 8-14, Heiwa-cho, Isesaki-shi, Gunma-ken (JP)**

(74) Representative: **Pritchard, Colin Hubert et al. Mathys & Squire 10 Fleet Street, London EC4Y 1AY (GB)**

(54) Improvements in scroll type fluid compressor units.

(57) A scroll type fluid compressor unit having an orbiting scroll member and a fixed scroll member which form at least one sealed off fluid pocket therebetween for fluid compression. Each spiral element (232 [242]) of each scroll member (23 [24]) is provided with a sealing element which is loosely fitted in a groove (35) formed in an axial end surface of the spiral element. During the operation, the compressed pressure fluid flows into the groove to urge the sealing element towards the end plate of the opposing scroll member and to the side wall of the groove, so that an axial sealing between the spiral element and the opposing end plate is obtained.

The groove may be constituted by an upper portion having a relatively wide opening and a lower portion having a relatively narrow opening, and the sealing element is loosely fitted into the upper portion of the groove so that the hollow portion in which the compressed pressure fluid is introduced is readily formed.



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This invention relates to scroll type fluid compressor units.

A scroll type apparatus has been well known in the prior art as disclosed in, for example, U.S. Patent No. 801,182, and others, which comprises two scroll members each having an end plate and a spiroidal or involute spiral element. These scroll members are so maintained angularly and radially offset that their spiral elements interfit to make a plurality of line contacts between their spiral curved surfaces, thereby to seal off and define at least one fluid pocket. The relative orbital motion of these scroll members shifts the line contacts along the spiral curved surfaces and, therefore, the volume of the fluid pocket increases or decreases in dependence on the direction of the orbital motion. Therefore, a scroll type apparatus is suitable for handling fluids or for compressing, expanding or pumping them.

In comparison with conventional compressors of the piston type, a scroll type compressor has some advantages such as less number of parts, continuous compression of fluid and others. But, there have been several problems; primarily

sealing of the fluid pocket, and others.

In order to resolve such sealing problem, U.S. Patent No. 3,924,977 discloses to non-rotatably support a fixed scroll member within the compressor housing in the axially floating condition. A high pressure fluid is introduced to the back of the fixed scroll member and, thereby, urge the fixed scroll member to the orbiting scroll member to establish a sufficient axial sealing.

In this arrangement, since the fixed scroll member is supported in the axial floating condition, the support of the fixed scroll member is insufficient so that the orbiting scroll member tends to deflect by the orbital motion of the orbiting scroll member. Therefore, the fluid compression tends to be performed imperfectly. In order to avoid such disadvantage, the pressure of the introduced high pressure fluid must be increased and the clearance between radial supporting parts must be made as small as possible. But it requires high accuracy of working parts to minimize the clearance. While the increase of the pressure of the introduced fluid results to the increased contact pressure between both scroll members which injures scroll members.

Another method for strengthening the axial sealing of fluid pockets is to use sealing elements which are mounted in the axial end surfaces of spiral elements, as disclosed in U.S. Patent No. 3,994,635. The sealing element is urged towards

the opposing circular plate by the use of the elastic element such as spring. In this arrangement, since the construction for urging the sealing element is complex, it is difficult to obtain the desired sealing force.

According to the present invention there is provided a scroll type fluid compressor unit including a compressor housing having a fluid inlet port and fluid outlet port, a first scroll member disposed within said compressor housing and having first end plate means to which first wrap means are affixed, a second scroll member disposed within said compressor housing and having second end plate means to which second wrap means are affixed, said first and second scroll members being superposed with said first and second wrap means interfitting, at a predetermined angular relationship, and having a plurality of line contacts so as to define at least one sealed off fluid pocket which moves with a reduction in volume thereof upon relative orbital motion of said first and second scroll members, thereby to compress fluid in the pocket, and driving means for causing the relative orbital motion of said first and second scroll members, wherein each of said first and second wrap means is provided with a groove which is formed in the axial end surface thereof to trace the spiral curve of said wrap means, and sealing element means are loosely fitted in said groove and short of the bottom surface of said groove, whereby the compressed fluid flows into said groove to urge said sealing element means to

adjacent ones of said first and second end plate means and to the side wall of said groove to make a sealing contact therebetween.

One embodiment of the invention is a scroll type fluid compressor unit wherein a sufficient compressive effect is obtained to effect an axial sealing of the fluid compressing pocket or pockets, the unit having a simple construction, a simple production method, and being of low cost.

In this embodiment, a sealing element is mounted in the axial end surface of each spiral element. The sealing element is urged onto the circular end plate of the opposing scroll member by the compressed high pressure fluid in the fluid pocket between the scroll members. Each sealing element is loosely fitted into a groove formed in an axial end surface of the associated spiral element. The compressed fluid flows into the groove from adjacent fluid pockets through the gap between the sealing element and the side walls of the groove so as to urge the sealing element towards the opposing circular end plate of each scroll member and to one of the side walls of the groove. Accordingly, the axial sealing between the circular end plate of each scroll member and the spiral element of each scroll member is established with a simple construction.

The groove may be constituted by an upper portion having a relatively wide opening and a lower portion having a relatively narrow opening. The sealing element is loosely fitted into

the upper portion, and, therfore, a hollow portion can be readily formed between the sealing element and the bottom of the groove. The compressed fluid flows into the hollow portion to urge the sealing element towards the opposing circular end plate.

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

Figs. 1a-1d are views for illustrating the principle of the operation of the scroll type compressor;

Fig. 2 is a vertical sectional view of a compressor unit of an embodiment of this invention;

Fig. 3 is a perspective view of each scroll member according to the embodiment of this invention;

Fig. 4a is a sectional view taken along a line IV-IV in Fig. 3;

Fig. 4b is a sectional view similar to Fig. 4a of another embodiment;

Fig. 5 is a sectional view for illustrating the axial sealing operation according to this invention;

Fig. 6 is a perspective view of a rotor in the embodiment in Fig. 2; and

Fig. 7 is a disassembled perspective view of a rotation preventing mechanism in the embodiment in Fig. 2.

~~Detailed Description of Preferred Embodiments~~

Before preferred embodiments of this invention will be described, the principle of the operation of the scroll type compressor unit is described referring to Figs. 1a-1d.

When two spiral elements or wrap means 1 and 2 are angularly offset and disposed interfitting to one another, spaces or fluid pockets 3 (dotted regions) which are defined by contact portions of both spiral elements are formed between both spiral elements, as shown in the figures. When spiral element 1 is now so moved in relation to the other spiral element 2 that the center O' of spiral element 1 revolves around the center O of spiral element 2 with a radius of O-O' while preventing the rotation of spiral element 1, fluid pockets 3 shift angularly and radially towards the center of interfitted spiral elements with volume of each fluid

pocket 3 being gradually reduced, as shown in Figs. 1a-1d. Therefore, the fluid in each pocket is compressed.

In the status of revolution of 360° angle as shown in Fig. 1a, both pockets 3 are disposed at a central portion and connected to one another to form a single pocket, and the volume of the connected single pocket is further reduced by further revolution of every 90° angle as shown in Figs. 1b, 1c and 1d, and is substantially zero in the status of Fig. 1d. In the course, outer spaces which open in the status of Fig. 1b change as shown in Figs. 1c, 1d and 1a, to form new sealed off pockets in which fluid is newly enclosed.

Accordingly, if circular plates are disposed at, and sealed to, axial opposite ends of spiral elements 1 and 2, respectively, and if one of the circular plates is provided with a discharge port 4 at the center thereof as shown in the figures, fluid is taken into fluid pockets at the radial outer portion and is discharged from the discharge port 4 after compressed.

In order to compress the fluid, it is important that each fluid pocket is sufficiently sealed.

Briefly stated, this invention attempts to urge sealing elements mounted in the axial end surface of each spiral element towards opposite circular plates by using compressed fluid pressure to secure the sufficient axial sealing.

Referring to Fig. 2, a refrigerant compressor unit 10 of an embodiment shown includes a compressor

housing comprising a front end plate 11, a rear end plate 12 and a cylindrical body 13 connecting between those end plates. Front end plate 11 is shown formed integrally with cylindrical body 13. The compressor housing defines a sealed off chamber therein which communicates outside the compressor housing through a fluid inlet port 124 and a fluid outlet port (not shown) formed in rear end plate 12. A drive shaft 15 is rotatably supported by a radial needle bearing 14 in front end plate 11. Front end plate 11 has a sleeve portion 16 projecting on the front surface thereof and surrounding drive shaft 15 to define a shaft seal cavity 18. Within shaft seal cavity 18, a shaft seal assembly 17 is assembled on drive shaft 15. Drive shaft 15 is driven by an external drive power source (not shown) through a rotational force transmitting means such as a pulley connected with drive shaft 15 and belt means connecting between the pulley and the external drive power source. A disk rotor 20 is fixedly mounted on an inner end of drive shaft 15 and is born on the inner surface of front end plate 11 through a thrust needle bearing 21 which is disposed concentric with drive shaft 15. Rotor 20 is shown formed integral with drive shaft 15 in the shown embodiment. Rotor 20 is provided with a balance weight 20a and balance hole 20b to compensate the dynamic unbalance as shown in Fig. 6. Disk rotor 20 is also provided with a drive pin 22 projecting on the rear end surface thereof. Drive pin 22 is radially offset

from drive shaft 15 by a predetermined length.

Reference numerals 23 and 24 represent a pair of intérfitting orbiting and fixed scroll members. Orbiting scroll member 23 includes an end circular plate 231 and a wrap means or spiral element 232 affixed onto one end surface of circular plate 231. Circular plate 231 is provided with a boss 233 projecting on the other end surface thereof. Drive pin 22 is fitted into boss 233 with a bush 25 and a radial needle bearing 26 therebetween, so that orbiting scroll member 23 is rotatably supported on drive pin 22.

A hollow member 27 having a radial flange 271 is fitted onto boss 233 non-rotatably by means of key and keyway connection. Radial flange 271 is supported on the rear end surface of disk rotor 20 by a thrust needle bearing 28 which is disposed concentric with drive pin 22. The axial length of hollow member 27 is equal to, or more than, the axial length of boss 233, so that the thrust load from orbiting scroll member 23 is supported on front end plate 11 through disk rotor 20. Therefore, the rotation of drive shaft 15 effects the orbital motion of orbiting scroll member 23 together with hollow member 27. Namely, orbiting scroll member 23 moves along a circle of a radius of the length between drive shaft 15 and drive pin 22.

Means 29 for preventing orbiting scroll member 23 from rotating during its orbital motion is disposed between circular plate 231 of orbiting scroll member

23 and radial flange 271 of hollow member 27.

Referring to Figs. 2 and 7, rotation preventing means 29 will be described. Orbiting scroll member 23 is provided with a pair of keyways 234a and 234b on the front end surface of circular plate 231 which are formed at both sides of boss 233 along a diameter. An Oldham ring 30 is disposed around a cylindrical portion 272 of hollow member 27. Oldham ring 30 is provided with a first pair of keys 30a and 30b on the surface opposite to the front end surface of circular plate 231, which are received in keyways 234a and 234b. Oldham ring 30 is also provided with a second pair of keys 30c and 30d on its opposite surface. Keys 30c and 30d are arranged along a diameter perpendicular to the diameter along which keys 30a and 30b are arranged. An annular plate 31 is disposed around cylindrical portion 272 of hollow member 27 and between radial flange 271 and Oldham ring 30, and is non-rotatably secured to the inner surface of cylindrical body 13 by key means 32. Annular plate 31 is provided with a pair of keyways 31a and 31b on the surface opposite to Oldham ring 30 for receiving keys 30c and 30d. Therefore, Oldham ring 30 is slidable in a radial direction by the guide of keys 30c and 30d by keyways 31a and 31b but is prevented from rotation. And orbiting scroll member 23 is slidable in the other radial direction by the guide of keys 30a and 30b by keyways 234a and 234b, but is prevented from rotation. Accordingly, orbiting scroll member 23 is

prevented from rotation, but is permitted to move in two radial directions perpendicular to one another. Therefore, since orbiting scroll member 23 is permitted to move along a circular orbit as a result of movement in the two radial directions but is prevented from rotation, it effects the orbital motion without rotation by the eccentric movement of drive pin 22 by the rotation of drive shaft 15.

The other fixed scroll member 24 also comprises an end circular plate 241 and a wrap means or spiral element 242 affixed on one end surface of the circular plate. Circular plate 241 is provided with a hole 243 formed at a position corresponding to the center of spiral element 242. Hole 243 is corresponding to discharge port 4 in Fig. 1a.

Circular plate 241 is interposed between rear end plate 12 and cylindrical portion 13, and is secured thereto by bolt means 33.

Rear end plate 12 is provided with an annular projection 121 on its inner surface to partition a suction chamber 122 and a discharge chamber 123. The axial projecting end surface of annular projection 121 is in tight contact with the rear end surface of circular plate 241 of fixed scroll member 24 around discharge port 243, so that discharge port 243 connects with discharge chamber 123. Within discharge chamber 123, a check valve 34 is disposed to close discharge port 243. Suction chamber 122 and discharge chamber 123 are connected

to inlet port 124 and the outlet port (not shown), respectively.

Referring to Figs. 2-5, each spiral element of 232 and 242 is provided with a groove 35 formed in its axial end surface to trace the spiral curve. Groove 35 extends from the inner end of each spiral element to its terminal end portion but short of the terminal end, as shown in Fig. 3.

In groove 35, a sealing element 36 of heat resistant materials, for example, polytetrafluoroethylene is loosely fitted, to remain a hollow portion and adjacent the bottom surface of the groove, as shown in Fig. 4a. Thus, the hollow portion is connected with adjacent fluid pockets which are formed between interfitting scroll members 23 and 24 through a gap between opposing circular plate and the axial end of the spiral element and a gap between the sealing element and the side walls of the groove. Therefore, during the operation, compressed fluid flows from adjacent fluid pockets into the hollow portion to urge sealing element 36 to the opposite circular plate 231 and 241, so that the seal between the spiral element and the circular plate is secured sufficient.

Referring to Fig. 5, considering adjacent fluid pockets 3 and 3' interposing spiral element 232, and assuming that fluid pocket 3 is nearer the center of scroll members than the other fluid pocket 3', the fluid pressure in fluid pocket 3 is higher than that in fluid pocket 3'. Therefore, sealing element 36 is

pressed onto the side wall 35a of groove 35 at the side of fluid pocket 3' by fluid pressure acting to sealing element 36 through a gap between circular end plate 241 and the axial end surface of spiral element 232. Furthermore, since the bottom portion of groove 35 communicates with fluid pocket 3 through the gap and through another gap between sealing element 36 and the other side wall 35b of groove 35, sealing element 36 is axially pressed to circular plate 241. Thus, axial sealing force is provided by the fluid pressure in fluid pocket 3, so that the sufficient axial sealing is established.

If the groove 35 is formed to open in the inner terminal end of each spiral element, as shown in Fig. 3, the compressed gas in the highest pressure fluid pocket is introduced into the bottom portion of groove 35 to urge sealing element 36 to the opposing circular end plate. Thus, the axial sealing force is backed up. But such arrangement is not absolutely necessary, but groove 35 may be short of the inner terminal end of spiral element.

Groove 35 may advantageously comprise an upper portion having a relatively wide open and lower portion having a relatively narrow open, as shown in Fig. 4b. In this construction, each side wall of the groove is stepped, so that sealing element 36 is prevented from being fitted into the lower portion. Accordingly, the hollow portion is securely maintained under the sealing element, so that the high pressure fluid reliably acts

on the sealing element to establish the axial seal of fluid pockets between scroll members.

In the above described compressor, when drive shaft 15 is rotated by an external drive power source (not shown), drive pin 22 moves eccentrically to effect the orbital motion of orbiting scroll member 23. At a time, since the rotation of orbiting scroll member 23 is prevented by rotation preventing means 29, the motion of orbiting scroll member 23 in relation to fixed scroll member 24 is similar to that as shown in Figs. 1a-1d. Therefore, the fluid introduced into the compressor housing through inlet port 124 is taken into fluid pockets (3, in Figs. 1a-1d) between both scroll members 23 and 24, and is compressed by the orbital motion of orbiting scroll member 23. The compressed fluid is discharged into discharge chamber 123 through hole 243, and, therefrom, discharged through the outlet port to, for example, a cooling circuit. The fluid returns into the compressor housing through inlet port 124 after circulating the cooling circuit.

During the operation, the compressed high pressure fluid in the fluid pockets shifted to the center portion is partially flows into the hollow portion between sealing element 36 and the bottom of groove 35 to urge sealing element 36 to the opposite surface of the corresponding circular plate of scroll member. Thus, the sufficient seal is established between the axial end surface of each spiral element and each circular plate, so that

any fluid leakage therebetween is prevented. While, since the side surface of spiral element of orbiting scroll member 23 is strongly urged onto the side surface of spiral element of fixed scroll member 24 by the centrifugal force due to the orbital motion of orbiting scroll member 23, the sufficient seal is established between the side surfaces of both spiral elements 232 and 242. Accordingly, the fluid taken into the fluid pockets is effectively compressed without any leakage.

According to this invention, since the seal between axial end surface of each spiral element and the opposite surface of each circular plate is established by the sealing element disposed therebetween, the wear of spiral elements and circular plates by direct contact with one another is avoidable. And since the seal is effected by the axial movement due to the high pressure fluid, it is secured even if there are any axial dimensional error of scroll members.

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

CLAIMS:

1. A scroll type fluid compressor unit including a compressor housing having a fluid inlet port and fluid outlet port, a first scroll member disposed within said compressor means are affixed, a second scroll member disposed within said compressor housing and having second end plate means to which second wrap means are affixed, said first and second scroll members being superposed with said first and second wrap means interfitting, at a predetermined angular relationship, and having a plurality of line contacts so as to define at least one sealed off fluid pocket which moves with a reduction in volume thereof upon relative orbital motion of said first and second scroll members, thereby to compress fluid in the pocket, and driving means for causing the relative orbital motion of said first and second scroll members, wherein each of said first and second wrap means is provided with a groove which is formed in the axial end surface thereof to trace the spiral curve of said wrap means, and sealing element means are loosely fitted in said groove and short of the bottom surface of said groove, whereby the compressed fluid flows into said groove to urge said sealing element means to adjacent ones of said first and second end plate means and to the side wall of said groove to make a sealing contact therebetween.

2. A unit as claimed in Claim 1, wherein said groove comprises a lower portion which is adjacent the bottom thereof

and is relatively narrow, and an upper portion having a wide opening so that each side wall is stepped, said sealing element means being fitted in said upper portion.

3. A unit as claimed in Claim 1 or 2, wherein each groove is formed to open in the inner terminal end face of the associated wrap means.

4. A unit as claimed in Claim 1, 2 or 3, wherein said sealing element is of polytetrafluoroethylene.

FIG. 1a

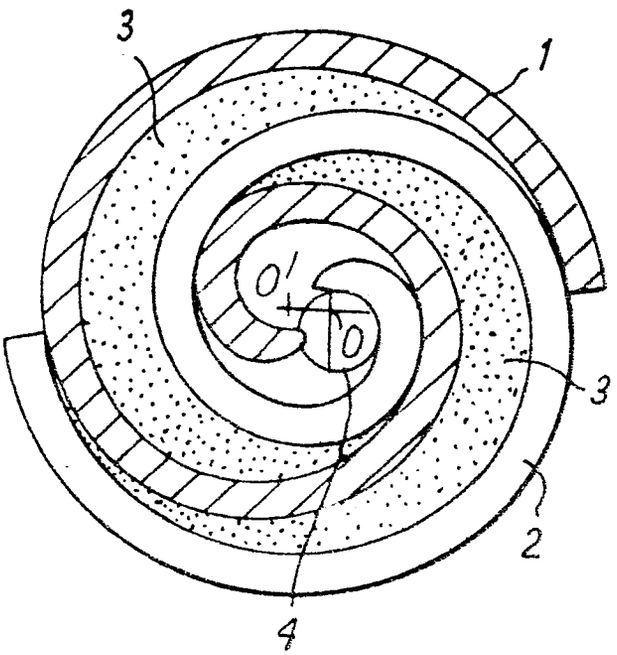


FIG. 1b

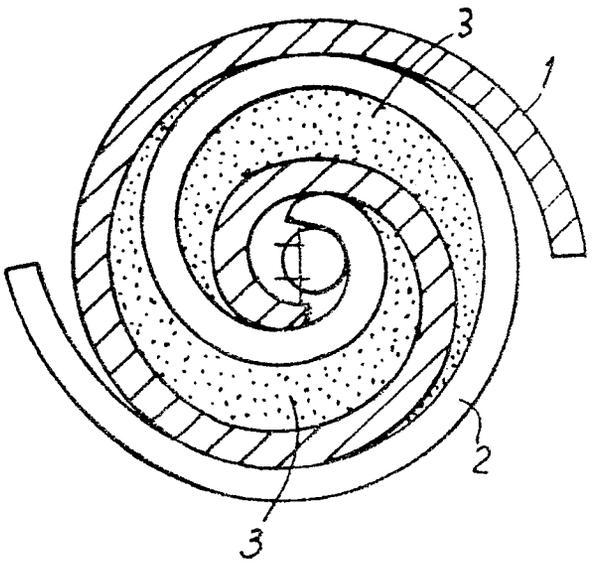


FIG. 1c

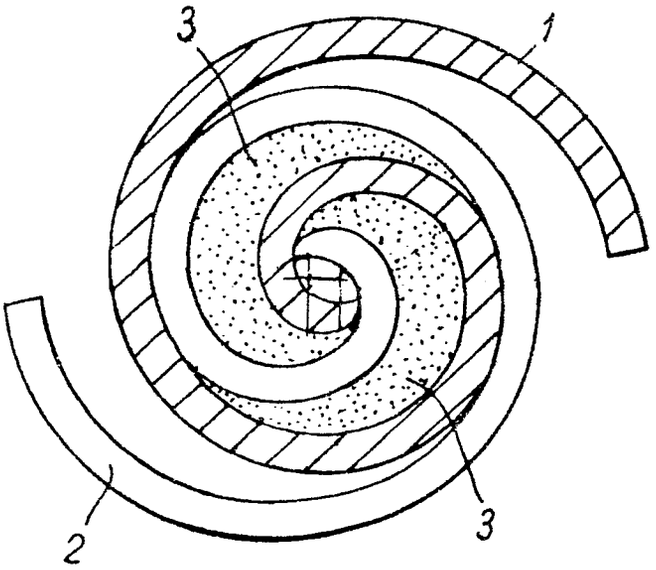


FIG. 1d

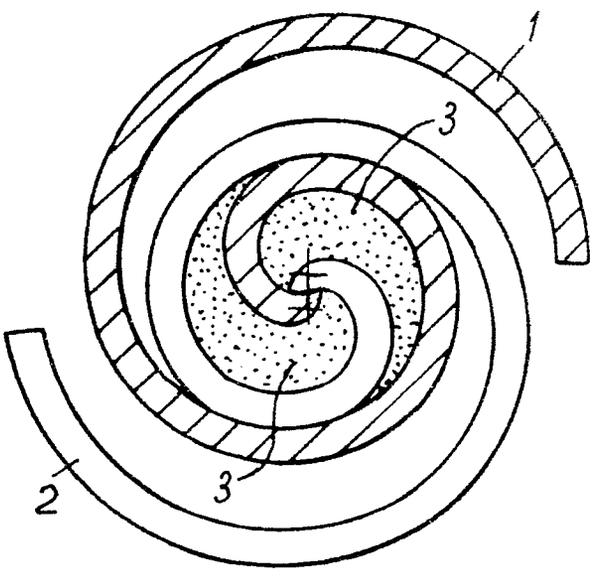


FIG. 2

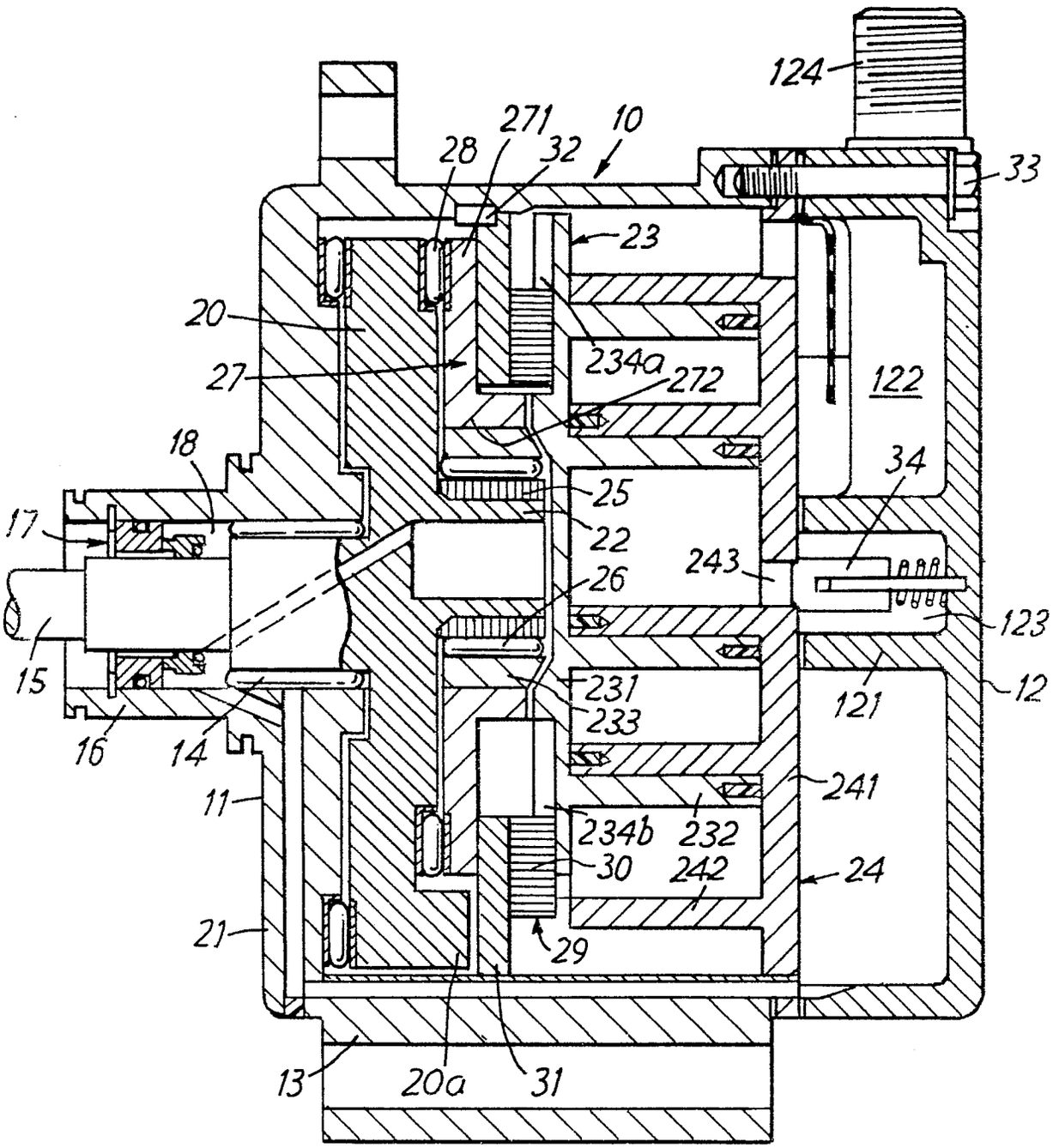

124
271
10
28
32
33
23
20
234a
272
27
122
18
34
25
17
22
243
26
123
15
231
12
233
121
16
14
241
11
234b
232
30
242
24
21
29
13
20a
31

FIG.3

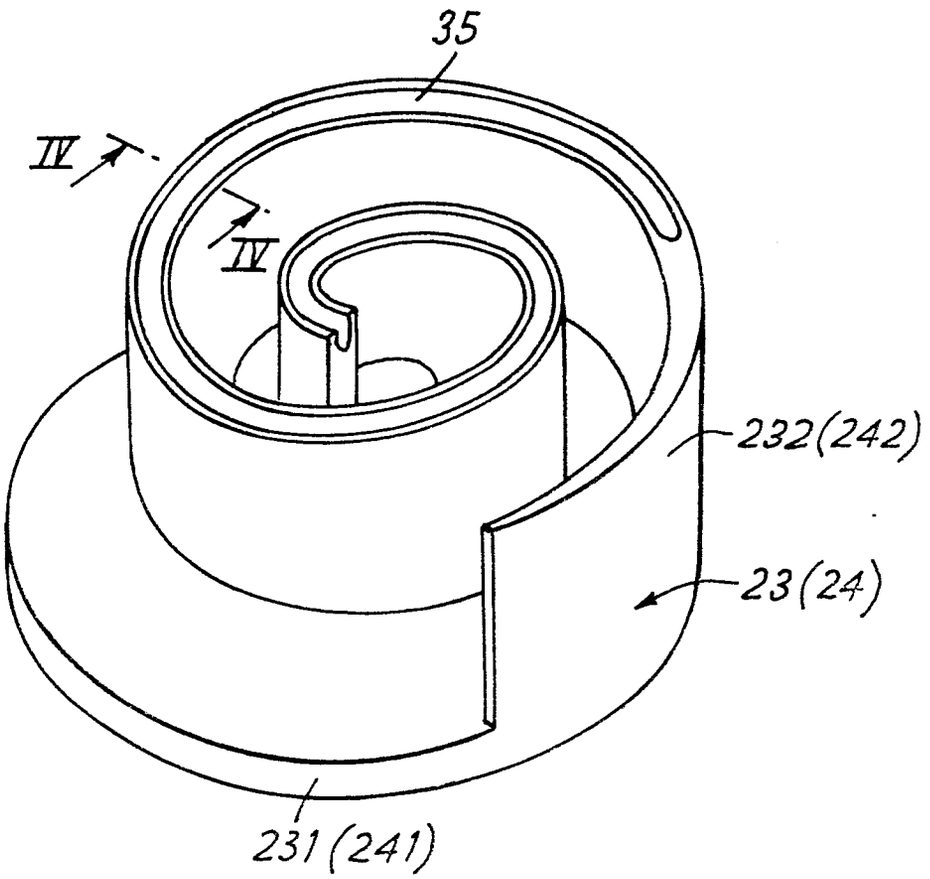


FIG.6

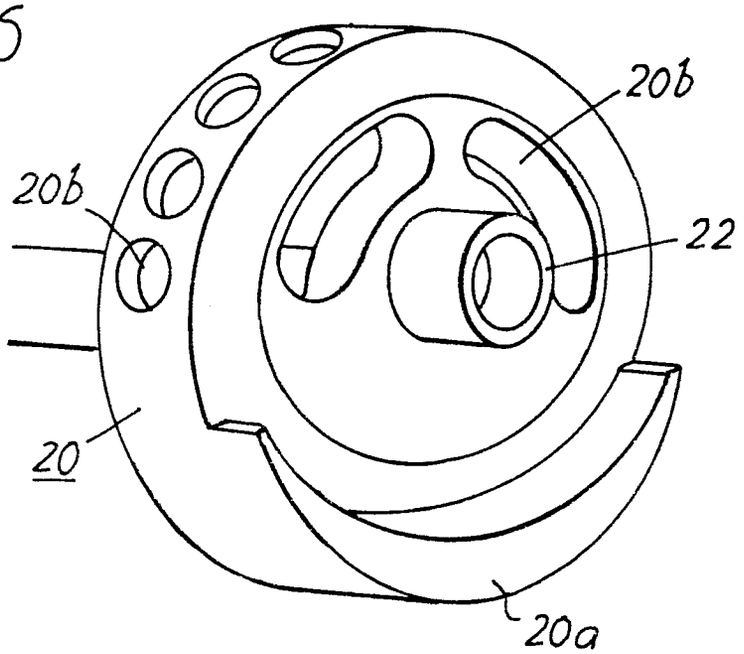


FIG.4a

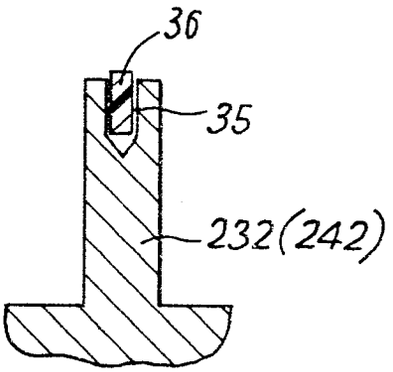


FIG.4b

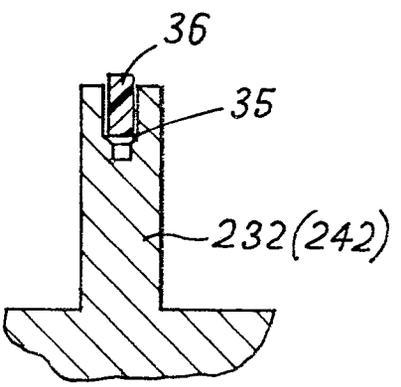


FIG.5

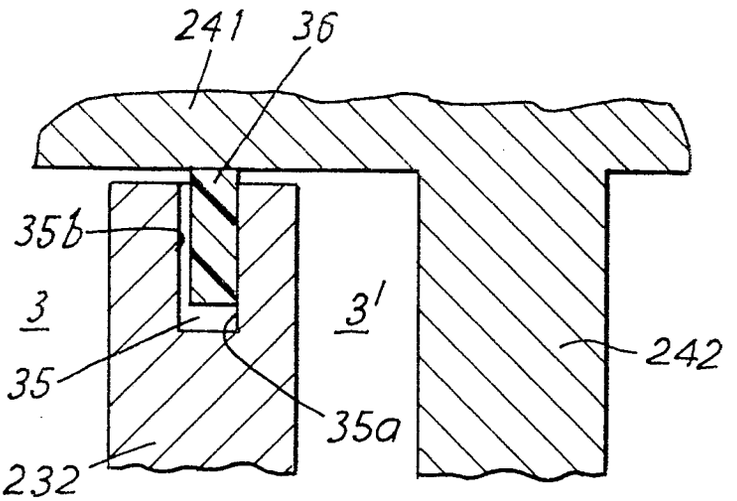
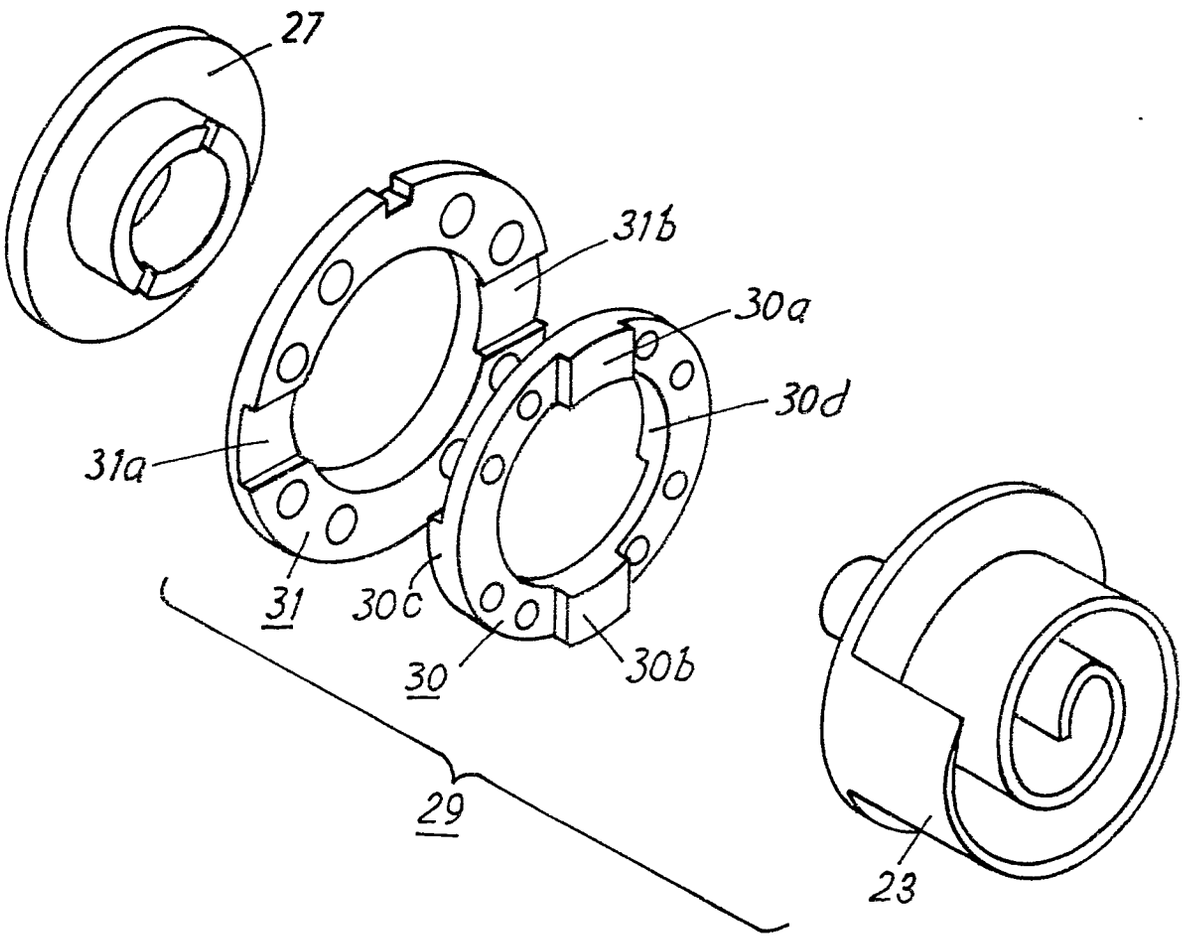


FIG.7



European Patent Office

EUROPEAN SEARCH REPORT

Application number
0012614
EP 79 30 2899

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	US - A - 3 994 636 (McCULLOUGH) * Column 8, line 22 to the end; column 9, figures 3-6 *	1,3,4
A	US - A - 4 106 780 (BLACK) * Column 2, lines 43-48; figure 2 *	2

CLASSIFICATION OF THE APPLICATION (Int. Cl.)

F 04 C 27/00

TECHNICAL FIELDS SEARCHED (Int.Cl.)

F 04 C
F 01 C

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	25-03-1980	KAPOULAS

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