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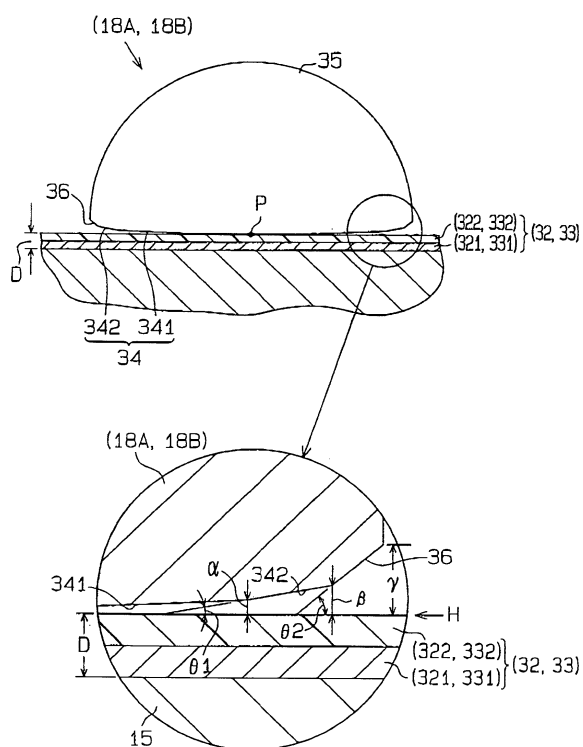
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(54) Coating for a swash plate of a swash plate compressor

(57) A swash plate type compressor that has a pair of shoes (18A, 18B, 18C, 18D, 18E) between a swash plate (15) and a piston (17). The motion of the swash plate is transmitted to the piston through the shoes. Each piston reciprocates according to the transmitted motion. A coating (32, 33) is applied to each surface of the swash plate to contact the corresponding shoe. The surface (H) of each coating (32, 33) is flat. Each shoe (18A to 18E) includes a substantially flat surface (34), which contacts the swash plate (15), and a semi-spherical portion (35), which is fitted to the piston (17). Each substantially flat surface (34) includes a main chamfered portion (342) near the periphery. The inclination angle ($\theta 1$) of each main chamfered portion (342) with respect to the corresponding coating is a predetermined angle or less. Each coating contacts one of the substantially flat surfaces (34). The maximum distance (β) between each main chamfered portion (342) and the corresponding coating is equal to or less than the thickness (D) of the corresponding coating (32, 33).

Fig.2



Description

[0001] The present invention relates to a swash plate type compressor. More particularly, the present invention relates to a swash plate type compressor that has a swash plate, on which coatings are formed, and pairs of shoes. Each shoe is located between the swash plate and one of the pistons. The coatings are applied to the area of the swash plate that contacts the shoes. Each shoe has a substantially flat surface and a semi-spherical portion. Each substantially flat surface contacts the swash plate, which integrally rotates with a rotary shaft. Each semi-spherical portion is fitted to one of two concave recesses of the corresponding piston. The rotational force of the swash plate is transmitted to the pistons through the shoes to drive the pistons.

[0002] Japanese Examined Patent Publication No. 61-1636 and Japanese Unexamined Patent Publication No. 11-193780 disclose a swash plate type compressor that has pistons, which reciprocate in accordance with the rotation of a swash plate that integrally rotates with a rotary shaft. A shoe is provided between the front peripheral portion of the swash plate and each piston and between the rear peripheral portion of the swash plate and each piston. The shoes transmit force from the swash plate to the pistons. The shoes slide along the rotating swash plate. Thus, the shoes, which are made of iron-based material, may wear out or seize. Therefore, it is necessary to improve the sliding performance of the swash plate with respect to the shoes.

[0003] According to the compressor described in Japanese Examined Patent Publication No. 61-1636, the flat surface of each hemispheric shoe is arched outward. The radius of curvature of the arched portions is very large. A first chamfered portion and a second chamfered portion are formed near the periphery of each arched surface. The inclination angle of the second chamfered portion, which is radially inward of the first chamfered portion, is smaller than the inclination angle of the first chamfered portion. The first and second chamfered portions draw lubricant from the peripheral portion of the swash plate, which enters between each shoe and the swash plate. This improves the sliding performance of the swash plate with respect to the shoes.

[0004] According to Japanese Unexamined Patent Publication 11-193780, coating, which has high sliding performance, is applied to the swash plate to further improve the sliding performance of the swash plate with respect to the shoes. The coating is applied to the front and rear peripheral portions of the swash plate, which contact the shoes.

[0005] According to Japanese Unexamined Patent Publication No. 6-336978, a filter is provided in a passage for refrigerant gas. The filter is provided for filtering foreign particles such as grinding chips of parts or wear particles in the compressor and an external refrigerant circuit. The filter only catches foreign particles that are more than certain size to avoid clogging of the filter.

Thus, the foreign particles that pass through the filter may be caught between the swash plate and the shoes. Therefore, in the compressor that has the coated swash plate, the coating may be damaged depending on the size of foreign particles caught between the swash plate and the shoes. When the coating is damaged, the sliding performance of the coating decreases.

[0006] The objective of the present invention is to prevent foreign particles from adversely affecting or decreasing the effectiveness of a coating.

[0007] To achieve the foregoing objective, the present invention provides a swash plate type compressor that has at least a pair of shoes between a swash plate and a piston. Motion of the swash plate is transmitted to the piston through the shoes. The piston reciprocates according to the transmitted motion. A coating is applied to each of two surfaces of the swash plate to contact the shoes, respectively. The surface of each coating is flat. Each shoe includes a substantially flat surface and a semi-spherical portion. Each substantially flat surface contacts the swash plate. Each semi-spherical portion is fitted to the piston. The substantially flat surface of each shoe includes a main chamfered portion. The main chamfered portion is provided near the periphery of the substantially flat surface. The inclination angle θ_1 of each main chamfered portion with respect to the corresponding coating is a predetermined angle or less. Each coating contacts one of the substantially flat surfaces. The maximum distance β between each main chamfered portion and the corresponding coating is equal to or less than the thickness D of the corresponding coating.

[0008] Other aspects and advantages of the 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.

[0009] 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 (a) is a cross-sectional view of a compressor according to a first embodiment. Fig. 1 (b) is an enlarged partial cross-sectional view of a pair of shoes and a swash plate;

Fig. 2 is an enlarged partial cross-sectional view of the a shoe and the swash plate;

Fig. 3 illustrates a diagrammatic profile of a shoe;

Fig. 4 is an enlarged partial cross-sectional view of a second embodiment;

Fig. 5 is an enlarged partial cross-sectional view of a third embodiment; and

Fig. 6 is an enlarged partial cross-sectional view of a fourth embodiment.

[0010] A first embodiment of the present invention will

be described with reference to Figs. 1 to 3.

[0011] Fig. 1 (a) illustrates the internal structure of a swash plate type variable displacement compressor. A rotary shaft 13 is supported by a front housing 12, which defines a control pressure chamber 121, and a cylinder block 11. The rotary shaft 13 is driven by an external drive source such as an engine of a vehicle. A rotor 14 is secured to the rotary shaft 13. A swash plate 15 is pivotally supported by the rotary shaft 13 to slide in the axial direction. A support body 151 is integrally molded with the swash plate 15 and is made of iron-based material. A pair of guide pins 16 (only one guide pin is shown in Fig. 1) are secured to the support body 151. Each guide pin 16 is slidably fitted in a corresponding guide hole 141, which is formed in the rotor 14. The guide holes 141 and the guide pins 16 cooperate with each other. This permits the swash plate 15 to tilt with respect to the axis of the rotary shaft 13 and to rotate integrally with the rotary shaft 13. The tilting motion of the swash plate 15 is guided by the guide holes 141, the guide pins 16, and the rotary shaft 13.

[0012] The inclination angle of the swash plate 15 is changed by controlling the pressure in the control pressure chamber 121. When the pressure in the control pressure chamber 121 increases, the inclination angle of the swash plate 15 decreases. When the pressure in the control pressure chamber 121 decreases, the inclination angle of the swash plate 15 increases. Refrigerant in the control pressure chamber 121 flows to a suction chamber 191 in a rear housing 19 through a pressure release passage, which is not shown in the figures. Refrigerant in a discharge chamber 192 in the rear housing 19 is supplied to the control pressure chamber 121 through a pressure supply passage, which is not shown in the figures. A displacement control valve 25 is provided on the pressure supply passage. The displacement control valve 25 controls the flow rate of refrigerant supplied to the control pressure chamber 121 from the discharge chamber 192. When the flow rate of refrigerant is supplied to the control pressure chamber 121 from the discharge chamber 192 increases, the pressure in the control pressure chamber 121 increases. When the flow rate of refrigerant supplied to the control pressure chamber 121 from the discharge chamber 192 decreases, the pressure in the control pressure chamber 121 decreases. Accordingly, the displacement control valve 25 controls the inclination of the swash plate 15.

[0013] When the swash plate 15 contacts the rotor 14, the swash plate 15 is at the maximum inclination angle. When a snap ring 24 on the rotary shaft 13 contacts the swash plate 15, the swash plate 15 is at the minimum inclination angle.

[0014] Cylinder bores 111 are located around the rotary shaft 13 in the cylinder block 11 (only two cylinder bores are shown in Fig. 1 (a)). A piston 17 is accommodated in each cylinder bore 111. A holder 171 is formed in each piston 17 and a pair of concave recesses 172, 173 are formed in the holder 171. As shown in Fig. 1 (b),

the rear concave recess 172 is coupled to a rear hemispherical shoe 18A and the front concave recess 173 is coupled to a front hemispherical shoe 18B. The hemispherical shoes 18A, 18B cannot be removed from the respective concave recesses 172, 173. Each shoe 18A, 18B is made of iron-based material.

[0015] The motion of the swash plate 15 is converted into linear reciprocation of the pistons 17 by the shoes 18A, 18B. Thus, each piston 17 reciprocates in the corresponding cylinder bore 111. The rear shoe 18A slides along the contact surface 30 of the swash plate 15. The front shoe 18B slides along the opposite contact surface 31 of the swash plate 15.

[0016] When one of the pistons 17 moves from the top dead center to the bottom dead center in the associated cylinder bore 111 (movement from right to left in Fig. 1 (a)), refrigerant in the suction chamber 191 flows into the associated cylinder bore 111 from the corresponding suction port 201 in a first valve plate 20 and causes a corresponding suction valve 211 on a second valve plate 21 to open.

[0017] When one of the pistons 17 moves from the bottom dead center to the top dead center in the associated cylinder bore 111 (movement from left to right in Fig. 1 (a)), refrigerant in the associated cylinder bore 111 is then discharged from a corresponding discharge port 202 on the first valve plate 20 to the discharge chamber 192 and causes a corresponding discharge valve 221 on a third valve plate 22 to open. Retainers 231 are formed on a fourth valve plate 23 to limit the opening degree of the discharge valves 221.

[0018] The discharge chamber 192 and the suction chamber 191 are connected by an external refrigerant circuit 26. Refrigerant in the discharge chamber 192 flows to the suction chamber 191 through the external refrigerant circuit 26, which includes a condenser 27, an expansion valve 28, an evaporator 29.

[0019] As shown in Figs. 1 (a) and 1 (b), coatings 32, 33 are formed on a rear peripheral portion 152 and a front peripheral portion 153 of the swash plate 15, respectively. The rear peripheral portion 152 and the front peripheral portion 153 are contact areas. Each coating 32, 33 has two layers. The two layers include metal layers 321, 331, which are respectively formed on the rear peripheral portion 152 and the front peripheral portion 153, and resin layers 322, 332, which are respectively formed on the metal layers 321, 331. Thus, the surfaces of the resin layers 322, 332 are contact surfaces 30, 31 that contact the shoes 18A, 18B, respectively.

[0020] The metal layers 321, 331 are respectively formed on the peripheral portions 152, 153. The metal layers 321, 331 are formed of aluminum-based material, which is mainly made of aluminum that contains silicon. The metal layers 321, 331 may be formed of copper-based material. Each resin layer 322, 332 is formed on the corresponding metal layer 321, 331. Each resin layer 322, 332 is formed of resin material such as polyamideimide, in which solid lubricant, such as molybdenum

disulfide and graphite, is dispersed. Thus, each coating 32, 33 is made of much softer material than the material of the swash plate 15. The thickness of each metal layer 321, 331 is approximately 60 to 70 μm . The thickness of each resin layer 322, 332 is approximately 10 to 20 μm . Therefore, the total thickness D of each coating 32, 33 is approximately 70 to 90 μm .

[0021] As shown in Fig. 2, each shoe 18A, 18B has a substantially flat surface 34 and a semi-spherical portion 35. The substantially flat surface 34 contacts the swash plate 15. The semi-spherical portion 35 is fitted to the corresponding concave recess 172, 173 of the associated piston 17. Each substantially flat surface 34 includes an arched surface 341 and a main chamfered portion 342. The radius of curvature of the arched surface 341 is very large. An annular main chamfered portion 342 is formed on the periphery of the substantially flat surface 34 such that the main chamfered portion 342 and the arched surface 341 are smoothly joined to each other. An annular sub-chamfered portion 36 is formed around the main chamfered portion 342 such that the sub-chamfered portion 36 and the main chamfered portion 342 are smoothly joined to each other. The distance between each main chamfered portion 342 and the corresponding coating 32, 33 gradually increases from the center of the corresponding substantially flat surface 34 in a radially outward direction. Each substantially flat surface 34 is an arched surface, the vertex P of which is at the center of the corresponding substantially flat surface 34.

[0022] Fig. 3 illustrates a diagrammatic profile of one of the shoes. In Fig. 3, the profile of the substantially flat surface 34 and the sub-chamfered portions 36 are enlarged in the direction perpendicular to the substantially flat surface 34 for the purpose of illustration. Point P represents the center of the substantially flat surface 34. Line H represents a flat surface that contacts the center P of the substantially flat surface 34. The average of first inclination angles θ_1 of the main chamfered portions 342 of the shoes with respect to the corresponding flat surface H is approximately 2 to 7 degrees. The average of second inclination angles θ_2 of the sub-chamfered portions 36 of the shoes with respect to the corresponding flat surface H is approximately 40 degrees. The inclination angles θ_1 , θ_2 represent the inclinations of line segments, that radially follow the main chamfered portion 342 and the sub-chamfered portion 36, respectively, with respect to the flat surface H. The maximum distance α between the flat surface H and the arched surface 341 is approximately 2 to 7 μm . The maximum distance β between the flat surface H and the main chamfered portion 342 is approximately 10 μm . The maximum distance γ between the flat surface H and the sub-chamfered portion 36 is greater than the thickness D of each coating 32, 33.

[0023] As the swash plate 15 rotates, lubricant on the contact surfaces 30, 31 of the swash plate 15 is drawn into the spaces between the sub-chamfered portions 36

and the contact surfaces 30, 31. The lubricant is further drawn into the spaces between the main chamfered portions 342 and the contact surfaces 30, 31 and into the spaces between the arched surfaces 341 and the contact surfaces 30, 31.

[0024] The first embodiment provides the following advantages.

(1) The average of the first inclination angles θ_1 of the main chamfered portions 342 with respect to the corresponding flat surface H is approximately 2 to 7 degrees. Each flat surface H contacts the center P of the corresponding substantially flat surface 34. When a foreign particle is caught between one of the main chamfered portions 342, which has a small inclination angle θ_1 , and the swash plate 15, the corresponding coating 32, 33 will be damaged. The maximum distance β between each main chamfered portion 342 and the corresponding contact surface 30, 31, however, is approximately 10 μm . Thus, a foreign particle that is larger in diameter than the thickness D (approx. 70 to 90 μm) of each coating 32, 33 cannot enter the space between the main chamfered portions 342 and the corresponding contact surface 30, 31.

[0025] In addition, foreign particles that are larger in diameter than the thickness D of each coating 32, 33 can enter the space between each sub-chamfered portion 36 and the corresponding contact surface 30, 31. The average of the inclination angles θ_2 of the sub-chamfered portions 36 with respect to the corresponding flat surface H, however, is approximately 40 degrees. Thus, foreign particles do not get caught in the space between each sub-chamfered portion 36 and the corresponding contact surfaces 30, 31. If foreign particles that are smaller in diameter than the thickness D of each coating 32, 33 enter the space between each main chamfered portion 342 and the swash plate, the foreign particles are completely buried in each coating 32, 33. Thus, the foreign particles do not roll while being caught between each shoe and the swash plate.

[0026] Accordingly, foreign particles larger than the thickness D, which may easily damage each coating 32, 33, do not get caught in the space between the swash plate 15 and the shoes 18A, 18B. This prevents foreign particles from damaging the coatings 32, 33.

[0027] In an experiment, aluminum particles and iron particles were put in the control pressure chamber 121. The compressor was then operated for one hour and the damage to each resin layer 322, 332 was checked. The total weight of the foreign particles was 12mg. The weight ratio of the aluminum particles and the iron particles was 2:1. The maximum diameter of the foreign particles was 100 μm . As a result of the experiment, no wear was found on the resin layers 322, 332.

(2) There is lubricant on the contact surfaces 30, 31

of the swash plate 15, on which the shoes 18A, 18B slide. The sub-chamfered portions 36, which are inclined by the large second inclination angle θ_2 , effectively draw the lubricant into the space between the substantially flat surfaces 34 and the corresponding contact surface 30, 31.

(3) The average of the second inclination angles θ_2 of the sub-chamfered portions 36 is approximately 40 degrees in the first embodiment. However, if each second inclination angle θ_2 is more than 20 degrees, a foreign particle that is larger in diameter than the thickness of the coating D may enter between one of the contact surfaces 30, 31 and the corresponding sub-chamfered portion 36. However, the foreign particle does not get caught in the space between the sub-chamfered portion 36 and the corresponding contact surface 30, 31. That is, there is little possibility that the coatings 32, 33 will be damaged when a foreign particle that is larger in diameter than the thickness of the coating D enters the space between one of the sub-chamfered portions 36 and the corresponding contact surface 30, 31. The second inclination angle θ_2 of the sub-chamfered portions 36 is more than 20 degrees. When the second inclination angle θ_2 of the sub-chamfered portions 36 is more than 20 degrees and the first inclination angle θ_1 of the main chamfered portions 342 is equal to or less than 20 degrees, the maximum distance β of the main chamfered portions 342 and the corresponding contact surfaces 30, 31 must be less than the thickness D of the coating 32, 33. This prevents the foreign particles from damaging the coatings 32, 33.

(4) When different materials slide against each other, there is a lower likelihood of seizure, as compared with the same materials sliding against each other. The swash plate 15 is made of iron-based material, and the metal layers 321, 331, which form coatings 32, 33, are made of aluminum-based material. The aluminum-based material is suitable for preventing seizure between the swash plate 15 and the shoes 18A, 18B.

(5) It is important to apply lubricant to the space between each contact surface 30, 31 of the swash plate 15 and the center of the corresponding substantially flat surface 34 of each shoe 18A, 18B for extending the life time of the coatings 32, 33. Each arched surface 341 plays an important role in drawing the lubricant into the space between each contact surface 30, 31 of the swash plate and the center of the corresponding substantially flat surface 34 of each shoe 18A, 18B.

(6) The sub-chamfered portions 36 eliminate sharp edges on the shoes 18A, 18B that contact the

swash plate 15.

[0028] A second embodiment will now be described with reference to Fig. 4. Like or the same reference numerals are given to those components that are like or the same as the corresponding components of the first embodiment.

[0029] An arched surface 341 and a main chamfered portion 342C of each shoe 18C are smoothly joined to each other. The main chamfered portion 342C and a sub-chamfered portion 36C are smoothly joined to each other. The average of first inclination angles θ_1 of the main chamfered portions 342C of the shoes 18C with respect to a corresponding flat surface H is approximately 10 degrees. The average of second inclination angles θ_2 of the sub-chamfered portions 36C with respect to the corresponding flat surface H is the same as that of the first embodiment. The maximum distance β between each main chamfered portion 342C and the corresponding flat surface H is approximately 70 to 80 μm . The thickness D of the coatings 32, 33 is the same as in the first embodiment.

[0030] The second embodiment provides the same advantages as in the first embodiment.

[0031] A third embodiment is shown in Fig. 5. Like or the same reference numerals are given to those components that are like or the same as the corresponding components of the first embodiment.

[0032] An arched surface 341 and a main chamfered portion 342D of each shoe 18D are smoothly joined to each other. The main chamfered portion 342D and a sub-chamfered portion 36D are smoothly joined to each other. The average of first inclination angles θ_1 of the main chamfered portions 342D of the shoes 18D with respect to a corresponding flat surface H is approximately 10 degrees. The average of second inclination angles θ_2 of the sub-chamfered portions 36D with respect to the corresponding flat surface H is approximately 60 degrees. The maximum distance β between each main chamfered portion 342D and the corresponding flat surface H is approximately 70 to 80 μm . The thickness D of the coatings 32, 33 is the same as in the first embodiment.

[0033] The third embodiment also provides the same advantages as in the first embodiment.

[0034] A fourth embodiment is shown in Fig. 6. Like or the same reference numerals are given to those components that are like or the same as the corresponding components of the first embodiment.

[0035] An arched surface 341 and a main chamfered portion 342E of each shoe 18E are smoothly joined to each other. The main chamfered portion 342E and a sub-chamfered portion 36E are smoothly joined to each other. The main chamfered portion 342E is formed of an outwardly arched chamfered portion 342E1 and a surrounding, inwardly arched chamfered portion 342E2. The chamfered portions 342E1 and 342E2 are smoothly joined to each other. The average of first inclination an-

gles θ_1 of the main chamfered portions 342E of the shoes 18E with respect to a corresponding flat surface H is approximately 10 degrees. The average of second inclination angles θ_2 of the sub-chamfered portions 36E with respect to the corresponding flat surface H is approximately 40 degrees. The maximum distance β between each main chamfered portion 342E and the corresponding flat surface H is approximately 70 to 80 μm . The thickness D of the coatings 32, 33 is the same as in the first embodiment.

[0036] The fourth embodiment provides the same advantages as the first embodiment. The present invention includes further embodiments as follows.

(1) The present invention may be used in a compressor that has a swash plate that is coated only by resin that contains solid lubricant.

(2) The present invention may be used in a compressor that has a swash plate that is coated only by metal.

(3) In the second, third, and fourth embodiments, the sub-chamfered portion may be eliminated and the main chamfered portion may be connected to the semi-spherical portion of each shoe directly.

[0037] 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 invention may be embodied in the following forms.

[0038] Therefore, 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.

[0039] A swash plate type compressor that has a pair of shoes (18A, 18B, 18C, 18D, 18E) between a swash plate (15) and a piston (17). The motion of the swash plate is transmitted to the piston through the shoes. Each piston reciprocates according to the transmitted motion. A coating (32, 33) is applied to each surface of the swash plate to contact the corresponding shoe. The surface (H) of each coating (32, 33) is flat. Each shoe (18A to 18E) includes a substantially flat surface (34), which contacts the swash plate (15), and a semi-spherical portion (35), which is fitted to the piston (17). Each substantially flat surface (34) includes a main chamfered portion (342) near the periphery. The inclination angle (θ_1) of each main chamfered portion (342) with respect to the corresponding coating is a predetermined angle or less. Each coating contacts one of the substantially flat surfaces (34). The maximum distance (β) between each main chamfered portion (342) and the corresponding coating is equal to or less than the thickness (D) of the corresponding coating (32, 33).

Claims

1. A swash plate type compressor, wherein at least a pair of shoes (18A, 18B, 18C, 18D, 18E) is provided between a swash plate (15) and a piston (17), wherein motion of the swash plate is transmitted to the piston through the shoes, and the piston reciprocates according to the transmitted motion, **characterized by** that a coating (32, 33) is applied to each of two surfaces of the swash plate to contact the shoes, respectively, and the surface (H) of each coating (32, 33) is flat, wherein each shoe (18A to 18E) includes a substantially flat surface (34) and a semi-spherical portion (35), and each substantially flat surface (34) contacts the swash plate (15), and each semi-spherical portion (35) is fitted to the piston (17), wherein the substantially flat surface (34) of each shoe includes a main chamfered portion (342), and the main chamfered portion (342) is provided near the periphery of the substantially flat surface (34), and the inclination angle (θ_1) of each main chamfered portion (342) with respect to the corresponding coating is a predetermined angle or less, wherein each coating contacts one of the substantially flat surfaces (34), and the maximum distance (β) between each main chamfered portion (342) and the corresponding coating is equal to or less than the thickness (D) of the corresponding coating (32, 33).
2. The compressor according to claim 1, **characterized by** that each shoe includes a sub-chamfered portion (36), which surrounds the corresponding main chamfered portion (342), wherein the sub-chamfered portion (36) is joined to the main chamfered portion (342), and wherein the inclination angle (θ_2) of the sub-chamfered portion (36) with respect to the corresponding coating is greater than the predetermined angle.
3. The compressor according to claim 1 or 2, **characterized by** that the predetermined angle of the inclination angle (θ_1) of each main chamfered portion (342) is 20 degrees.
4. The compressor according to claim 1 or 2, **characterized by** that each coating (32, 33) is formed of a metal layer (321, 331) and a resin layer (322, 332), wherein the resin layer (322, 332) includes solid lubricant, and the resin layer (322, 332) is formed on the metal layer (321, 331).
5. The compressor according to claim 4, **characterized by** that the swash plate (15) is made of iron-based material, and the metal layers (321, 331) are made of aluminum-based or copper-based material.

6. The compressor according to claim 1 or 2, **characterized by** that the distance between each main chamfered portion (342) and the corresponding coating gradually increases from the center of the corresponding substantially flat surface in a radially outward direction. 5
7. The compressor according to claim 1 or 2, **characterized by** that each substantially flat surface (34) is an arched surface, the vertex of which is at the center of the corresponding substantially flat surface. 10
8. The compressor according to claim 4, **characterized by** that the metal layers (321, 331) are formed of metal that is softer than the material of the swash plate. 15

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Fig.1(a)

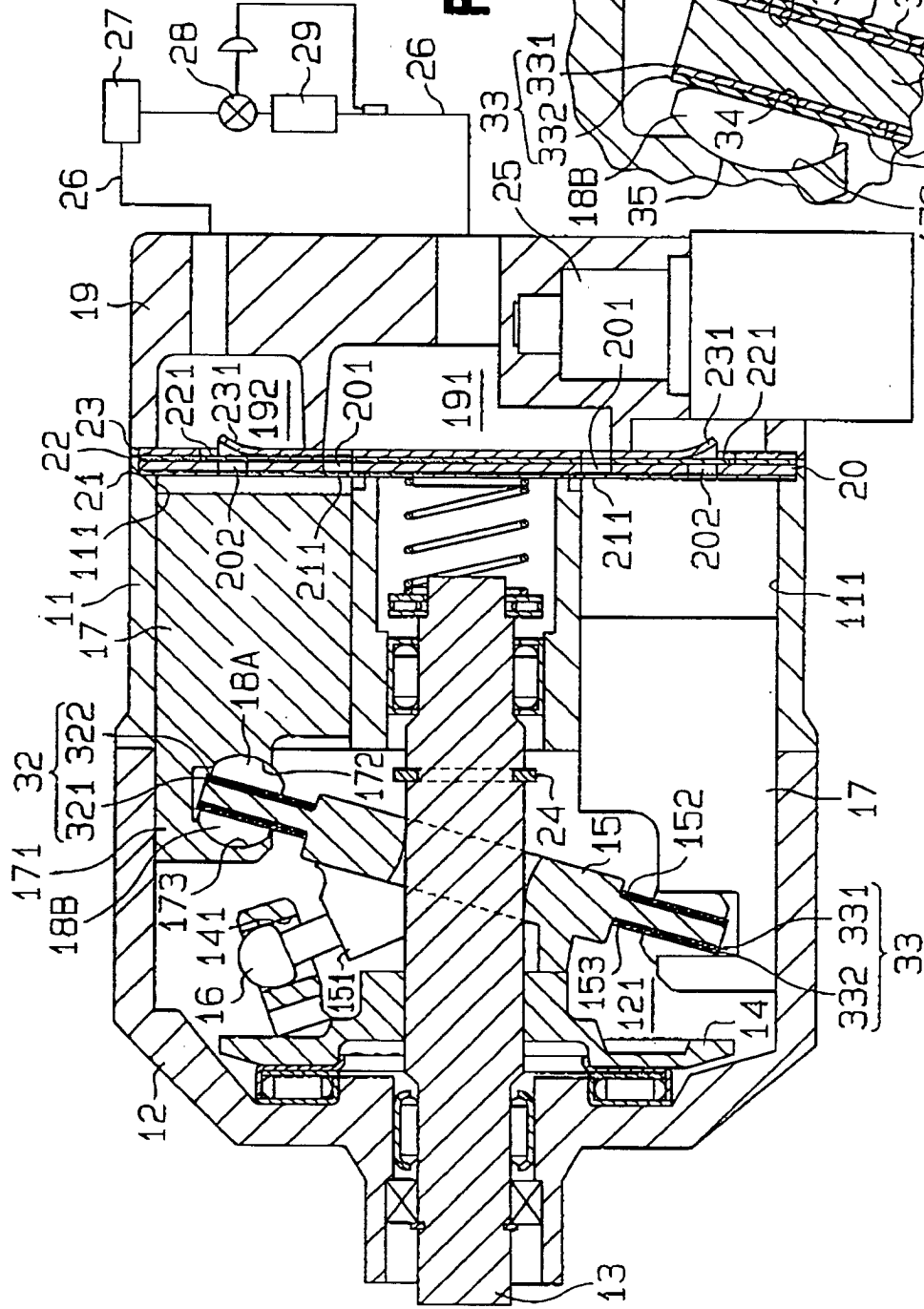


Fig.1(b)

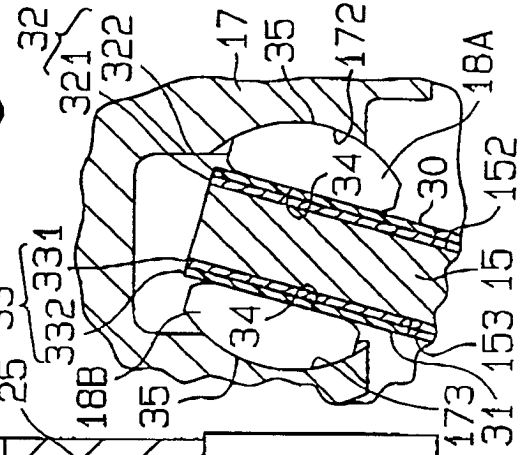


Fig.2

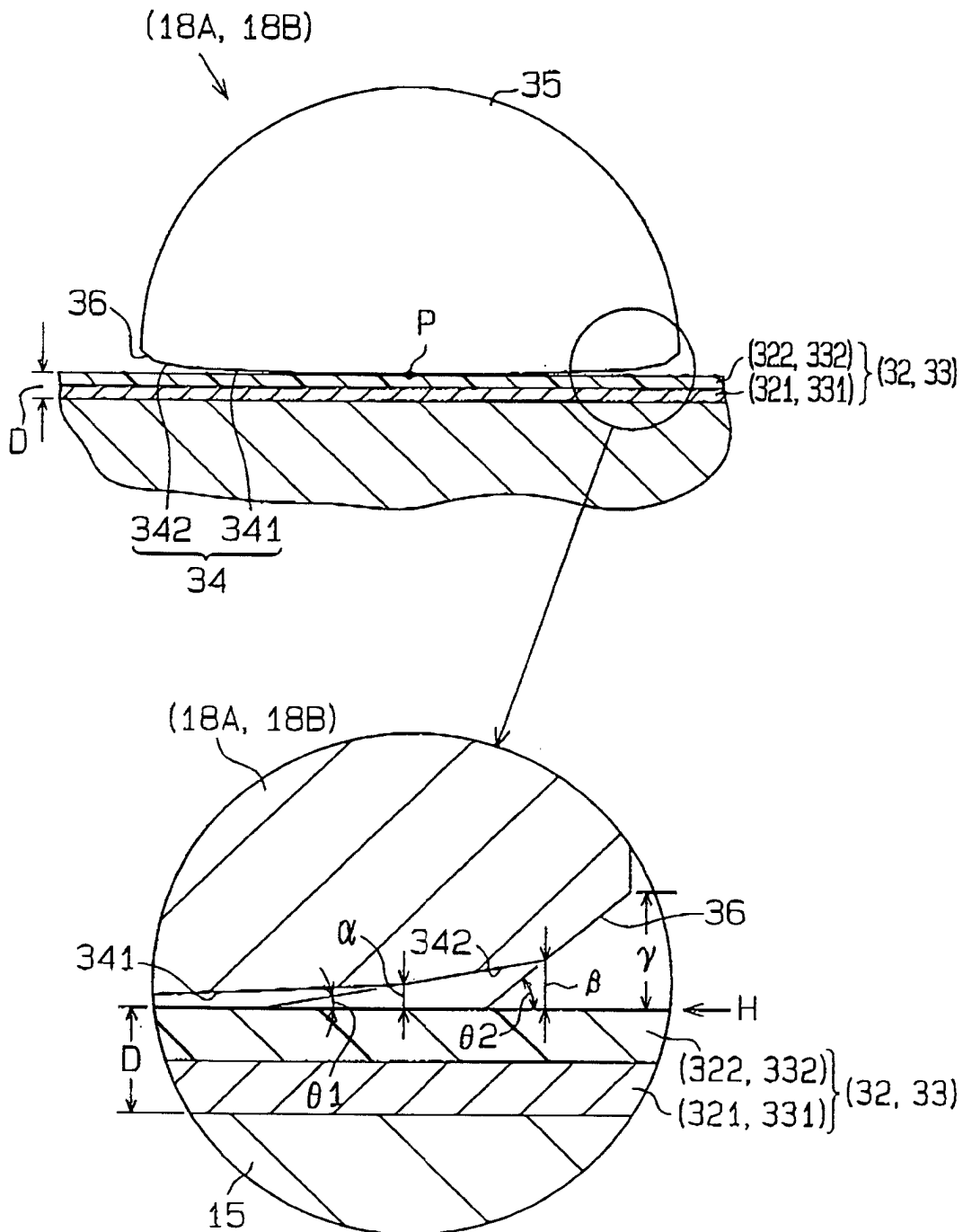


Fig.3

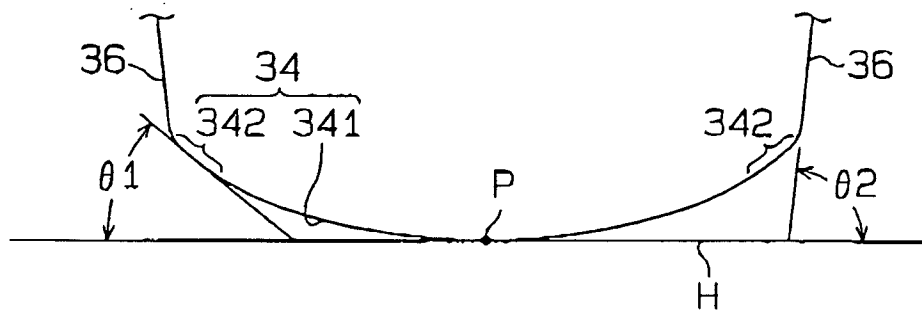


Fig.4

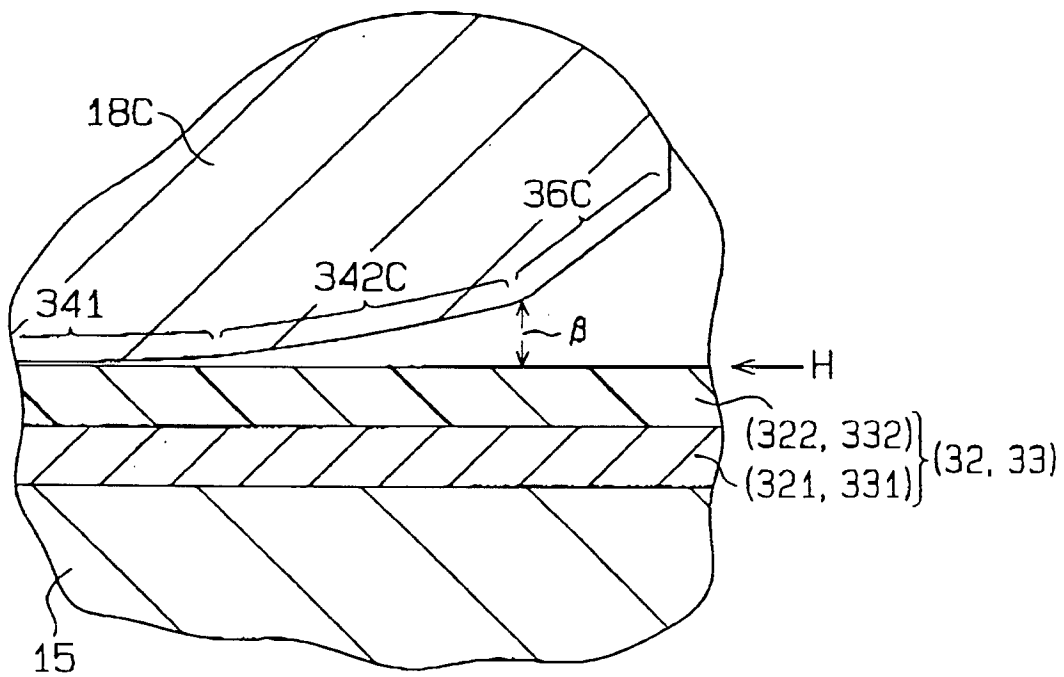


Fig.5

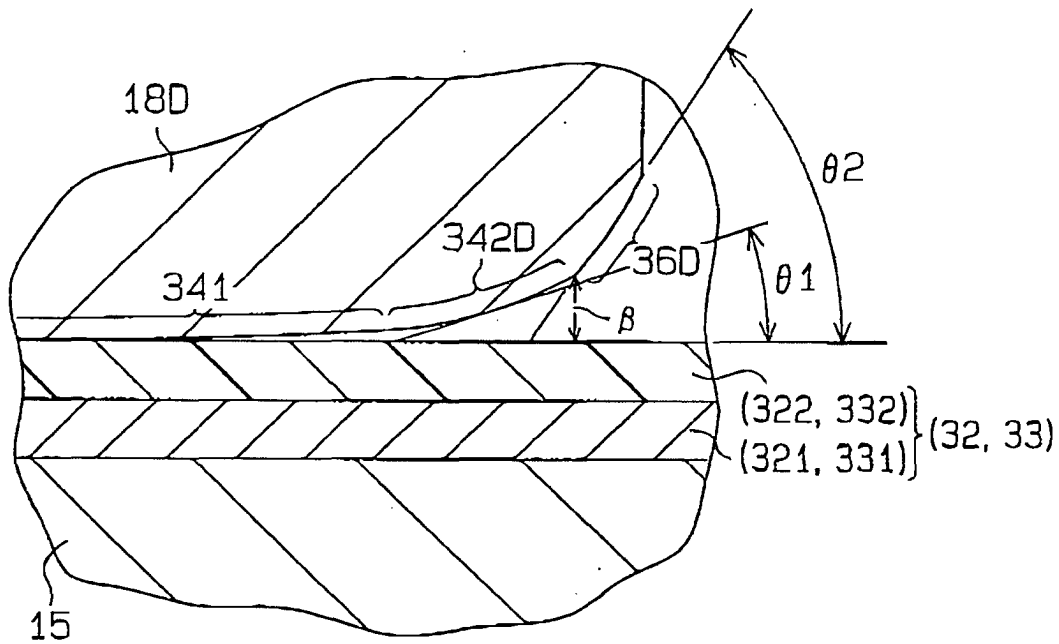


Fig.6

