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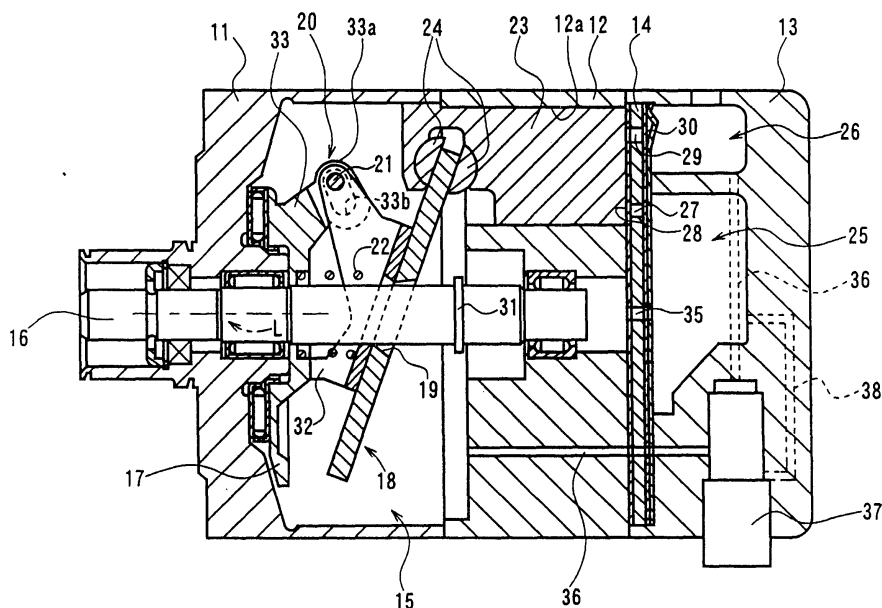
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(54) **Variable displacement compressor**

(57) A cam plate of a variable displacement compressor is easily manufactured. The compressor includes a lug plate (17) fixed to a drive shaft (16), a cam plate (18) supported in an inclinable manner by the drive shaft, and a hinge mechanism (20) connecting the lug

plate and the cam plate. The cam plate includes a disk (18a) engaged with a piston (23) and a joint (18b; 50) formed separately from the disk and fixed to the disk. The joint forms the hinge mechanism. At least one of the joint and the disk is press-formed.

Fig. 1



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Description

[0001] The present invention relates to a cam plate of a variable displacement compressor.

[0002] Japanese Unexamined Patent Publication No. 10-274153 describes a typical compressor employed in an automobile air conditioner. As shown in Figs. 6 and 7, the compressor includes a lug plate 101, a drive shaft 102, and a cam plate 103. The lug plate 101 is fixed to the drive shaft 102. A shaft hole 103a extends through the center of the cam plate 103. The drive shaft 102 extends through the shaft hole 103a. A clearance, having a predetermined dimension, is formed between the drive shaft 102 and the wall surface that defines the shaft hole 103a to support the cam plate 103 in an inclinable manner. A housing 105 accommodates the lug plate 101, the drive shaft 102, and the cam plate 103. A piston 104 is retained in each cylinder bore 105a. Each piston 104 is engaged to the peripheral portion of the cam plate 103 by means of a pair of shoes 106.

[0003] The lug plate 101 and the cam plate 103 are connected to each other by a hinge mechanism 107. The hinge mechanism 107 includes two guide pins 108, which extend from the cam plate 103, and support arms 109, which extend from the lug plate 101 in correspondence with the guide pins 108. Spherical portions 108a are defined on the distal end of each guide pin 108. A guide bore 109a extends through each support arm 109. The axis of each guide bore 109a is inclined relative to the axis of the drive shaft 102. The spherical portion 108a of each guide pin 108 is inserted in the guide bore 109a of the corresponding guide pin 108.

[0004] The lug plate 101 and the hinge mechanism 107 rotate integrally with the drive shaft 102. The rotational movement of the cam plate 103 is converted to reciprocal linear movement of the pistons 104 by means of the shoes 106. As a result, a compression cycle, which includes the suction, compression, and discharge of refrigerant gas, is performed in each cylinder bore 105a. Referring to Fig. 6, a top dead center portion D1 and a bottom dead center portion D2 are defined on the inclined cam plate 103. When a certain point on the inclined cam plate 103 rotates 180 degrees from the top dead center portion D1, the certain point reaches the bottom dead center portion D2. The piston 104 engaged with the top dead center portion D1 of the cam plate 103 is arranged at the top dead center in the associated cylinder bore 105a. Further, the piston 104 engaged with the bottom dead center portion D2 of the cam plate 103 is arranged at the bottom dead center in the associated cylinder bore 105a.

[0005] The hinge mechanism 107 enables the cam plate 103 to incline between a maximum inclination position (the state shown in Fig. 6) and a minimum inclination position (not shown). When the inclination of the cam plate 103 is altered, the bottom dead center position changes, although the top dead center position remains the same. This changes the stroke of the pistons

104 and adjusts the displacement of the compressor.

[0006] The cam plate 103 has a contacting portion 103b that opposes the guide pins 108 on the same surface of the cam plate 103 as the guide pins 108. A seat 101a is defined on the lug plate 101 at a position corresponding to the contacting portion 103b. When the inclination of the cam plate 103 is maximal, the contacting portion 103b contacts the seat 101a. In this state, the cam plate 103 is arranged at the maximum inclination position.

[0007] In the prior art, the cam plate 103 is manufactured by machining a cast material. As shown in Fig. 7, the cam plate 103, which is integrally cast, includes a thick portion 103d, the contacting portion 103b, guide pin holding portions 103e, and a disk portion 103c. Predetermined portions of the cast cam plate 103 are machined. The guide pins 108, which are formed separately from the cam plate 103, are fitted to holes that are formed in the guide pin holding portions 103e. This completes the final cam plate 103. The parts of the cam plate 103 that undergo machining include the circumferential surface and the two opposing flat surfaces of the disk portion 103c, the flat end surfaces of the guide pin holding portions 103e, the holes for receiving the guide pins 108, the surface of the contacting portion 103b, and the shaft hole 103a.

[0008] The cam plate 103 is cast and thus includes unnecessary material. As a result, the cast cam plate 103 is heavy. Further, many parts of the cam plate 103 must be machined. Thus, it takes time to machine the cam plate 103.

[0009] It is an object of the present invention to provide a variable displacement compressor that includes an easily formed cam plate.

[0010] To achieve the above object, the present invention provides a variable displacement compressor for drawing, compressing, and discharging refrigerant with a piston reciprocated by converting rotation of a drive shaft via a lug plate fixed to the drive shaft, a cam plate supported in an inclinable manner by the drive shaft, and a hinge mechanism connecting the lug plate and the cam plate. The displacement of the compressor varies in accordance with the inclination of the cam plate. The cam plate includes a disk engaged with the piston, and a joint forming the hinge mechanism. The joint is formed separately from the disk and connected to the disk. At least one of the joint and the disk is press-formed.

[0011] A further perspective of the present invention is a method for manufacturing a cam plate of a variable displacement compressor. The compressor draws, compresses, and discharges refrigerant with a piston reciprocated by converting rotation of a drive shaft via a lug plate fixed to the drive shaft, the cam plate, and a hinge mechanism connecting the lug plate and the cam plate. The cam plate is supported in an inclinable manner by the drive shaft. The displacement of the compressor varies in accordance with the inclination of the cam

plate. The method includes press forming a disk having a hole from a metal plate, bending a metal plate to form a joint having two bent pieces, and fixing the disk and the joint to each other.

[0012] Other aspects and advantages of the present invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

[0013] The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

Fig. 1 is a cross-sectional view showing a variable displacement compressor according to the present invention;

Fig. 2 is a perspective view showing a cam plate of the compressor of Fig. 1;

Fig. 3 is a perspective view showing a disk of the cam plate of Fig. 2;

Fig. 4 is a perspective view showing a joint of the cam plate of Fig. 2;

Fig. 5 is a perspective view showing a joint of a further embodiment according to the present invention;

Fig. 6 is a cross-sectional view showing a prior art variable displacement compressor; and

Fig. 7 is a perspective view showing a cam plate of the compressor of Fig. 6.

[0014] A single-headed piston type variable displacement compressor according to the present invention will now be discussed. The compressor is employed in an air conditioning system of a vehicle.

[0015] As shown in Fig. 1, a front housing 11 is fixed to the front end of a cylinder block 12. A rear housing 13 is fixed to the rear end of the cylinder block 12. A valve plate 14 is arranged between the rear housing 13 and the cylinder block 12. A crank chamber 15 is defined in the front housing 11 and the cylinder block 12. The front housing 11 and the cylinder block 12 rotatably support a drive shaft 16, which extends through the crank chamber 15. The drive shaft 16 is connected to the vehicle engine (not shown) by a clutch mechanism such as an electromagnetic clutch. Accordingly, the drive shaft 16 is rotated if the electromagnetic clutch connects the drive shaft 16 to the engine when the engine is running.

[0016] A lug plate 17 is fixed to the drive shaft 16 in the crank chamber 15. A cam plate 18 is accommodated in the crank chamber 15. The drive shaft 16 is inserted through a shaft hole 19, which extends through the central portion of the cam plate 18. The hinge mechanism 20 connects the lug plate 17 and the cam plate 18.

[0017] The cam plate 18 will now be described with reference to Figs. 1 to 4. The cam plate 18 of Fig. 2 is

formed by fixing a disk 18a, which is shown in Fig. 3, and a joint 18b, which is shown in Fig. 4, to each other. The joint 18b forms part of the hinge mechanism 20. To fix the disk 18a and the joint 18b to each other, for example, the disk 18a and the joint 18b may be welded (e. g., spot welding or projection welding) to each other. Alternatively, the disk 18a and the joint 18b may be fixed to each other by rivets or the like. As shown in Fig. 3, a disk hole 19a, which forms part of the shaft hole 19, extends through the central portion of the disk 18a. The disk 18a, which has the disk hole 19a, is formed by, for example, pressing out a sheet of rolled steel. Further, referring to Fig. 4, the joint 18b is formed by, for example, pressing a sheet of rolled steel in a C-shaped manner. The joint 18b has two bent pieces, which are separated from each other by a predetermined distance. A connecting portion 18c and an engaging portion 32 are defined on each bent piece. A pin hole 18d extends through the distal end of each connecting portion 18c to receive a hinge pin 21, which is shown in Fig. 1. A joint hole 19b, which forms part of the shaft hole 19, extends through the central portion of the joint 18b.

[0018] Referring to Fig. 1, the lug plate 17 includes a support arm 33, which has a bifurcated portion 33a, corresponding to the connecting portion 18c. The two connecting portions 18c of the joint 18b are arranged between the bifurcated portion 33a. Further, the bifurcated portion 33a has guide holes 33b. The hinge pin 21 is inserted through the guide holes 33b and the pin holes 18d. The hinge pin 21 is movable in the guide holes 33b. Thus, the cam plate 18 is movable between a maximum inclination position, in which the engaging portion 32 contacts the lug plate 17, and a minimum inclination position, in which the disk 18a of the cam plate 18 contacts a snap ring 31, which is attached to the drive shaft 16. A compression spring 22 is arranged between the lug plate 17 and the cam plate 18. The support arm 33 and the hinge pin 21 form part of the hinge mechanism 20.

[0019] A plurality of equally spaced cylinder bores 12a (only one shown in Fig. 1) extend through the cylinder block 12 about the axis L of the drive shaft. A single-headed piston 23 is retained in each cylinder bore 12a. Each piston 23 is engaged with the peripheral portion of the disk 18a by means of a pair of shoes 24.

[0020] A suction chamber 25 is defined in the central portion of the rear housing 13. A discharge chamber 26 is defined in the peripheral portion of the rear housing 13. A suction port 27, a suction valve 28, a discharge port 29, and a discharge valve 30 are provided for each piston 23 in the valve plate 14.

[0021] The lug plate 17 and the hinge mechanism 20 rotate the cam plate 18 integrally with the drive shaft 16. When the drive shaft 16 rotates, the inclination of the cam plate 18 relative to the axis L reciprocates the pistons 23 by means of the shoes 24.

[0022] When each piston 23 moves from the top dead center to the bottom dead center in the associated cylinder bore 12a, refrigerant gas is drawn into the cylinder

bore 12a from the suction chamber 25 through the suction port 27 and the suction valve 28. When the piston 23 moves from the bottom dead center to the top dead center, the refrigerant gas drawn into the cylinder bore 12a is compressed and then discharged into the discharge chamber 26 through the discharge port 29 and the discharge valve 30.

[0023] A bleeding passage 35 connects the crank chamber 15 and the suction chamber 25. A gas supply passage 36 connects the discharge chamber 26 and the crank chamber 15. A displacement control valve 37 is arranged in the gas supply passage 36. A pressure sensing passage 38 connects the suction chamber 25 and the displacement control valve 37. The displacement control valve 37 detects the pressure in the suction chamber 25 through the pressure sensing passage 38 and is controlled based on the detected pressure.

[0024] The displacement control valve 37 adjusts the opening degree of the gas supply passage 36 to change the pressure in the crank chamber 15 and adjust the differential pressure acting on the pistons 23 (i.e., the difference between the pressure in the crank chamber 15 and the pressure in the cylinder bores 12a). This alters the inclination of the cam plate 18, changes the stroke of the pistons 23, and varies the displacement of the compressor.

[0025] When the cooling load is small, the pressure in the suction chamber 25, or the suction pressure, is lower than a predetermined value. In this state, the displacement control valve 37 functions to increase the opening degree of the gas supply passage 36. Thus, the refrigerant gas drawn into the crank chamber 15 from the discharge chamber 26 increases the pressure in the crank chamber 15. Accordingly, the hinge pin 21 moves in the guide holes 33b toward the axis L. Further, the cam plate 18 moves along the drive shaft 16 toward the minimum inclination position, as its inclination decreases. This decreases the stroke of the pistons 23. As a result, the displacement of the compressor decreases, and the suction pressure is increased so that it approaches the predetermined value.

[0026] When the cooling load is large, the suction pressure is greater than a predetermined value. Thus, the displacement control valve 37 functions to decrease the opening degree of the gas supply passage 36, and the refrigerant gas in the crank chamber 15 is released into the suction chamber 25 through the bleeding passage 35. This decreases the pressure in the crank chamber 15. Accordingly, the hinge pin 21 moves in the guide holes 33b away from the axis L. Simultaneously, the cam plate 18 moves along the drive shaft 16 toward the maximum inclination position, as its inclination increases. This increases the stroke of the pistons 23. As a result, the displacement of the compressor increases, and the suction pressure is decreased so that it approaches the predetermined value.

[0027] The advantages of the preferred and illustrated embodiment will now be described.

(1) The cam plate 18 is formed by fixing the disk 18a and the joint 18b, which are press-formed, to each other. This drastically decreases portions that undergo machining in comparison to the prior art in which a cast material is machined. Accordingly, the manufacturing process is simplified and the time required for machining is shortened.

(2) Since the cam plate 18 is press-formed, the cam plate 18 does not include unnecessary material. Thus, in comparison to an integrally cast cam plate, the cam plate 18 is light.

(3) The disk 18a and the joint 18b are each press-formed. Thus, the disk 18a and the joint 18b may be formed from high-strength material or general-purpose material. Accordingly, each component may be formed from the optimal material. This improves the quality and reliability of the compressor.

[0028] It should be apparent to those skilled in the art that the present invention may be embodied in many other specific forms without departing from the spirit or scope of the invention. Particularly, it should be understood that the present invention may be embodied in the following forms.

[0029] Referring to Fig. 5, a generally U-shaped plate 50 may be employed as the joint. The joint 50 is press-formed so that its distal portions, which serve as connecting portions 52, is inclined relative to its basal portion, which serves as an engaging portion 51. Each connecting portion 52 includes a pin hole 53 through which the hinge pin 21 is inserted. Fastening holes 54 are formed in the joint 50. Rivets are inserted in the fastening holes 54 and fastened to the joint 50 to fix the joint 50 and the disk 18a to each other. This structure has the same advantages as the above embodiment.

[0030] The present examples and embodiments are to be considered as illustrative and not restrictive, and the invention is not to be limited to the details given herein, but may be modified within the scope and equivalence of the appended claims.

[0031] A cam plate of a variable displacement compressor is easily manufactured. The compressor includes a lug plate (17) fixed to a drive shaft (16), a cam plate (18) supported in an inclinable manner by the drive shaft, and a hinge mechanism (20) connecting the lug plate and the cam plate. The cam plate includes a disk (18a) engaged with a piston (23) and a joint (18b; 50) formed separately from the disk and fixed to the disk. The joint forms the hinge mechanism. At least one of the joint and the disk is press-formed.

Claims

1. A variable displacement compressor for drawing, compressing, and discharging refrigerant with a pis-

ton (23) reciprocated by converting rotation of a drive shaft via a lug plate (17) fixed to the drive shaft (16), a cam plate (18) supported in an inclinable manner by the drive shaft, and a hinge mechanism (20) connecting the lug plate and the cam plate, wherein the displacement of the compressor varies in accordance with the inclination of the cam plate, the compressor being **characterized in that:**

the cam plate (18) includes a disk (18a) engaged with the piston, and a joint (18b; 50) forming the hinge mechanism, wherein the joint is formed separately from the disk and is connected to the disk, and at least one of the joint and the disk is press-formed.

2. The variable displacement compressor according to claim 1, **characterized in that** the cam plate (18) is formed by fixing the joint (18b; 50) and the disk (18a) to each other.

3. The variable displacement compressor according to claim 1 or 2, wherein the disk (18a) is a press-formed component.

4. The variable displacement compressor according to any one of claims 1 to 3, **characterized in that** the joint (18b; 50) is a press-formed component.

5. The variable displacement compressor according to any one of claims 1 to 5, **characterized in that** the lug plate (17) includes a support arm (33), the joint (18b; 52) of the cam plate (18) includes a connecting portion (18c; 52), and the hinge mechanism (20) includes the support arm, the connecting portion of the joint of the cam plate, and a hinge pin (21) for connecting the support arm and the connecting portion.

6. The variable displacement compressor according to any one of claims 1 to 5, **characterized in that** the joint (18b; 50) of the cam plate further includes an engaging portion (32) for contacting the lug plate (17) and a hinge hole (18d; 53) for receiving the hinge pin (21).

7. The variable displacement compressor according to any one of claims 1 to 6, **characterized in that** the joint (18b) further includes a shaft hole (19b) through which the drive shaft (16) is inserted.

8. The variable displacement compressor according to any one of claims 5 to 7, **characterized in that** the connecting portion (18c; 53) is one of two connecting portions, and the two connecting portions are separated from each other by a predetermined distance.

9. A method for manufacturing a cam plate (18) of a variable displacement compressor, wherein the compressor draws, compresses, and discharges refrigerant with a piston (23) reciprocated by converting rotation of a drive shaft via a lug plate (17) fixed to the drive shaft (16), the cam plate, and a hinge mechanism (20) connecting the lug plate and the cam plate, the cam plate being supported in an inclinable manner by the drive shaft, wherein the displacement of the compressor varies in accordance with the inclination of the cam plate, the method being **characterized by** the steps of:

press forming a disk (18a) having a hole from a metal plate;
bending a metal plate to form a joint (18b; 50) having two bent pieces; and
fixing the disk (18a) and the joint (18b) to each other.

10. The method according to claim 9, further being **characterized by** the steps of:

forming a hole (18d; 53) for engaging a hinge pin to form the hinge mechanism (20) in each bent piece.

Fig. 1

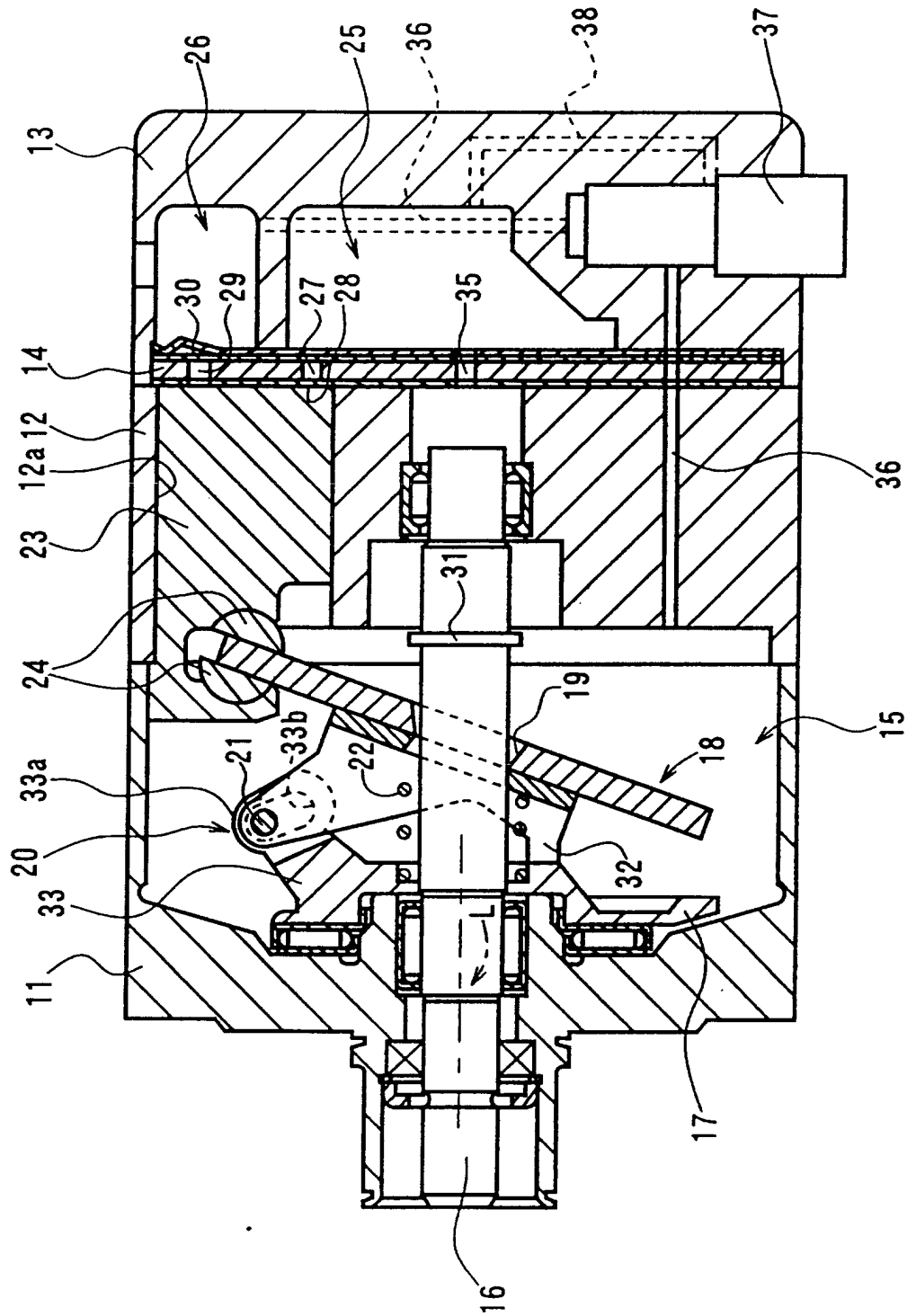
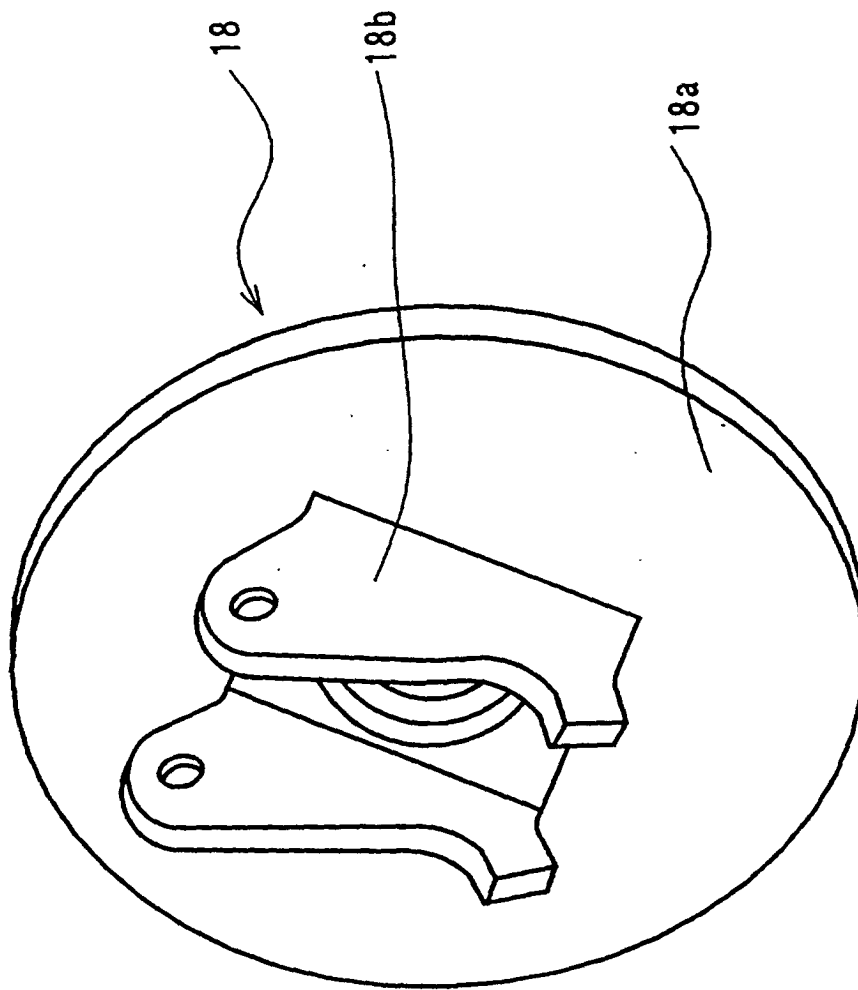
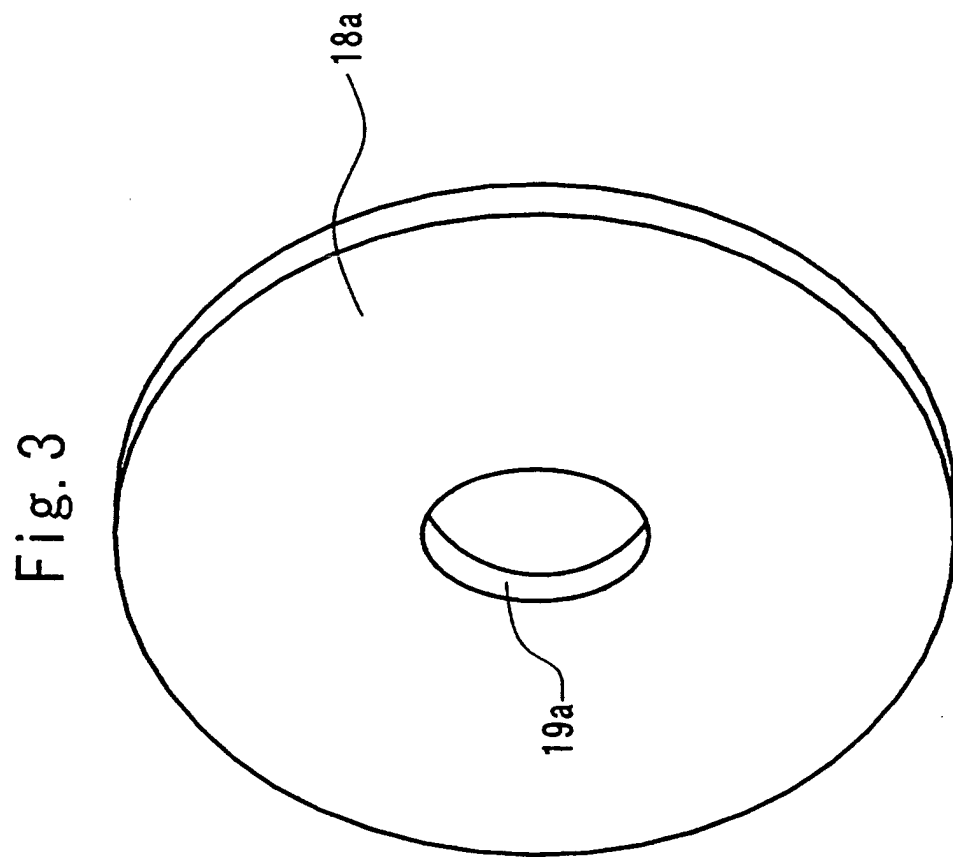
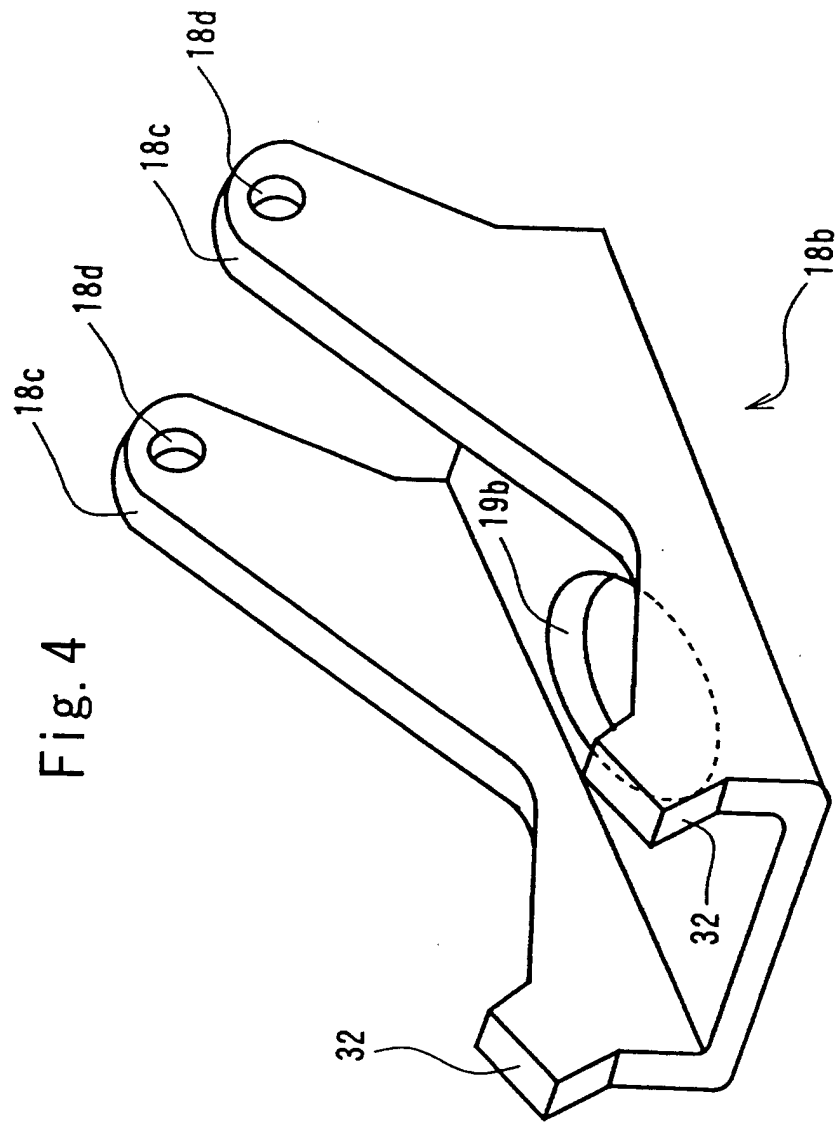


Fig. 2







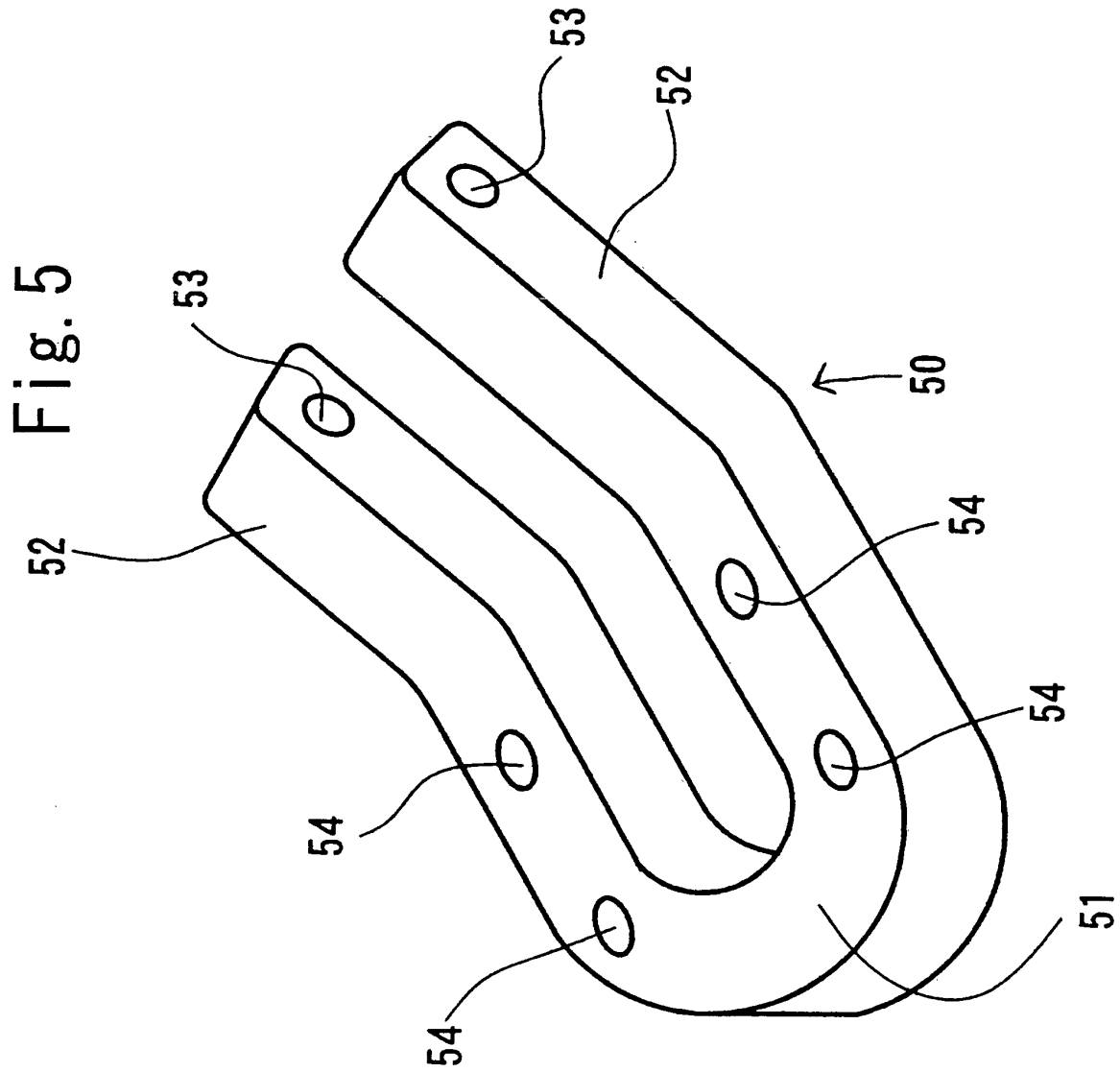


Fig. 6

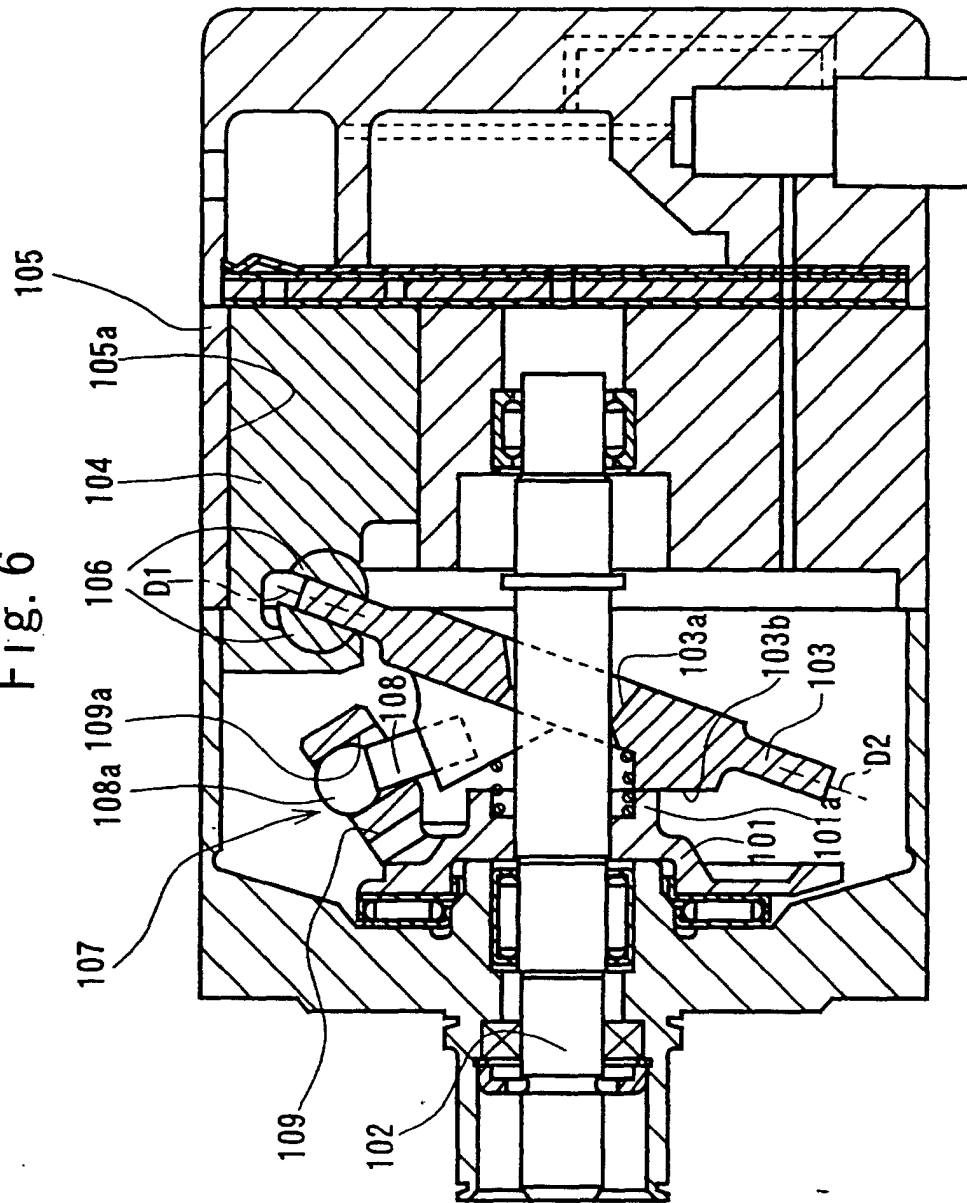
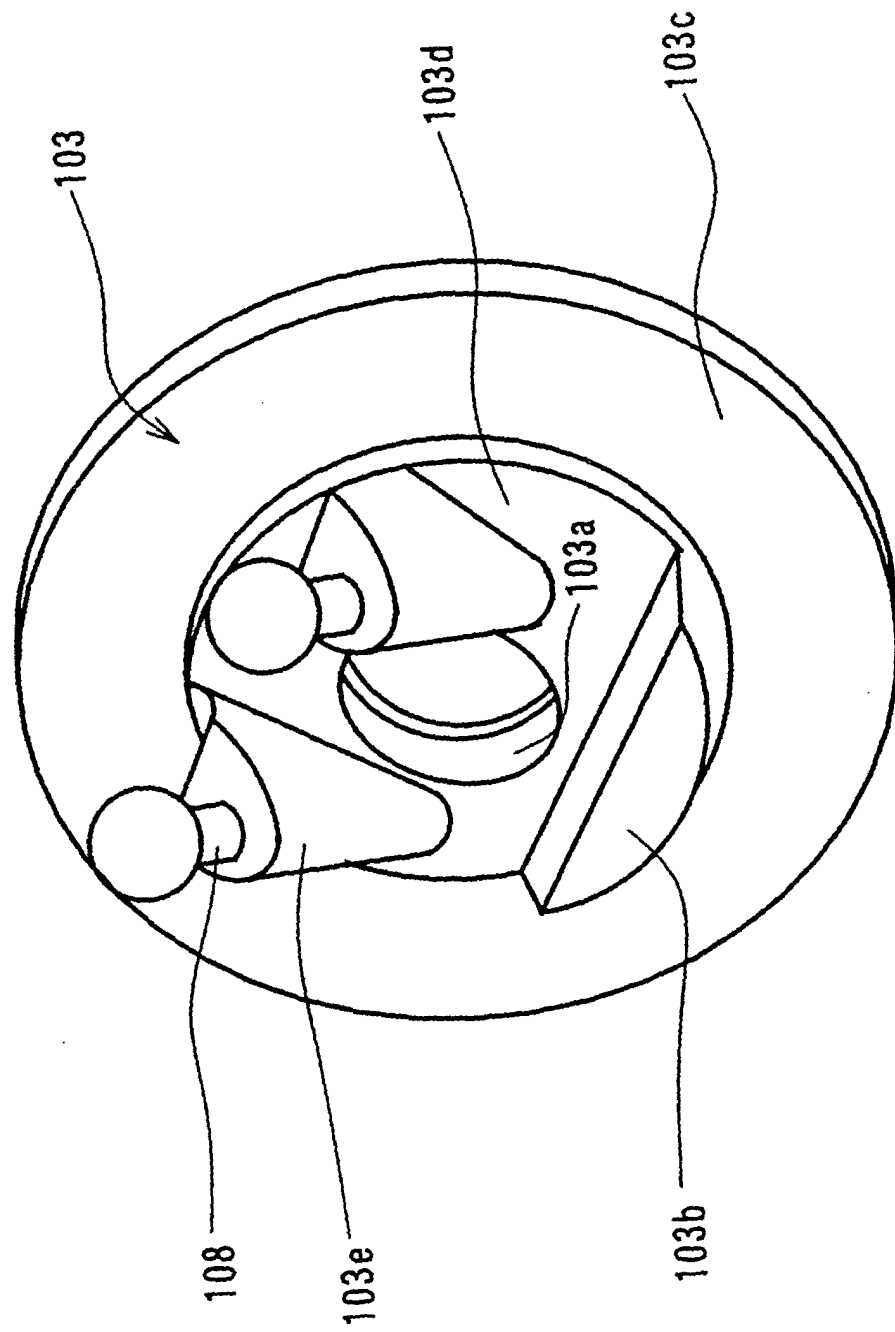


Fig. 7





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EUROPEAN SEARCH REPORT

Application Number
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			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
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The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 25 February 2002	Examiner Pinna, S
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