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(54) Swash plate type compressor having an improved torque transmission mechanism between a shaft and a swash plate

(57) In a swash plate type compressor win which a hinge mechanism (6) supporting a swash plate (5) on a shaft (4) in such a manner that the swash plate has an inclination angle variable relative to the axial direction, the hinge mechanism serves to transmit a driving torque of the shaft to the swash plate and comprises a fixed hinge (7) fixedly connected to the shaft and a movable hinge (8) fixedly connected to the swash plate. The fixed hinge has a fixed arm (72). The movable hinge has a movable arm (82) which is coupled to the fixed arm to be pivotal around an axis extending perpendicular to the axial direction. The fixed and the movable arms transmit a part of the driving torque to the swash plate in cooperation with each other. Further, the fixed hinge has an auxiliary fixed coupling portion (73). The movable hinge has an auxiliary movable coupling portion (86) engaged with the auxiliary fixed coupling portion. With this arrangement, another part of the driving torque is transmitted from the shaft to the swash plate in cooperation of the auxiliary fixed and the auxiliary movable coupling portions.

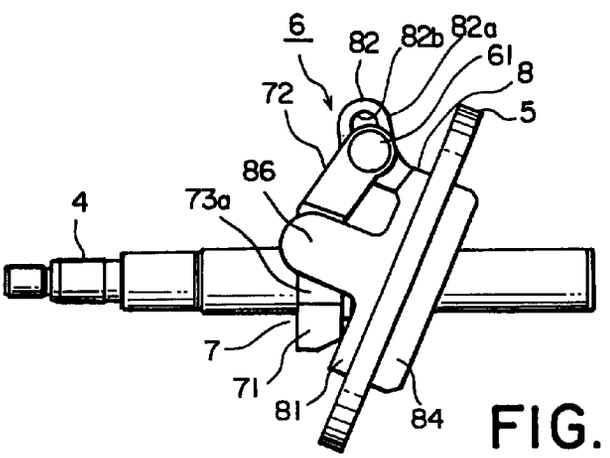

FIG. 2B

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Description

Background of the Invention:

[0001] The present invention relates in general to a volume variable swash plate type compressor.

[0002] With reference to Figs. 4 through 6, description will be made as regards an earlier technology of such a compressor. The volume variable swash plate type compressor 1 has, in general, a housing 3, a shaft 4 rotatably disposed in the housing 3, a swash plate 5 mounted to the shaft 4, and a hinge mechanism 6 which is mounted to the shaft 4 and serves to support the swash plate 5 in a valuable angular relation with respect to an axial direction of the shaft 4 so that the inclination angle of the swash plate can be varied and a driving torque transmitted to the shaft 4 is transmitted to the swash plate 5. The hinge mechanism 6 has a fixed hinge 7 fixed to the shaft 4 and having a fixed arm 72, and a movable hinge 8 mounted to the shaft 4 and having a movable arm 82 rotatably connected with the fixed arm 72. The fixed arm 72 has a fixed coupling surface 72a. The movable arm 8 has a movable coupling surface 82a which is slidably contacted with the fixed coupling surface 72a and receives a driving torque from the fixed coupling surface 72a.

[0003] The housing 3 is provided at its one end with a cylinder block 34 in a unitary structure. The cylinder block 34 is provided with a plurality of cylinder bores 34b. A piston 12 is slidably inserted into each of the cylinder bores 34b. The piston 12 is coupled with the swash plate 5 with a pair of shoes 18 disposed therebetween,

[0004] An end of the fixed arm 72 serves as a fixed coupling portion, at which a fixed coupling surface 72a is formed. Similarly, an end of the movable arm 82 serves as a movable coupling portion, at which a movable coupling surface 82a is formed.

[0005] The fixed hinge 7 is coupled with the movable hinge at the positions only of the fixed coupling portion and the movable coupling portion.

[0006] During an operation of the volume variable swash plate type compressor 1, a force is generated as illustrated in Figs. 5A, 5B and 5C. Namely, when the shaft 4 is rotated by an external driving source (not shown), a driving torque T is effected on the shaft 4, a compressive reaction being given to the piston 12. At this moment, a moment M1 and a moment M2 are simultaneously effected to the fixed arm 72 and the movable arm 82, respectively. The moment M1 is a four-turn shaft moment which is generated when the fixed hinge 7 receives a driving torque T from the shaft 4, then the driving torque T being transmitted from the fixed hinge 7 to the movable hinge 8. The moment M2 is generated when the swash plate 5 receives a compressive reaction force P and is a moment, which serves to rotate the swash plate 5 in a rotational direction perpendicular to an axis of the shaft 4.

[0007] In the volume variable swash plate type compressor 1, various moments are added to or effected on the fixed arm and the movable arm during operation. Therefore, it is required and important that the fixed arm and the movable arm have a sufficient rigidity.

[0008] In order to secure the desired rigidity to the arm portions, arm portions is formed to have a greater thickness. This results in heavy weight of the arm portions. Therefore, the balanced rotation of the hinge mechanism is not expected. Consequently, since adjustment of an inclination angle of the swash plate is not achieved in a smooth manner, responsive characteristics of volume control for the compressor is not fulfilled.

Summary of the invention:

[0009] It is therefore an object of the present invention to provide a new and improved volume variable, swash plate type compressor which has arm portions of light weight in the hinge mechanism and reliable responsive characteristics of the volume control for the compressor.

[0010] Other objects of the present invention will become clear as the description proceeds.

[0011] According to an aspect of the present invention, there is provided a swash plate type compressor which comprises a rotatable shaft extending in an axial direction, a swash plate, a hinge mechanism supporting said swash plate on said shaft in such a manner that said swash plate has an inclination angle variable relative to said axial direction, said hinge mechanism serving to transmit a driving torque of said shaft to said swash plate and comprises a fixed hinge fixedly connected to said shaft and a movable hinge fixedly connected to said swash plate, said fixed hinge having a fixed arm, said movable hinge having a movable arm which is coupled to said fixed arm to be pivotal around an axis extending perpendicular to said axial direction, said fixed and said movable arms transmitting a part of said driving torque to said swash plate in cooperation with each other. The swash plate type compressor is characterized in that said fixed hinge has an auxiliary fixed coupling portion, said movable hinge having an auxiliary movable coupling portion engaged with said auxiliary fixed coupling portion, so that another part of said driving torque is transmitted from said shaft to said swash plate in cooperation of said auxiliary fixed and said auxiliary movable coupling portions.

[0012] According to another aspect of the present invention, there is provided a swash plate type compressor which comprises a housing including a cylinder block having a plurality of cylinder bores, a drive shaft rotatably supported by the housing, a plurality of pistons each of which is slidably disposed within each of the cylinder bores, a swash plate having an angle of tilt and tiltably connected to the drive shaft, a rotor member fixed to the drive shaft to be rotatable with the drive shaft, a hinge mechanism joining the rotor member to the swash plate for varying the inclination of the swash plate with

respect to the drive shaft and transmitting a part of driving torque of the drive shaft to the swash plate, and coupling means coupling the swash plate to the pistons, so that the pistons are driven in reciprocating motion within the cylinder bores upon nutation of the plate. The swash plate type compressor is characterized by further comprising transmitting means coupled between the rotor member and the swash plate for transmitting another part of the driving torque of the drive shaft from the rotor member to the swash plate.

Brief Description of the Drawing:

[0013]

Fig. 1 is a vertical sectional view of a volume variable swash plate type compressor according to an embodiment of the invention;

Figs. 2A, 2B, and 2C are a front view, a side view, and a plan view, respectively, of the volume variable swash plate type compressor shown in Fig. 1, showing a related portion of the compressor in a case of a maximum volume;

Figs. 3A, 3B, and 3C are a front view, a side view, and a plan view, respectively, of the volume variable swash plate type compressor shown in Fig. 1, showing a related portion of the compressor in a case of a minimum volume,

Fig. 4 is a vertical sectional view of a volume variable swash plate type compressor in an earlier technology;

Figs. 5A, 5B, and 5C are a front view, a side view, and a plan view, respectively, of the volume variable swash plate type compressor shown in Fig. 4, showing a related portion of the compressor in a case of a maximum volume; and

Figs. 6A, 6B, and 6C are a front view, a side view, and a plan view, respectively, of the volume variable swash plate type compressor shown in Fig. 4, showing a related portion of the compressor in a case of a minimum volume.

Description of the Preferred Embodiment:

[0014] Referring to Figs. 1 to 3, description will be made as regards a volume valuable swash plate type compressor according to an embodiment of the present invention.

[0015] The swash plate type compressor is designated by a reference numeral 1 and comprises a housing 3, a drive shaft 4, a swash plate 5 and a hinge mechanism. The housing 3 has a housing body 31, a front end plate 32 and a cylinder head 33. The housing body 31 is substantially cylindrical and has an opening at one end and a cylinder block 34 integrally formed at the other end. The cylinder block 34 has a central hole 34a at its center portion. The central hole 34a has therein a radial needle bearing 10 and a control valve 11. On the outer circumferential surface of the cylinder block 34 is provided a plurality of cylinder bores 34b at a constant interval around the central hole 34a. A piston 12 is slidably inserted into each of the cylinder bores 34b.

[0016] The front end plate 32 is substantially cone shaped and fitted to an end of the housing body 31 to close the end. The front end plate 32 has at its central portion a radial needle bearing 13 and a shaft sealing member 14.

[0017] The cylinder head 33 is substantially bowl shaped and has a suction chamber 33a and exhaust (discharge) chamber 33b and is connected with the cylinder block 34 through a valve device 15 by means of a bolt 16.

[0018] The shaft 4 is rotatably supported at its tip end portion to the front end plate 32 through the needle bearing 13 and rotatably supported at its rear end to the cylinder block 34 through the needle bearing 10. Thus, the shaft 4 is rotatably disposed in the housing 3, the tip end being extended out of the housing 3 through the front end plate 32. The extended portion of the shaft 4 from the housing 3 is coupled with an electromagnetic clutch 17 fitted to the front end plate 32.

[0019] The swash plate 5 is ring shaped and mounted on the shaft 4 such that the shaft 4 is extended through the central hole 5a. The swash plate 5 is supported to the hinge mechanism 6. The swash plate 5 and the piston 12 are connected with each other by a pair of shoes 18.

[0020] The hinge mechanism 6 is mounted on the shaft 4 and serves to support the swash plate 5 so that an inclination angle is variable relative to an axis of the shaft 4, and the torque transmitted to the shaft 4 is transmitted to the swash plate 5. The hinge mechanism 6 comprises a fixed hinge 7 and the movable hinge 8.

[0021] The fixed hinge 7 comprises a rotor member or a fixed hinge body 71 and a fixed arm 72. The fixed hinge body 71 is ring shaped and fixed to the shaft 4 such that the shaft 4 is inserted into the central hole 71a. The fixed arm 72 is of a plate shape and integrally formed as a first arm portion on the fixed hinge body 71. The fixed arm 72 is extended along a surface which is contacted, in parallel, with the axis of the shaft 4 in the state that the fixed hinge 7 is fixed to the shaft 4. The tip end of the fixed arm 72 serves as a fixed main coupling portion. The fixed coupling portion has a fixed coupling portion 72a which is parallel to a plane contacted, in parallel, with an axis of the shaft 4. Further, a pin 61 is fixed to the fixed coupling portion and is extended perpendicularly to the fixed coupling surface 72a.

[0022] The movable hinge 8 comprises a flange portion 81, a movable arm 82, and a boss portion 83. The flange portion 81 is of a ring shape. The movable arm 82 is provided as a second arm portion on a surface of the flange portion 81 and its tip end serves as a movable main coupling portion, which has a movable coupling surface 82a parallel to a surface which is parallel

to an axis of the shaft 4. Further, the movable coupling portion is provided with an elongated or oblong hole 82b into which a pin 61 disposed to the fixed arm 72 is inserted. A snap ring 62 is fit is fitted to the end of the pin 61 to prevent the pin 61 from being dropped out of the oblong hole 82b. Thus, the movable arm 82 is rotatably coupled with the fixed arm 72. The movable coupling surface 82a is slidably contacted with the fixed coupling surface 72a of the fixed arm 72 with a washer 19 interposed therebetween so that a driving torque is received from the fixed coupling surface 72a. A boss portion 83 is provided on the other surface of the flange portion 81 and has a male screw 83a on its outer circumferential surface. The swash plate 5 is mounted on the boss portion 83 and a press ring 84 having a female screw 84a engageable with the male screw 83a is engaged with the boss portion 83, so that the swash plate 5 is fixed to the other surface of the flange portion 81. A slant hole 85 is provided at a center portion of the boss portion 83 and the flange portion 81. The central, slant hole 85 is a portion which serves to receive therethrough the shaft 4. The inner surface of the slant hole 85 is slidably contacted with an outer circumferential surface of the shaft 4. Consequently, a smooth rotation of the movable hinge 8 is established.

[0023] The fixed hinge 7 has an auxiliary fixed coupling portion which, in this embodiment, is projected in an opposed relation from the side surfaces of the fixed hinge body 71 to form a pair of receiving portions or projections 73 having a pair of plain surfaces 73a.

[0024] The plain surfaces 73a are in a confronting relation with each other. Each of the plain surfaces 73a is a surface which is parallel to one surface contacting in parallel with the axis of the shaft 4 and passing through the coupling portion between the fixed arm 72 and the movable arm 82. The projections 73 having the surfaces 73a are provided nearer or proximal to the shaft 4 relative to the fixed main coupling portion of the fixed arm 72. Thus, the projections 73 having the surfaces 73a are formed in a paired configuration and, in addition, located adjacent to the shaft 4. Therefore, a rotational balance of the fixed hinge 7 is maintained by the provision of the projections having the plain surfaces 73a.

[0025] Similarly, the movable hinge 8 has an auxiliary movable coupling portion which, in this embodiment, comprises a pair of auxiliary arms 86 provided on one surface of the flange portion 81. Each of the auxiliary arms 86 has a surface which is parallel to one surface contacting in parallel with the axis of the shaft 4 and passing through the coupling portion between the fixed arm 72 and the movable arm 82. Further, the auxiliary arms 86 are slidably contacted with a pair of the plain surface 73a in such a manner that a pair of the projections 73 of the fixed hinge 7 are grasped. The paired auxiliary arms 86 are located more proximal or nearer to the shaft 4 than the movable main coupling portion of the movable arm 82. Thus, the auxiliary arm 86 are formed in a paired relation and proximal to the shaft 4 as described above. Therefore, a rotational balance of the movable hinge 8 can be maintained by provision of the auxiliary arms 86.

[0026] By the plain surfaces 73a of the fixed hinge 7 and the auxiliary arms 86 of the movable hinge 8, both of which are in a paired structure, a part of the driving torque transmitted from the shaft 4 to the fixed hinge 7 is successfully transmitted to the movable hinge 8.

[0027] With the swash plate type compressor, the hinge mechanism has an auxiliary fixed coupling portion and an auxiliary movable coupling portion. Therefore, a rigidity of the fixed arm of the fixed hinge and the movable arm of the movable hinge can be reduced relative to the conventional compressors. In addition, the weight of the fixed arm and movable arm can be reduced. Thus, the rotational balance of the hinge mechanism can be improved relative to the compressors in an earlier technology. Further, adjustment and control of the inclination angle of the swash plate can be made readily. Accordingly, responsiveness of the volume control of the compressor can be improved substantially.

[0028] While the present invention has thus far been described in connection with a few embodiments thereof, it will readily be possible for those skilled in the art to put this invention into practice in various other manners. For example, it should be appreciated that the auxiliary fixed coupling portion and the auxiliary movable coupling portion are not limited to those of the embodiment described above. Alterations and modifications can be made if a part of the driving torque transmitted to the fixed hinge can be transmitted desirably to the movable hinge without providing any inconveniences to rotation of the movable hinge.

Claims

1. A swash plate type compressor comprising a rotatable shaft (4) extending in an axial direction, a swash plate (5), a hinge mechanism (6) supporting said swash plate on said shaft in such a manner that said swash plate has an inclination angle variable relative to said axial direction, said hinge mechanism serving to transmit a driving torque of said shaft to said swash plate and comprises a fixed hinge (7) fixedly connected to said shaft and a movable hinge (8) fixedly connected to said swash plate, said fixed hinge having a fixed arm (72), said movable hinge having a movable arm (82) which is coupled to said fixed arm to be pivotal around an axis extending perpendicular to said axial direction, said fixed and said movable arms transmitting a part of said driving torque to said swash plate in cooperation with each other, characterized in that said fixed hinge has an auxiliary fixed coupling portion (73), said movable hinge having an auxiliary movable coupling portion (86) engaged with said auxiliary fixed coupling portion, so that another part

of said driving torque is transmitted from said shaft to said swash plate in cooperation of said auxiliary fixed and said auxiliary movable coupling portions.

2. A swash plate type compressor as claimed in claim 1, wherein said auxiliary fixed and said auxiliary movable coupling portions are located proximal to said shaft relative to said fixed and said movable arms.

3. A swash plate type compressor as claimed in claim 1 or 2, wherein said auxiliary fixed coupling portion is contacted, in parallel, with an axial line of said shaft and has a pair of surfaces (73a) extending in parallel with a surface passing through the coupling portion between said fixed and said movable arms, said auxiliary movable coupling portion having a pair of auxiliary arms (86) slidably contacted with each of said pair of the surfaces.

4. A swash plate type compressor as claimed in any one of claims 1-3, further comprising a housing (3) including a cylinder block with a plurality of cylinder bores (34b), a plurality of pistons (12) slidably disposed within said cylinder bores, respectively, and coupling means (18) coupled to said swash plate and said pistons for making said pistons be driven in reciprocating motion within said cylinder bores upon nutation of said plate.

5. A swash plate type compressor comprising a housing (3) including a cylinder block (34) having a plurality of cylinder bores (34b), a drive shaft (4) rotatably supported by said housing, a plurality of pistons (12) each of which is slidably disposed within each of said cylinder bores, a swash plate (5) having an angle of tilt and tiltably connected to said drive shaft, a rotor member (71) fixed to said drive shaft to be rotatable with said drive shaft, a hinge mechanism (6) joining said rotor member to said swash plate for varying the inclination of said swash plate with respect to said drive shaft and transmitting a part of driving torque of said drive shaft to said swash plate, and coupling means (18) coupling said swash plate to said pistons, so that said pistons are driven in reciprocating motion within said cylinder bores upon nutation of said plate, characterized by further comprising transmitting means (73, 86) coupled between said rotor member and said swash plate for transmitting another part of said driving torque of said drive shaft from said rotor member to said swash plate.

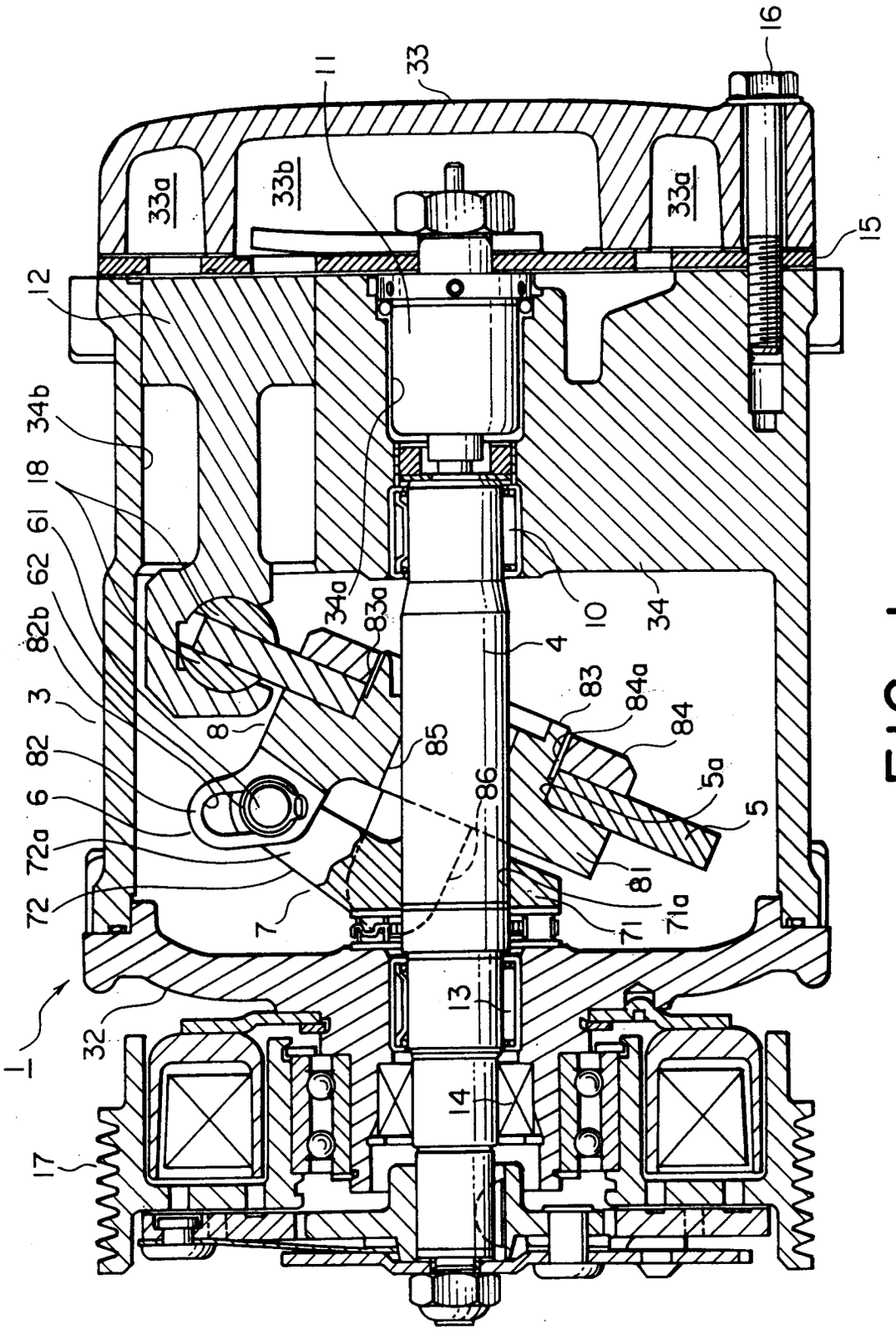
6. A swash plate type compressor as claimed in claim 5, wherein said transmitting means comprises a pair of receiving portions (73) formed on radial opposite sides of said rotor member, and a pair of arms (86) extending from an axial end surface of said swash plate and coupled to the pair of said receiving portions of said rotor member.

7. A swash plate type compressor as claimed in claim 6, wherein said receiving portions of said rotor member includes surfaces (73a) formed thereon for slidably contacting with the pair of said arms of said swash plate.

8. A swash plate type compressor as claimed in claim 7, wherein said surfaces of the receiving portions extends in parallel to each other with a space left therebetween, the pair of said arms of said swash plate being inserted in said space to be in slidable contact with said surfaces of the receiving portions, respectively.

9. A swash plate type compressor as claimed in one of claims 5 to 8, wherein said hinge mechanism comprises a first arm portion (72) extending from said rotor member and a second arm portion (82) extending from said swash plate and having an elongated slot (82b) through which passes a pin member (61) fixedly connected to said first arm portion.

10. A swash plate type compressor as claimed in one of claims 5 to 9, wherein said coupling means is a plurality of shoes (18) disposed between said pistons and said swash plate.


16
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33
33a
33b
33a
15
12
34b
18
61
62
82b
3
82
6
72a
72
1
32
17
34a
83a
10
34
4
83
84a
84
85
8
86
5a
5
81
71
71a
7
13
14

FIG. 1

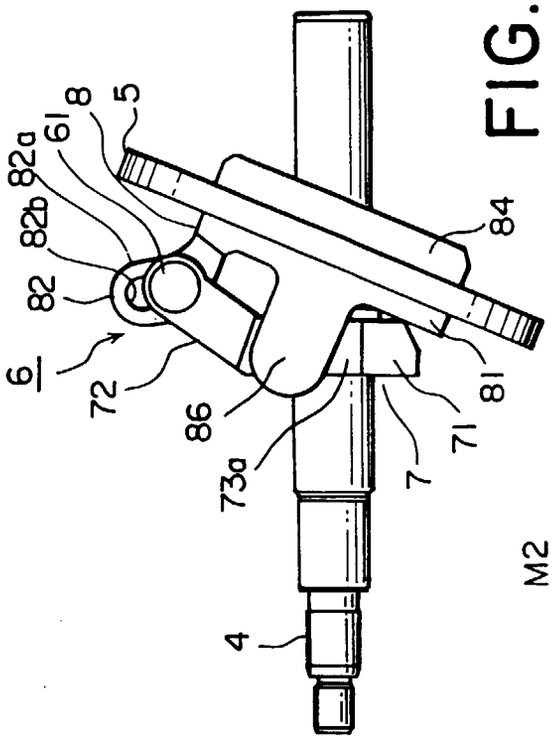

FIG. 2B

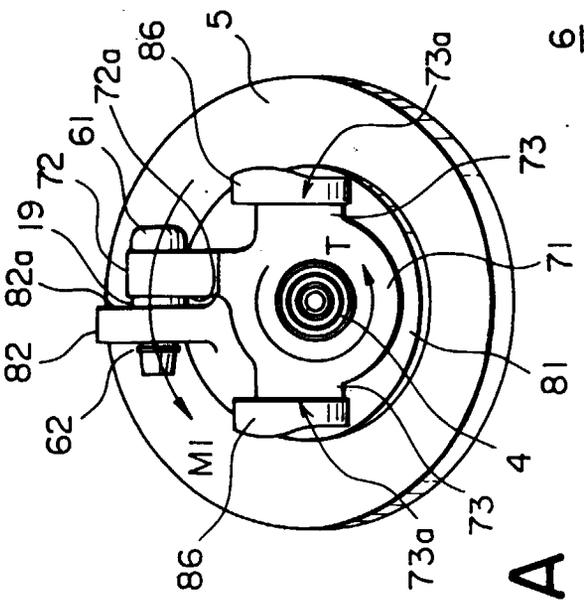

FIG. 2A

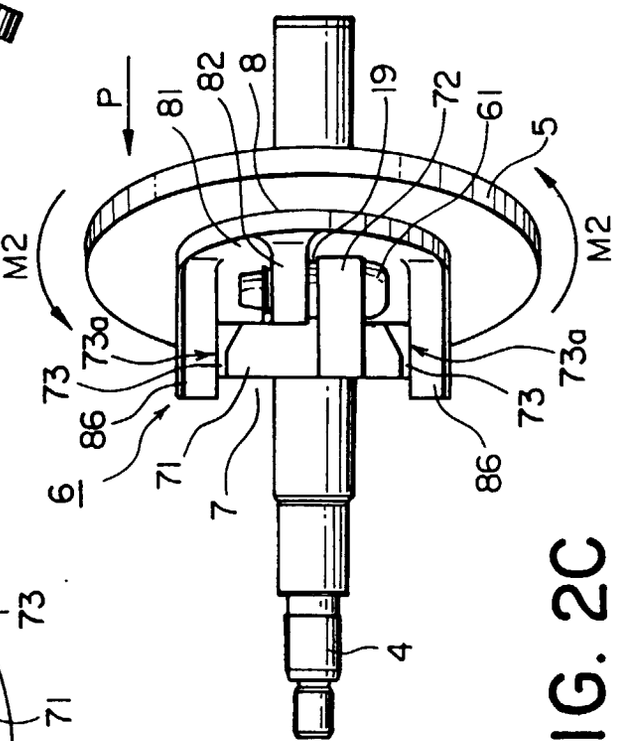

FIG. 2C

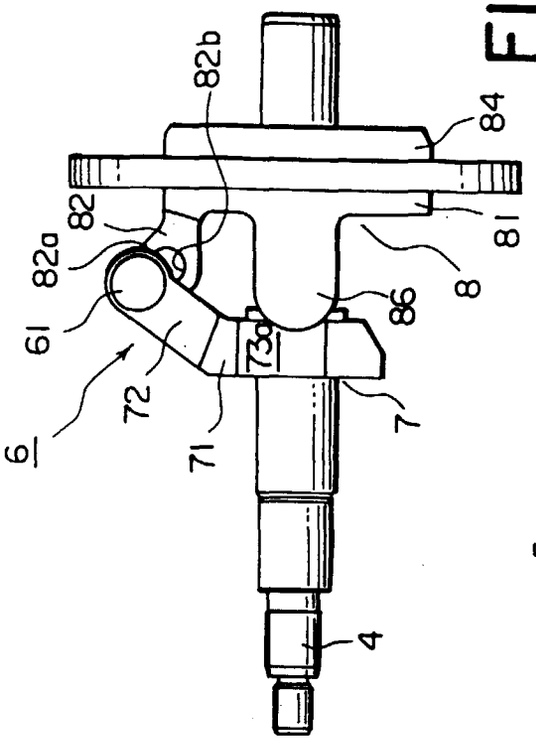

FIG. 3B

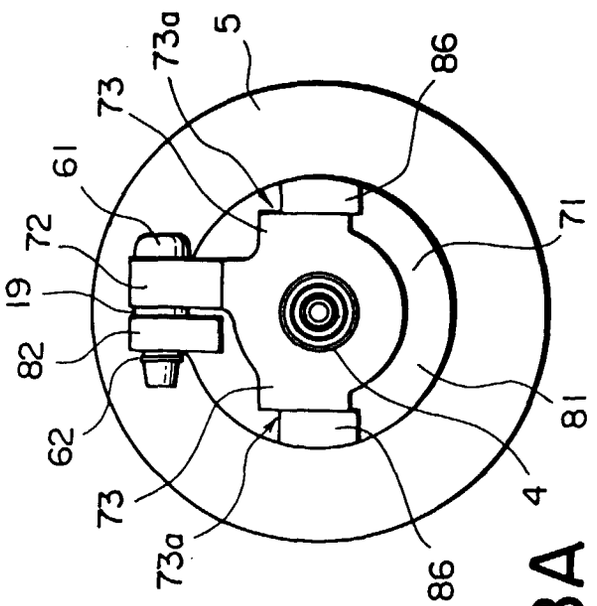

FIG. 3A

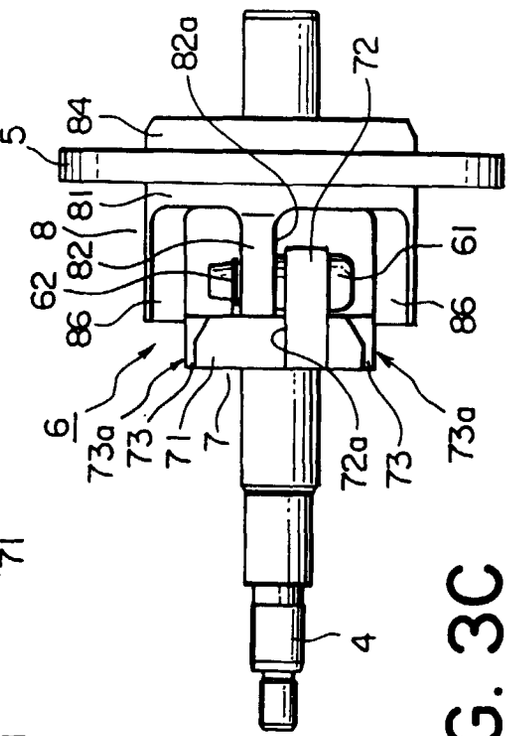

FIG. 3C

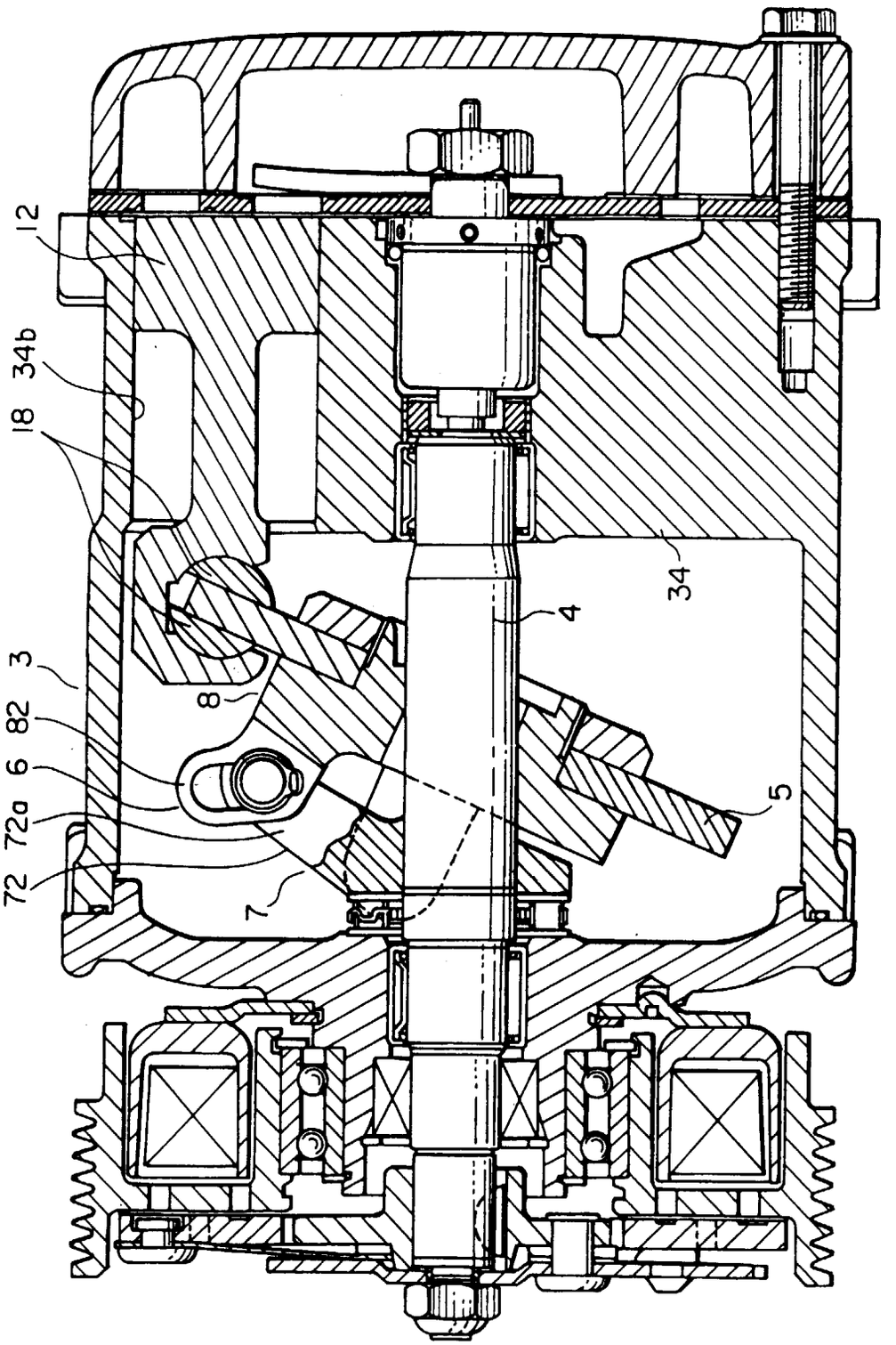

FIG. 4

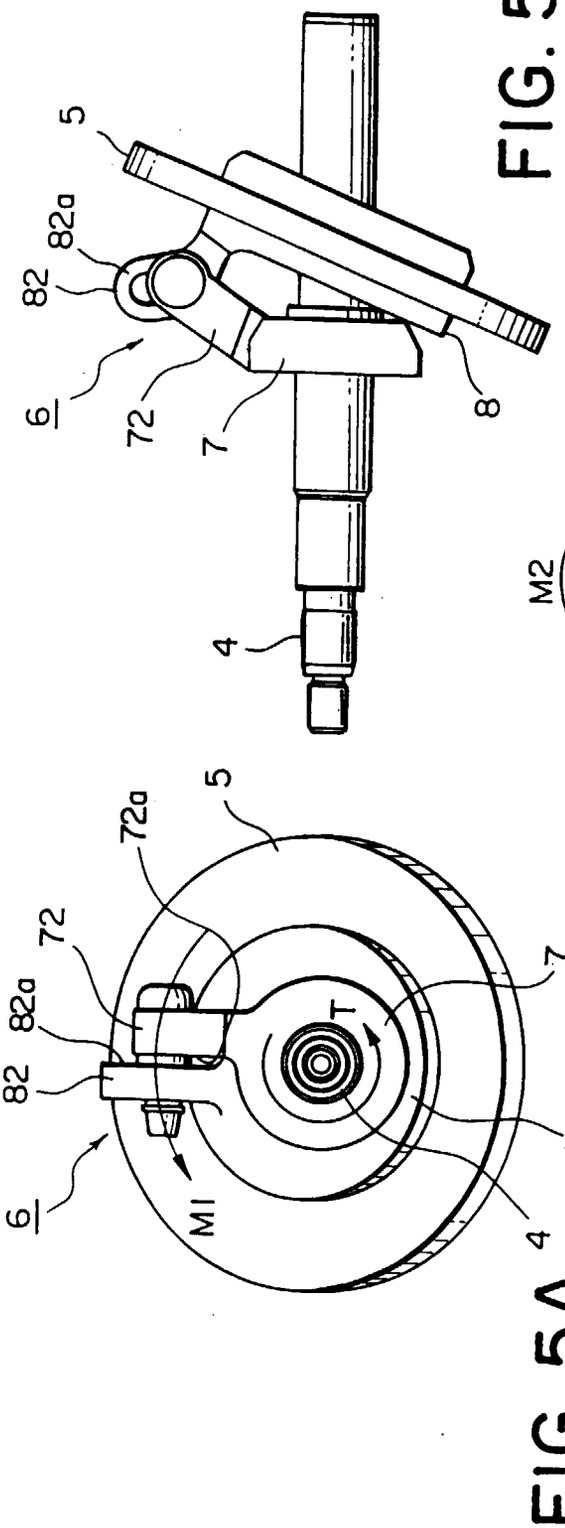

FIG. 5A

FIG. 5B

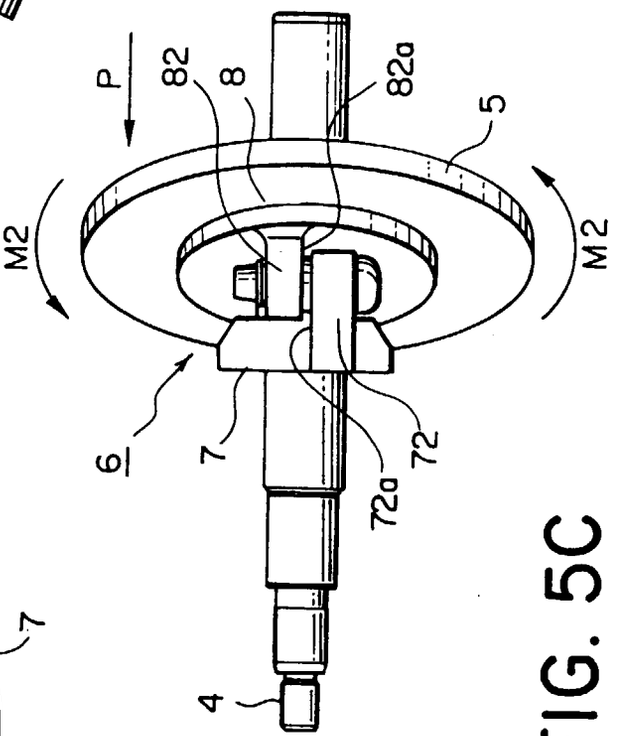

FIG. 5C

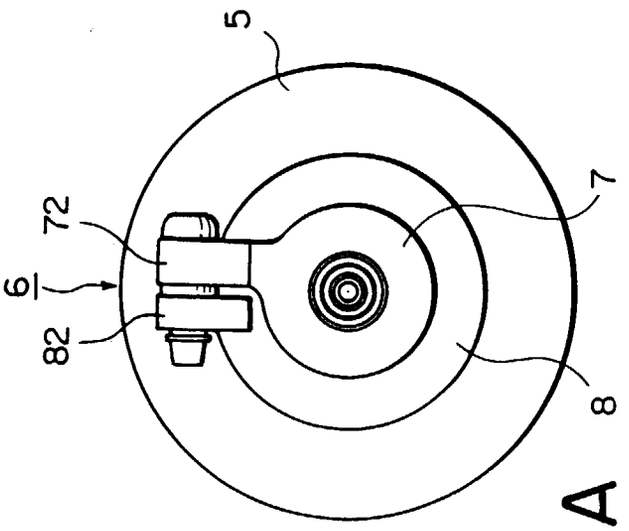

FIG. 6A

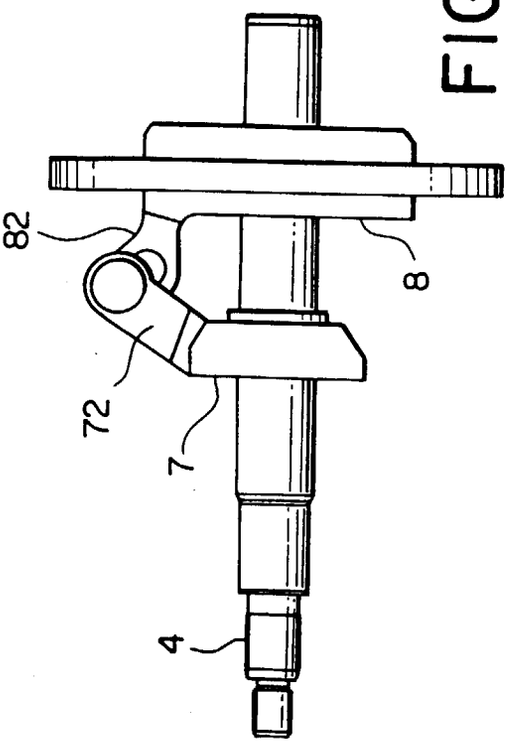

FIG. 6B

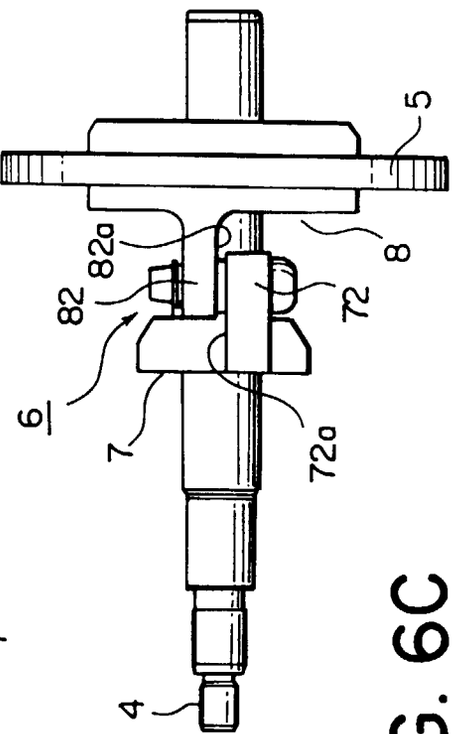

FIG. 6C