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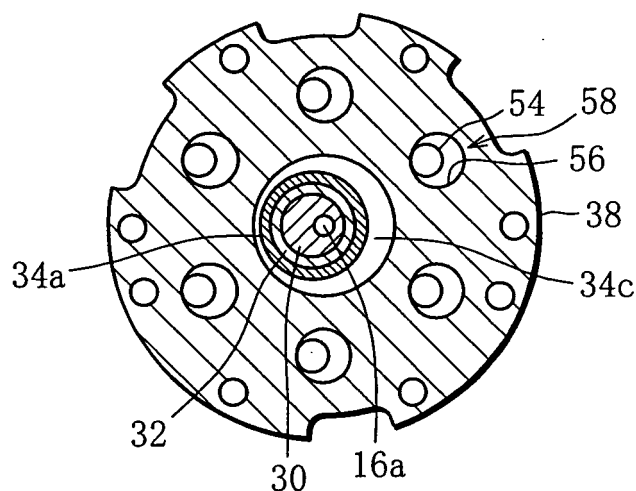
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(54) **Scroll-type fluid machine**

(57) A scroll-type fluid machine has a movable scroll (34) that is accommodated in a housing so as to be revolvable with respect to a fixed scroll and a rotation blocking device that blocks the rotation of the movable scroll (34). The rotation blocking device includes five or more units (58) that are spaced away from each other in the

circumferential direction of the movable scroll (34) and block the rotation of the movable scroll (34) in consort with each other. Each of the units (58) has at least one pin (54) and an inner circumferential surface brought into sliding contact with the pin (54) along with the revolution of the movable scroll (34).

FIG. 2



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a scroll-type fluid machine.

Description of the Related Art

[0002] The scroll-type fluid machine is used, for example, to compress a refrigerant, and has a movable scroll that is set in a housing so as to be revolvable with respect to a fixed scroll. A pressure chamber is formed in between the movable and fixed scrolls. As the movable scroll revolves, the pressure chamber carries out the process of suction, compression, and discharge of the refrigerant.

[0003] During the revolution of the movable scroll, the rotation of the movable scroll is blocked by a rotation blocking mechanism or device.

[0004] For instance, the rotation blocking device for a scroll compressor which is disclosed in Unexamined Japanese Patent Publication No. 2000-27774 has four units, each being formed of a pin and a guiding recess that is in sliding contact with the pin. These units are spaced at 90 degrees from each other in the circumferential direction of the movable scroll.

[0005] A rotation blocking device of a scroll compressor in Unexamined Japanese Patent Publication No. 2005-240700 also includes four units spaced at 90 degrees from each other in the circumferential direction of a movable scroll. A pin of each unit slidably contacts a ring that is fixed into a ring hole.

[0006] According to the scroll compressors described in these two publications, the four units of the rotation blocking device are spaced at 90 degrees from each other in the circumferential direction of the movable scroll. Therefore, the loads applied from the movable scroll to the rotation blocking device have to be borne by one of the units when the revolving angle of the movable scroll reaches a certain value. As a result, the contact pressure created between the pin and the inner circumferential surfaces of the guiding recess and the ring in each unit temporarily reaches an extremely high level. Thus the sliding conditions of the pin and the inner circumferential surfaces are severe.

[0007] Especially in the situation where a hermetic type scroll compressor is utilized to compress CO₂, the scroll compressor is operated at a high number of revolutions. The sliding conditions are then heavily severe.

[0008] In order to prevent an abrasion of the pin and that of the inner circumferential surface of the guiding recess and the like under such severe sliding conditions, it is necessary to use bearing steel as material for the pin and a member forming the guiding recess and the like (sliding members) and to subject the pin and the sliding member to pretreatment, such as nitridation, for en-

hancement of hardness. On the other hand, the bearing steel is expensive, and to provide the nitridation treatment is to add another process, so that these methods increase the production cost of the scroll compressor.

SUMMARY OF THE INVENTION

[0009] It is an object of the present invention to provide a scroll-type fluid machine at a low price, which has a rotation blocking device of high durability.

[0010] In order to achieve the above-mentioned object, the scroll-type fluid machine of the invention has a movable scroll that is accommodated in a housing so as to be revolvable with respect to a fixed scroll and a rotation blocking device that blocks a rotation of the movable scroll. The rotation blocking device includes five or more units that are spaced away from each other in a circumferential direction of the movable scroll and block the rotation of the movable scroll in consort with each other. Each of the units has at least one pin and an inner circumferential surface brought into sliding contact with the pin along with a revolution of the movable scroll.

[0011] More specifically, the pins of the two or more circumferentially adjacent units are brought into contact with the respective inner circumferential surfaces at any revolving angle of the movable scroll.

[0012] The rotation blocking device includes the five or more units. To be concrete, among the pins, those of the two or more circumferentially adjacent units are brought into contact with the respective inner circumferential surfaces at any revolving angle of the movable scroll. Accordingly, regardless of the revolving angle of the movable scroll, loads applied from the movable scroll to the rotation blocking device are always distributed to two or more of the units. This reduces contact pressure produced between the pin and the inner circumferential surface of each of the units, and prevents an abrasion of the pin and the inner circumferential surface. Since the contact pressure is reduced, it is not necessary to use special material for the pin and a member forming the inner circumferential surface or provide pretreatment. Consequently, the scroll-type fluid machine of the invention is low in price in spite of being provided with the rotation blocking device of high durability.

[0013] Preferably, the inner circumferential surface is a side wall of a hole formed in a member facing a substrate of the movable scroll.

[0014] Preferably, the pin slidably contacts the side wall of the hole formed in the member facing the substrate of the movable scroll. Since each unit has a very simple structure constituted by the pin and the hole, the scroll-type fluid machine is particularly low in price.

[0015] Preferably, the scroll-type fluid machine is used to compress CO₂ gas. Preferably, even when the scroll-type fluid machine is operated at a high number of revolutions for compression of CO₂ gas, the abrasion of the pins and the inner circumferential surfaces is prevented because the sliding conditions of the pins and the inner

circumferential surfaces are relieved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The present invention will become more fully understood from the detailed description given hereinafter and the accompanying drawings which are given by way of illustration only, and thus, are not limitative of the present invention, and wherein:

FIG. 1 is a longitudinal section of a scroll-type fluid machine according to one embodiment of the present invention;

FIG. 2 is a cross-section along the line II-II of FIG. 1;

FIG. 3 is a graph showing a relationship between a revolving angle of a movable scroll and loads applied to each units of a rotation blocking device in the scroll-type fluid machine of FIG. 1;

FIG. 4 is a cross-section of a scroll-type fluid machine as a comparative example;

FIG. 5 is a graph showing a relationship between a revolving angle of a movable scroll and loads applied to units of a rotation blocking device in the scroll-type fluid machine of FIG. 4;

FIG. 6 is a cross-section showing the vicinity of a unit of a rotation blocking device according to a modification example; and

FIG. 7 is a cross-section showing the vicinity of a unit of a rotation blocking device according to another modification example.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] FIG. 1 shows a scroll-type fluid machine according to one embodiment of the present invention. The fluid machine is applied, for example, to a refrigeration system, an airconditioning system, a hot-water supply system, etc., and compresses a refrigerant or the like as working fluid.

[0018] The scroll-type fluid machine has a housing (air-tight container) 2. The housing 2 is constituted by a cylinder 4, and an upper cover 6 and a lower cover 8 that are airtightly fitted to upper and lower ends, respectively, of the cylinder 4. The cylinder 4 is connected with a suction pipe 10 for introducing a refrigerant into the housing 2. A discharge pipe 12 for discharging the refrigerant compressed in the housing 2 is connected to the upper cover 6.

[0019] Accommodated in the cylinder 4 is an electric motor 14, which has a cylindrical stator 14a. The stator 14a is fixed to the cylinder 4. A column-shaped rotor 14b is rotatably and concentrically placed within the stator 14a.

[0020] The rotor 14b is axially pierced by a rotary shaft 16. The rotary shaft 16 is rotatable integrally with the rotor 14b. Accordingly, the rotary shaft 16 is rotated by supplying power to the electric motor 14. The rotary shaft 16

has an inner channel 16a running through the rotary shaft 16 in the axial direction.

[0021] The lower end of the rotary shaft 16 reaches a central hole of a partition wall 18. A sleeve 20 with a collar that fits over the lower end of the rotary shaft 16 is set in the central hole of the partition wall 18. A needle bearing 21 is interposed between the sleeve 20 and the rotary shaft 16.

[0022] The partition wall 18 divides the housing 2 into upper and lower parts. An oil storage chamber 24 that stores lubricating oil is marked off between the partition wall 18 and the lower cover 8. An end plate 22 is fixed onto the partition wall 18 to block up a lower end of the sleeve 20. In a recess formed in the collar of the sleeve 20, there are accommodated an outer rotor 23a with internal teeth and an inner rotor 23b with external teeth.

[0023] The outer rotor 23a is fixed to an inner circumferential surface of the recess. The inner rotor 23b is fitted to the lower end of the rotary shaft 16 so as to be integrally rotatable. In other words, the sleeve 20 and the end plate 22 form a casing of a trochoid pump 26. An outlet of the trochoid pump 26, which is formed in an upper face of the end plate 22, communicates with the inner channel 16a of the rotary shaft 16. The trochoid pump 26 has an inlet that opens in a lower face of the end plate 22. The inlet faces into the oil storage chamber 24 and leads to the vicinity of a bottom of the oil storage chamber 24 through a nozzle 28 that is fixed to the partition wall 18.

[0024] An introduction hole 18a for the lubricating oil is produced in the partition wall 18. The lubricating oil that flows down from above in the cylinder 4 enters the oil storage chamber 24 through the introduction hole 18a.

[0025] An upper part of the rotary shaft 16 is formed into an eccentric bushing 30. The eccentric bushing 30 is encircled by a boss 34a of the movable scroll 34 with a sliding bearing 32 interposed therebetween. The movable scroll 34 is revolvably situated in a space formed between an upper block 36 and a lower block (center frame) 38. The upper block 36 and the center frame 38 are fixed to the cylinder 4 by welding.

[0026] In a lower portion of the upper block 36, there is formed a swirling wall 40 engaging with a swirling wall 34b of the movable scroll 34. A pressure chamber 42 is formed in between the upper block 36 and the movable scroll 34. The upper block 36 functions as a fixed scroll. Therefore, the upper block 36 is also referred hereinafter to as a fixed scroll 36.

[0027] Along with the revolution of the movable scroll 34, the pressure chamber 42 is displaced from the radial outside of the movable scroll 34 toward radial inside thereof along the swirling wall 34b. At the same time, the pressure chamber 42 is reduced in capacity. To put it differently, the pressure chamber 42 is capable of compressing the working fluid that is sucked in on the radial outside. For the purpose of supplying the working fluid to the pressure chamber 42, the fixed scroll 36 is provided with a communicating path, not shown, which connects the pressure chamber 42 located on the radial outside

to an inner end of the suction pipe 10.

[0028] A discharge hole 44 is formed in the fixed scroll 36. The discharge hole 44 axially pierces through a substantial center of the fixed scroll 36. The discharge hole 44 is opened/closed by a lead valve that functions as a discharge valve 46. The discharge valve 46 is covered with a cover 48.

[0029] Space in the cover 48 is connected to the partition wall 18 through downward channels, not shown, for the working fluid and the lubricating oil contained in the working fluid, which are formed in the fixed scroll 36, the center frame 38 and the rotor 14b, and also through gaps between slots in the stator 14a. An upward channel for the working fluid that flows from the partition wall 18 to the upper cover 6, or the discharge pipe 12 is formed along the peripheries of the stator 14a, the center frame 38, and the fixed scroll 36.

[0030] In an upper part of the center frame 38, there is formed a recess in which a substrate 34c of the movable scroll 34 is revolvably accommodated. An intermediate hole that receives the boss 34a of the movable scroll 34 opens in the center of a bottom 50 of the recess. A shaft hole extends between a bottom of the intermediate hole and a lower end of the center frame 38. A sliding bearing 52 is interposed between the shaft hole and the rotary shaft 16.

[0031] The substrate 34c of the movable scroll 34 and the bottom 50 of the recess face each other across a given gap in the axial direction of the rotary shaft 16. In between the substrate 34c and the bottom 50, there is disposed a rotation blocking device that blocks the rotation of the movable scroll 34 during the revolution of the movable scroll 34.

[0032] To be specific, the rotation blocking device has six pins 54. Each of the pins 54 has a base pressed into a pin hole that opens in a back face of the substrate 34c. A tip end of the pin 54 is interfitted in a bottomed hole 56 that opens in the bottom 50 of the recess.

[0033] As illustrated in FIG. 2, the pins 54 are spaced at 60 degrees to each other in the circumferential direction of the movable scroll 34. The bottomed holes 56 are arranged at 60 degrees to each other so as to correspond to the spatial periodicity of the arrangement of the pins 54. In short, a rotation blocking device has six units 58, each of which is constituted by one pin 54 and one bottomed hole 56.

[0034] In each of the units 58, the pin 54 is in contact with a side wall, or an inner circumferential surface, of the bottomed hole 56 at an outer circumferential surface thereof in a given circumferential position corresponding to a circumferential position (revolving angle) of the movable scroll 34. Comparing the units 58 to each other, the circumferential positions of the pins 54 in the bottomed holes 56 coincide, with each other.

[0035] In FIG. 2, the cylinder 4 is omitted.

[0036] Operation (usage) of the scroll-type fluid machine will be described below.

[0037] When power is supplied to the electric motor

14, the rotor 14b and the rotary shaft 16 are rotated. The rotation of the rotary shaft 16 is then converted into a revolution of the movable scroll 34 by the eccentric bushing 30 and the sliding bearing 32. Along with the revolution of the movable scroll 34 around the fixed scroll 36, the pressure chamber 42 carries out a sequence of processes including the steps of sucking in the working fluid through the suction pipe 10, compressing the working fluid that has been sucked in, and discharging the compressed working fluid to the discharge pipe 12.

[0038] During the revolution of the movable scroll 34, the rotation of the movable scroll 34 is blocked by the rotation blocking device.

[0039] More specifically, during the revolution of the movable scroll 34, the pin 54 revolves along the inner circumferential surface of the bottomed hole 56, and the outer circumferential surface of the pin 54 slidably contacts the inner circumferential surface of the bottomed hole 56. FIG. 3 shows a relationship between the revolving angle of the movable scroll 34 and loads applied from the outer circumferential surfaces of the pins 54 onto the inner circumferential surfaces of the bottomed holes 56. Curved lines A, B, C, D, E and F indicate the loads applied from the respective pins 54 in relative values.

[0040] As is apparent from FIG. 3, the loads periodically change with the same magnitude, the same time and phase differences in multiples of 60 degrees among all the six units 58 so as to correspond to the revolving angle of the movable scroll 34. Based upon the phase differences, positive loads are applied to the bottomed holes 56 from at least the two or more adjacent pins 54, whatever the revolving angle of the movable scroll 34 is. That is to say, regardless of the revolving angle of the movable scroll 34, loads applied from the movable scroll 34 to the rotation blocking device are always distributed to two or more of the units 58. This reduces contact pressure (Hertz surface pressure) produced between the pins 54 and the inner circumferential surfaces of the bottomed holes 56 in the units 58, and prevents an abrasion of the pins 54 and the inner circumferential surfaces of the bottomed holes 56. The distribution of the loads improves a safety ratio (allowable stress/load) in each unit 58, and enhances the reliability of the rotation blocking device.

[0041] Since the contact pressure is reduced, it is needless to use special material for the pin 54 and the center frame 38 in which the bottomed hole 56 are formed or provide pretreatment. Consequently, the above-described scroll-type fluid machine is low in price in spite of being provided with the rotation blocking device of high durability.

[0042] FIG. 4 shows a cross-section of a scroll-type fluid machine of a comparative example. This fluid machine has four units 58. Curved lines V, W, X and Y shown in FIG. 5 represent loads applied to the units 58 in the scroll-type fluid machine of the comparative example. For example, when the revolving angle is 90 degrees, only one unit 58 is applied with the loads.

[0043] The invention is not limited to the above-de-

scribed one embodiment, and may be modified in various fashions.

[0044] For instance, the rotation blocking device of the scroll-type fluid machine according to the invention has the six units 58. The number of the units 58, however, has only to be at least five or more.

[0045] Although each unit 58 of the rotation blocking device of the scroll-type fluid machine is constituted by the pin 54 and the bottomed hole 56, there is no constraint in the structure of each unit 58.

[0046] In view of characteristics of sliding movement, however, bearing steel is desirable as material of the pins 54. If the center frame 36 is made of cast iron, it is preferable that surface treatment such as nitridation be provided to the inner circumferential surfaces of the bottomed holes 56. In other words, the pins 54 and the inner circumferential surfaces of the bottomed holes 56 preferably have hardness of 60 HRC or more. The pins 54 may be made of alloy steel for structural use.

[0047] For example, FIG. 6 shows a unit 60 according to a modification example. The unit 60 has a bottomed hole 62 with a larger diameter, and a sliding ring 64 is interfitted in the bottomed hole 62. In this case, along with the revolution of the movable scroll 34, the pin 54 slidably contacts the inner circumferential surface of the sliding ring 64.

[0048] FIG. 7 shows a unit 66 according to another modification example. The unit 66 has a bottomed hole 68 with a still larger diameter. A second pin 70 is set up in the center of the bottomed hole 68. A sliding ring 72 encircling the pin (first pin) 54 and the second pin 70 is revolvably disposed in the bottomed hole 68. In this case, outer circumferential surfaces of the first and second pins 54 and 70 are brought into sliding contact with an inner circumferential surface of the sliding ring 72. At the same time, an outer circumferential surface of the sliding ring 72 slidably contacts an inner circumferential surface of the bottomed hole 68.

[0049] However, as in the one embodiment, if each unit 58 has the very simple structure constituted by the pin 54 and the bottomed hole 56, the scroll-type fluid machine can be offered at a particularly low price.

[0050] The above-described scroll-type fluid machine is applicable to compression of various working fluids, but is preferably used to compress CO₂ gas. The reason is that, even if the scroll-type fluid machine is operated at a high number of revolutions, the abrasion of the pins 54 and the inner circumferential surfaces of the bottomed holes 56 is prevented due to the improved sliding conditions of the pins 54 and the inner circumferential surfaces of the bottomed holes 56.

Claims

1. A scroll-type fluid machine comprising:

a movable scroll (34) accommodated in a hous-

ing (2) so as to be revolvable with respect to a fixed scroll (36); and
a rotation blocking device blocking a rotation of the movable scroll (34), **characterized in that:**

the rotation blocking device includes five or more units (58) spaced away from each other in a circumferential direction of the movable scroll (34) and blocking the rotation of the movable scroll (34) in consort with each other; and
each of the units (58) has at least one pin (54) and an inner circumferential surface brought into sliding contact with the pin (54) along with a revolution of the movable scroll (34).

2. The scroll-type fluid machine according to claim 1, **characterized in that:**

the pins (54) of the two or more circumferentially adjacent units (58) are brought into contact with the respective inner circumferential surfaces at any revolving angle of the movable scroll (34).

3. The scroll-type fluid machine according to claim 1 or 2, **characterized in that:**

the inner circumferential surface is a side wall of a hole (56) formed in a member (38) facing a substrate (34c) of the movable scroll (34).

4. The scroll-type fluid machine according to any one of claims 1, 2 and 3, **characterized in that:**

the scroll-type fluid machine is used to compress CO₂ gas.

FIG. 1

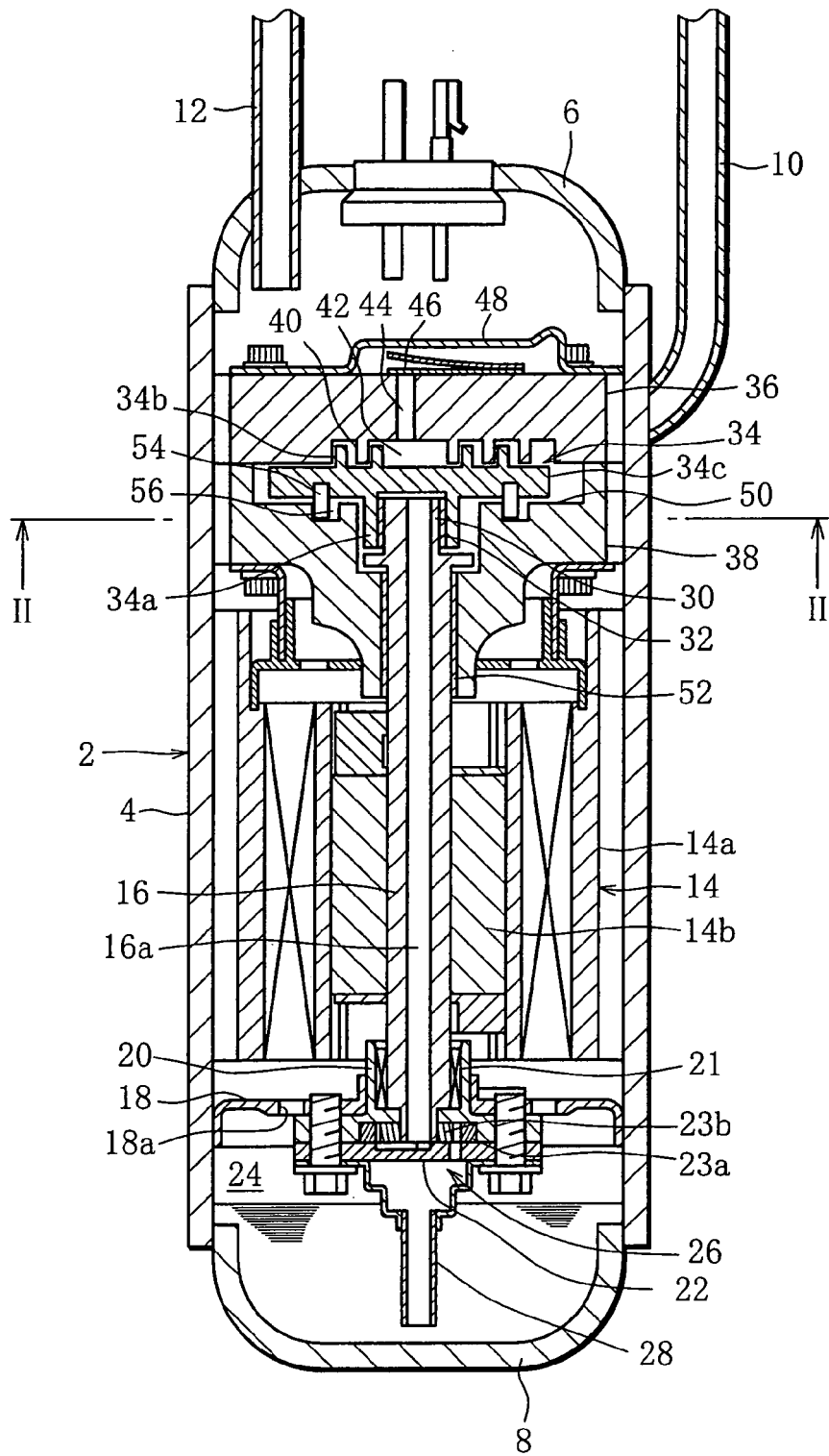


FIG. 2

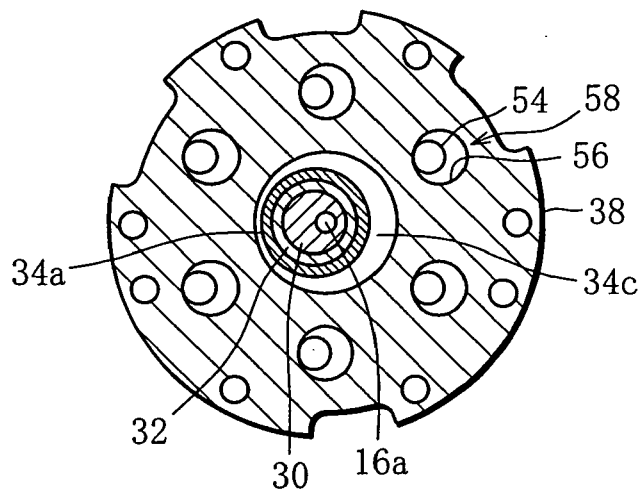


FIG. 3

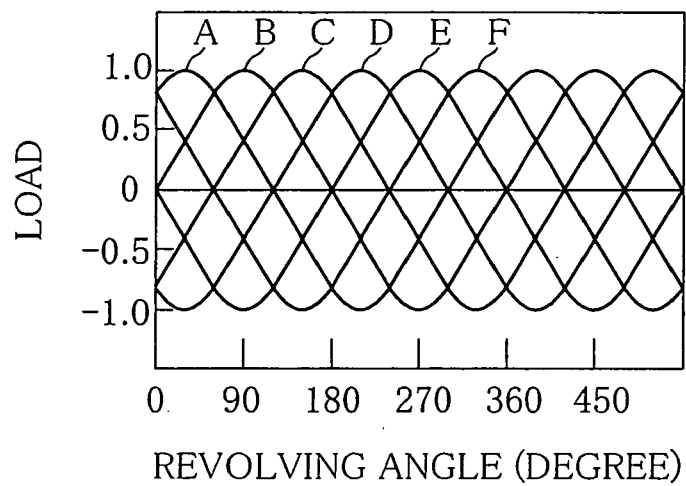


FIG. 4

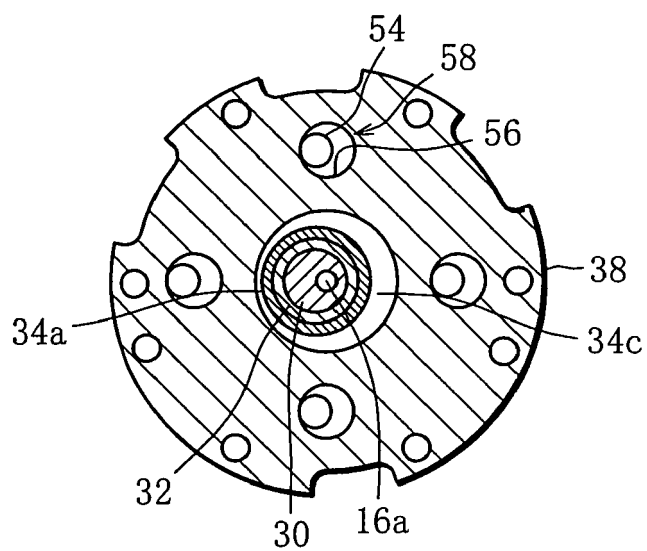


FIG. 5

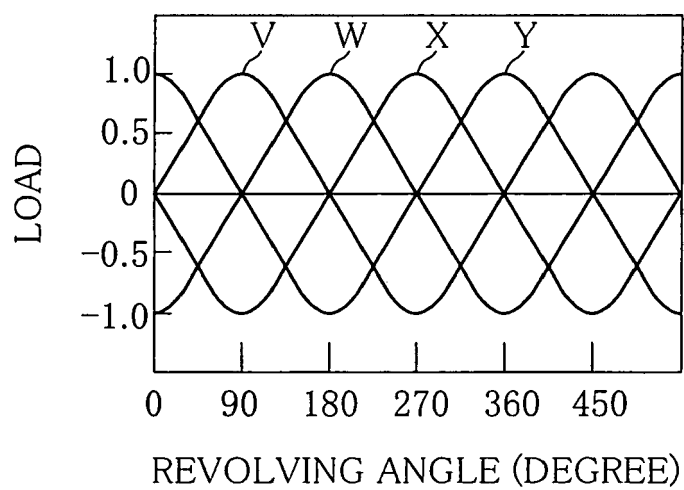


FIG. 6

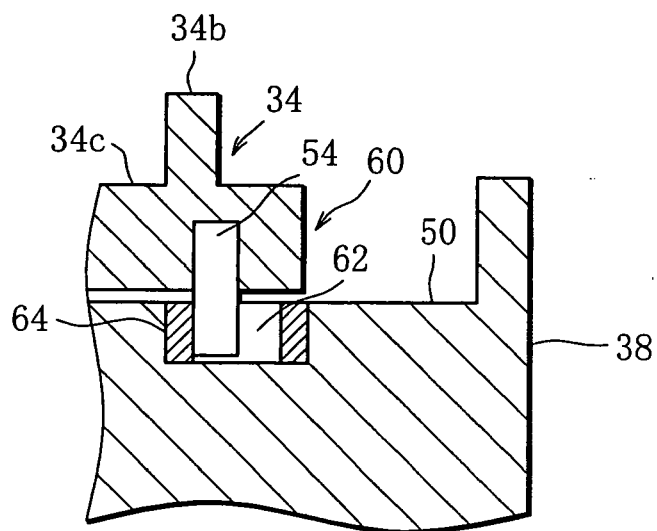
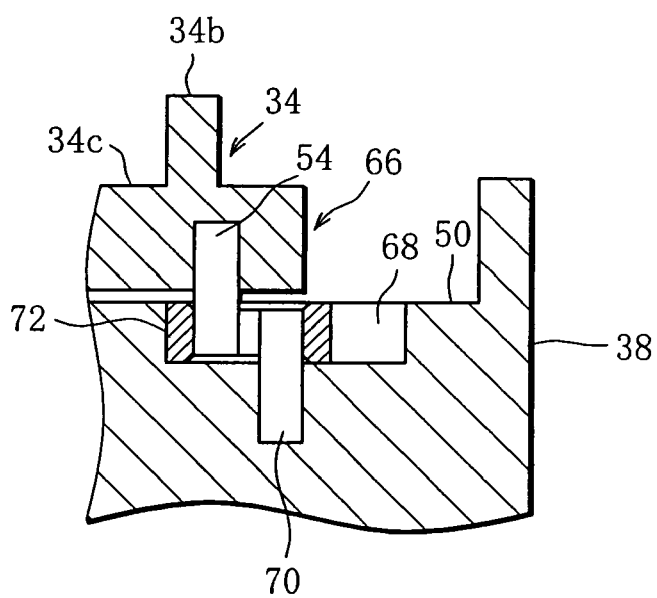


FIG. 7





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 08 00 1200

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Place of search The Hague		Date of completion of the search 7 April 2008	Examiner Biloen, David
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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