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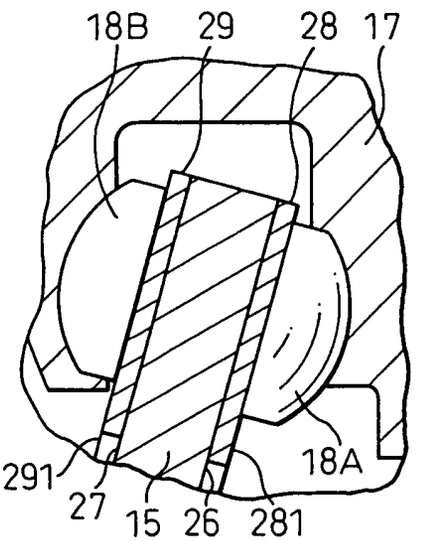
(54) Compressor coating

(57) Lubricating films are formed on end surfaces of a swash plate, respectively. The lubricating films make slide contact with shoes, respectively. The lubricating films are made of a copper based material which contains bismuth but does not contain lead. A good slide contact characteristic may be obtained while restricting the amount of lead to be used.

Fig.1B



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a component having a lubricating surface formed therein in a compressor.

2. Description of the Related Art

[0002] A swash plate type compressor has pistons which reciprocatingly move upon rotation of a swash plate which rotates with a rotating shaft, as disclosed in the Japanese Unexamined Patent Publication No.59-231181, No.8-199327, No.9-209926 and No.10-153169. Shoes are disposed between the front end surface of the swash plate and the piston and between the back end surface of the swash plate and the piston, so that the rotational force of the swash plate is transferred to the pistons via the shoes. The shoes are made of an iron based material and make slide contact with the rotating swash plate, so the slide contact portion between the shoe and the swash plate may possibly abrade or sticking may occur between the shoe and the swash plate. For this reason, it is required to improve the slide contact characteristic of the swash plate to the shoe.

[0003] In the art disclosed in the above described respective publications, an example is shown in which a lubricating surface formed of a copper based material mainly containing copper is provided on the slide contact portion of the swash plate. Such lubricating surface improves the slide contact characteristic of the swash plate to the shoes.

[0004] In order to further improve the sliding property of the swash plate to the shoes, the copper based material contains lead, having a low melting point, in the arts disclosed in the Japanese Unexamined Patent Publication No. 59-231181 and No.10-153169. The lead contained in the copper based material is softened due to the high temperature caused by the friction between the swash plate and the shoes, and the softened lead appears on the slide contact surfaces between the swash plate and the shoes to increase lubricity of the slide contact surfaces.

[0005] However, it is not desirable to use lead, which would cause lead poisoning, and it is required to restrict the amount of lead to be used.

SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to provide a component of a compressor, which includes a lubricating surface portion in a slide contact area, and in which a good slide contact characteristic may be obtained while restricting the amount of lead.

[0007] In order to achieve the above object, the present invention provides a component of a compressor, the component including a lubricating surface portion in a slide contact area, the lubricating surface portion being formed of a copper based material containing bismuth.

[0008] Preferably, the copper based material comprises copper-tin based alloy.

[0009] In the above arrangement, the bismuth contained in the copper based material is metal having a low melting point like lead and has an identical function to lead. Because of the bismuth contained in the copper based material, the amount of lead to be used may be restricted.

[0010] Preferably, the copper based material does not contain lead.

[0011] In this case, the amount of lead to be used is zero but a good lubricity may be obtained.

[0012] Preferably, a lubricating film made of a copper based material containing bismuth is provided in the slide contact area to form said lubricating surface portion.

[0013] In this case, preferably, the lubricating film is made on a base material by sintering.

[0014] The surface of the lubricating film made of the copper based material becomes the lubricating surface.

[0015] Preferably, the compressor comprises a swash plate type compressor having a swash plate rotatable with a rotating shaft, a piston, and a shoe disposed between the swash plate and the piston so as to make slide contact with the swash plate and the piston, whereby a rotational motion of the swash plate is transferred to the piston via the shoe to reciprocatingly move the piston and said component is the swash plate, in which the swash plate has a lubricating surface and the shoe has a lubricating surface to make slide contact with the lubricating surface of the swash plate.

[0016] The slide contact area of the swash plate, which makes slide contact with the shoe, is suitable for the area where a lubricating surface is formed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The present invention will become more apparent from the following description of the preferred embodiments,

with reference to the accompanying drawings, in which:

Fig.1A is a cross-sectional view of a whole compressor according to the first embodiment of the present invention;
Fig.1B is an enlarged cross-sectional view of a portion of the compressor of Fig.1B;
Fig.2 is an enlarged cross-sectional view of a portion of the compressor of the second embodiment; and
Fig.3 is an enlarged cross-sectional view of a portion of the compressor of the third embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] A specific embodiment of the present invention is now explained with reference to Figs.1A and 1B.

[0019] Fig.1A shows the internal structure of a variable displacement compressor. A front housing 12 and a cylinder block 11, which form a pressure control chamber 121, support a rotating shaft 13. The rotating shaft 13 is supplied with a rotational drive force from an external driving source (e.g., vehicle engine). A rotating supporter 14 is fixed to the rotating shaft 13, and a swash plate 15 is supported by the rotating shaft 13 so as to be able to slide in the axial direction of the rotating shaft 13 and to tilt with respect to the axial direction. A supporter 151 is integrally formed with the swash plate 15 made of an iron based material, and guide pins 16 are fixed to the supporter 151. The guide pins 16 are slidably inserted in guide holes 141 which are formed in the rotating supporter 14. The swash plate 15 can tilt with respect to the axial direction of the rotating shaft 13 and rotate with the rotating shaft 13, by the linkage of the guide pins 16 with the guide holes 141. The tilting motion of the swash plate 15 is guided by the slide guide relation between the guide holes 141 and the guide pins 16 and the slidable support action of the rotating shaft 13.

[0020] The angle of inclination of the swash plate 15 may be changed by controlling the pressure in the pressure control chamber 121. As the pressure in the pressure control chamber 121 increases, the angle of inclination of the swash plate 15 decreases, and as the pressure in the pressure control chamber 121 decreases, the angle of inclination of the swash plate increases. The coolant in the pressure control chamber 121 flows out to a suction chamber 191 in a rear housing 19 through a pressure discharge passage (not shown), and the coolant in a discharge chamber 192 in the rear housing 19 is introduced into the pressure control chamber 121 through a pressure supply passage (not shown). A capacity control valve 25 is disposed in the pressure supply passage, and the flow rate of the coolant supplied from the discharge chamber 192 to the pressure control chamber 121 is controlled by the capacity control valve 25. As the flow rate of the coolant supplied from the discharge chamber 192 to the pressure control chamber 121 increases, the pressure in the pressure control chamber 121 increases, and as the flow rate of the coolant supplied from the discharge chamber 192 to the pressure control chamber 121 decreases, the pressure in the pressure control chamber 121 decreases. That is, the angle of inclination of the swash plate 15 is controlled by the capacity control valve 25.

[0021] The maximum angle of inclination of the swash plate 15 is defined as the angle at which the swash plate 15 is in abutment with the rotating supporter 14. The minimum angle of inclination of the swash plate 15 is defined as the angle at which the swash plate 15 is in contact with the circlip 24 on the rotating shaft 13.

[0022] The cylinder block 11 has a plurality of cylinder bores 111 (only two are shown in Fig.1A) which are disposed around the rotating shaft 13. Each cylinder bore 111 accommodates a piston 17. The rotational motion of the swash plate 15 rotating with the rotating shaft 13 is converted into a longitudinal reciprocating motion of the pistons 17 via hemispherical shoes 18A and 18B, whereby the piston 17 moves forward and backward in the cylinder bore 111. The shoe 18A made of bearing steel makes slide contact with one lubricating surface of the swash plate 15, and the shoe 18B made of bearing steel makes slide contact with the other lubricating surface of the swash plate 15.

[0023] Due to the backward motion (the motion from right to left in Fig.1A) of the piston 17, the coolant in the suction chamber 191 flows into the cylinder bore 111 from a suction port 201 in a valve plate 20, pushing open a suction valve 211 on a valve forming plate 21. The coolant flowing into the cylinder bore 111 is then discharged, due to the forward motion (the motion from left to light in Fig.1A) of the piston 17, into the discharge chamber 192 from a discharge port 202 in the valve plate 20, pushing open a discharge valve 221 on a valve forming plate 22. The opening of the discharge valve 221 is limited by a retainer 231 on a retainer forming plate 23.

[0024] As shown in Figs.1A and 1B, lubricating films 28 and 29 are formed on the end surfaces 26 and 27 of the swash plate 15, respectively, which are slide contact areas. The lubricating films 28 and 29 are thermal spray layers of a copper (Cu) based material which includes copper as a main component. Surfaces of the lubricating films 28 and 29 are lubricating surfaces 281 and 291 which make slide contact with the shoes 18A and 18B, respectively. Table 1 shows the weight percentages of the components of the lubricating films 28 and 29. Three examples are shown in Table 1. In all examples, bismuth (Bi) is contained as a component of the copper based material.

Table 1

No.	Cu	Sn	Zn	Bi	Sb	P	Ni
1	85.77	11.5	0.1	0.8	0.08	0.15	1.5
2	84.49	10.3	2.5	1.5	1.2	0.01	-
3	84.42	4.5	7.2	3.1	0.6	0.08	0.1

[0025] In the first embodiment, the following effect may be obtained.

(1-1) In any one of No.1, No.2, and No.3 examples in Table 1, lead (Pb) is not contained, and bismuth having low melting point like lead takes the place of lead. That is, the bismuth contained in the lubricating films 28 and 29 is softened due to the high temperature caused by the friction between the swash plate 15 and the shoes 18A and 18B, and the softened bismuth appears on the slide contact surfaces between the swash plate 15 and the shoes 18A and 18B to increase the lubricity of the slide contact surfaces. In any one of No.1, No.2, and No.3 examples, the lubricating films 28 and 29 demonstrate the same degree of good slide contact characteristic as the lubricating film made of the copper based material which contains lead. That is, the bismuth contained in the copper based material demonstrates the identical function to lead. In addition, since the amount of lead to be used is zero, there would be no problem about environmental health.

(1-2) Under the condition that the degrees of weight percentages of copper and tin (Sn) are the same as No.1, No.2 and No.3, weight percentage of bismuth has been varied, and abrasion-resistance and sticking-resistance of the lubricating film are checked. In the range from 0.5 wt% to 20 wt% of bismuth, reliable abrasion-resistance and sticking-resistance have been obtained. In the range from 0.8 wt% to 10 wt% of bismuth, good abrasion-resistance and sticking-resistance have been obtained.

(1-3) The end surfaces 26 and 27 of the swash plate 15 on which the lubricating surface portions are formed are under the severe sliding condition, and the end surfaces 26 and 27 of the swash plate 15 require high sliding performance. For this reason, the end surfaces 26 and 27 which are the slide areas of the swash plate 15 where it makes slide contact with the shoes 18A and 18B, are suitable for the areas where the lubricating films are made.

[0026] In the present invention, the second embodiment shown in Fig.2 and the third embodiment shown in Fig.3 are also conceivable. In the second embodiment in Fig.2, lubricating films 30 and 31 made of resin are provided on the surfaces of the lubricating films 28 and 29 made of metal, respectively. In the lubricating films 30 and 31 made of resin, solid lubricant is scattered in the resin. Provision of the lubricating films 30 and 31 made of resin is effective upon the slide contact in the non-lubricant condition.

[0027] In the third embodiment in Fig.3, the swash plate 15A itself is made of a copper based material which contains bismuth but does not contain lead. The end surfaces 26 and 27 of the swash plate 15A themselves are lubricating surfaces.

[0028] In the present invention, the following embodiments are also conceivable.

(1) An embodiment, wherein lubricating films 28 and 29 are formed on a base material, by sintering the powder of the copper based material which contains bismuth.

(2) An embodiment, wherein the present invention is applied to a swash plate of a constant displacement swash plate type compressor.

(3) An embodiment, wherein the piston 17 is a component on which a lubricating surface is formed, and the periphery of the piston which makes slide contact with the inner surface of the cylinder bore is the area where the lubricating surface is formed.

The following features can be grasped from the embodiments mentioned above.

(4) The component of the compressor, wherein the component itself is made of the copper based material which contains bismuth.

(5) The component of the compressor, wherein the component itself is made by sintering the powder of the copper based material which contains bismuth.

[0029] As described above in detail, in the present invention, bismuth is contained in a copper based material for forming a lubricating surface portion in the slide contact area in a component of a compressor, and thereby good effect may be obtained that slide contact characteristic is good while restricting the amount of lead to be used.

Claims

1. A component of a compressor, said component including a lubricating surface portion in a slide contact area, the lubricating surface portion being formed of a copper based material containing bismuth.

2. The component according to claim 1, wherein said copper based material comprises copper-tin based alloy.

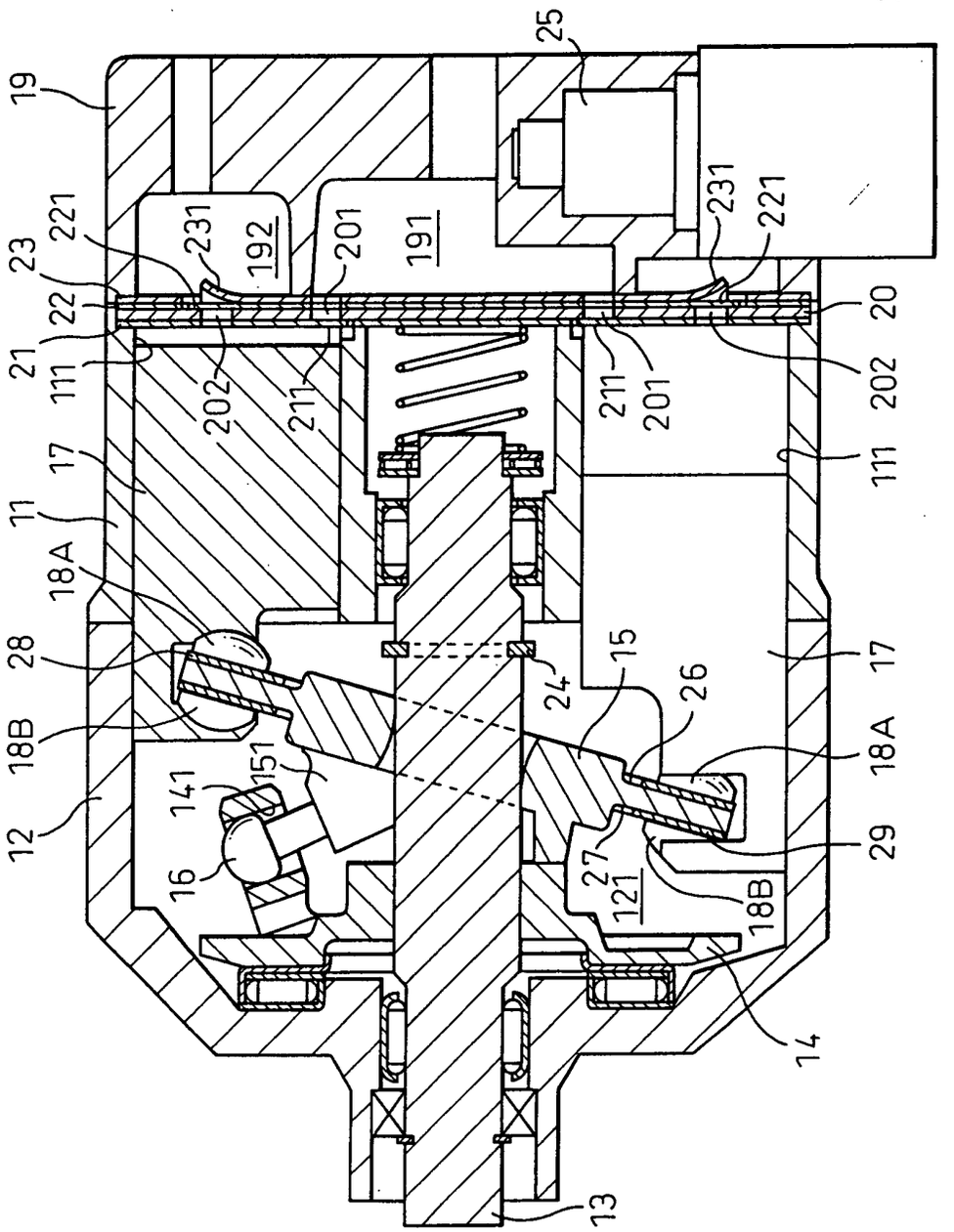
3. The component according to claim 1, wherein said copper based material does not contain lead.

4. The component according to one of claims 1 to 3, wherein a lubricating film made of a copper based material containing bismuth is provided in said slide contact area to form said lubricating surface portion.

5. The component according to claim 4, wherein said lubricating film is made on a base material by sintering.

6. The component according to one of claims 1 to 5, wherein said compressor comprises a swash plate type compressor having a swash plate rotatable with a rotating shaft, a piston, and a shoe disposed between the swash plate and the piston so as to make slide contact with said swash plate and said piston, whereby a rotational motion of said swash plate is transferred to said piston via said shoe to reciprocatingly move said piston, and said component is said swash plate, in which said swash plate has lubricating surface and said shoe has a lubricating surface to make slide contact with the lubricating surface of said swash plate.

Fig.1A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18A
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18B
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18A
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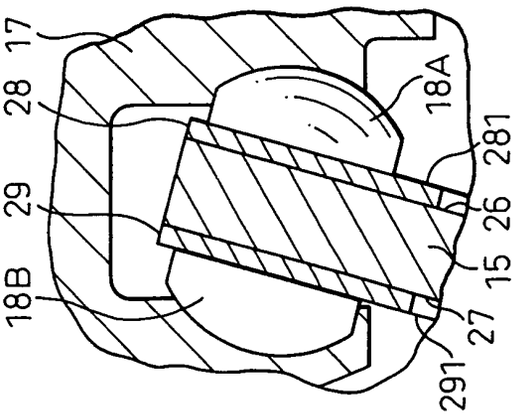
121
18B
14
13

Fig.1B


17
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18A
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18B
15
27
291

Fig.2

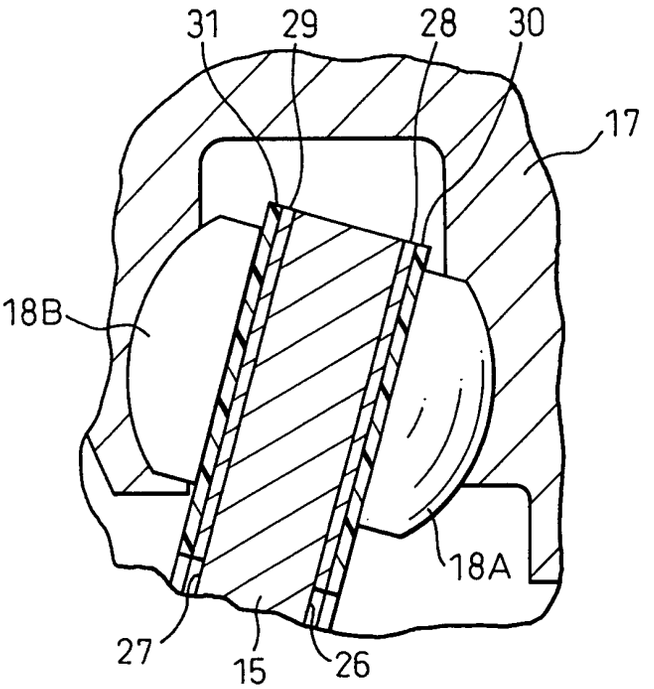

Fig.3