

[54] APPARATUS FOR LUBRICATING A
ROTARY SWASH PLATE TYPE
COMPRESSOR

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[22] Filed: Oct. 13, 1971

[21] Appl. No.: 188,911

[30] Foreign Application Priority Data

Oct. 15, 1970	Japan	45/102605
Apr. 6, 1971	Japan	46/25594

- [52] U.S. Cl. 184/6.16, 184/27 R
[51] Int. Cl. F16n 13/20
[58] Field of Search 62/84, 470; 55/437;
184/6.23, 6.24, 6.16, 27 R, 6.17

[57] ABSTRACT

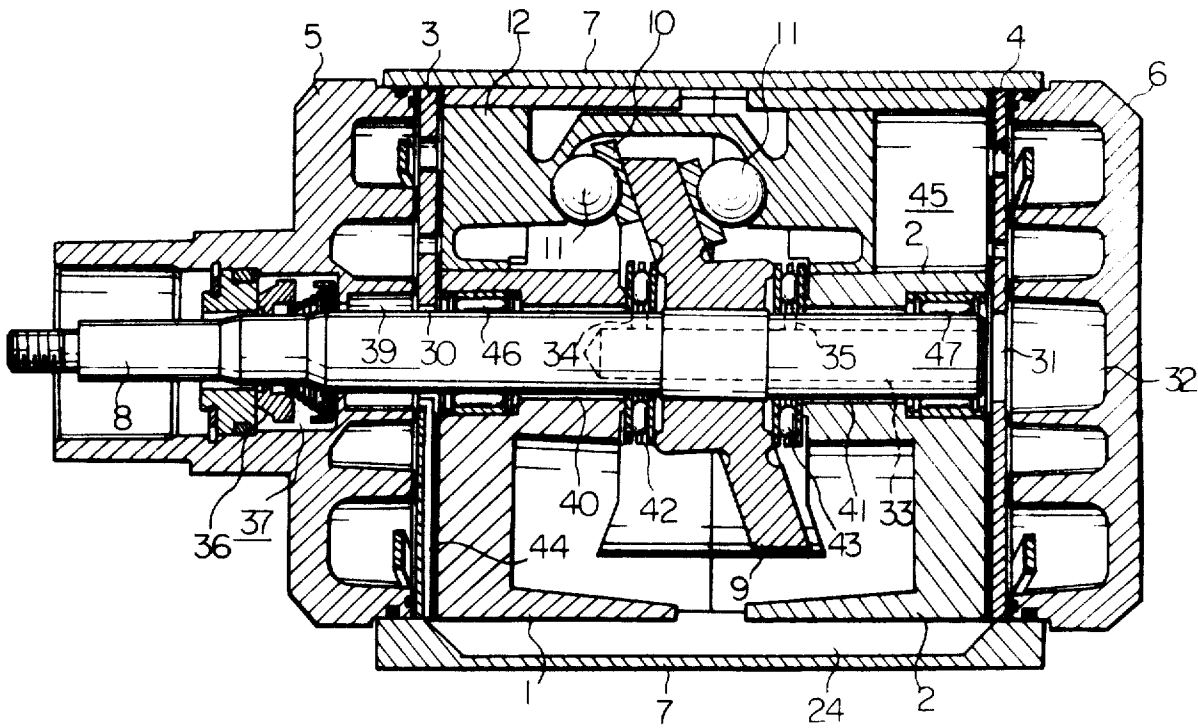
An apparatus for lubricating a rotary swash plate type compressor characterized by an improved and simplified internal arrangement for distributing the lubricating oil separated from the refrigerant being returned continuously from a refrigerating circuit, into the slidably moving sections and elements of the compressor to give a smooth motion in addition to preventing the burning phenomenon of the sliding sections of the compressor, elimination of the oil pump, and the entire compressor-size being extremely compact.

[56] References Cited

16 Claims, 9 Drawing Figures

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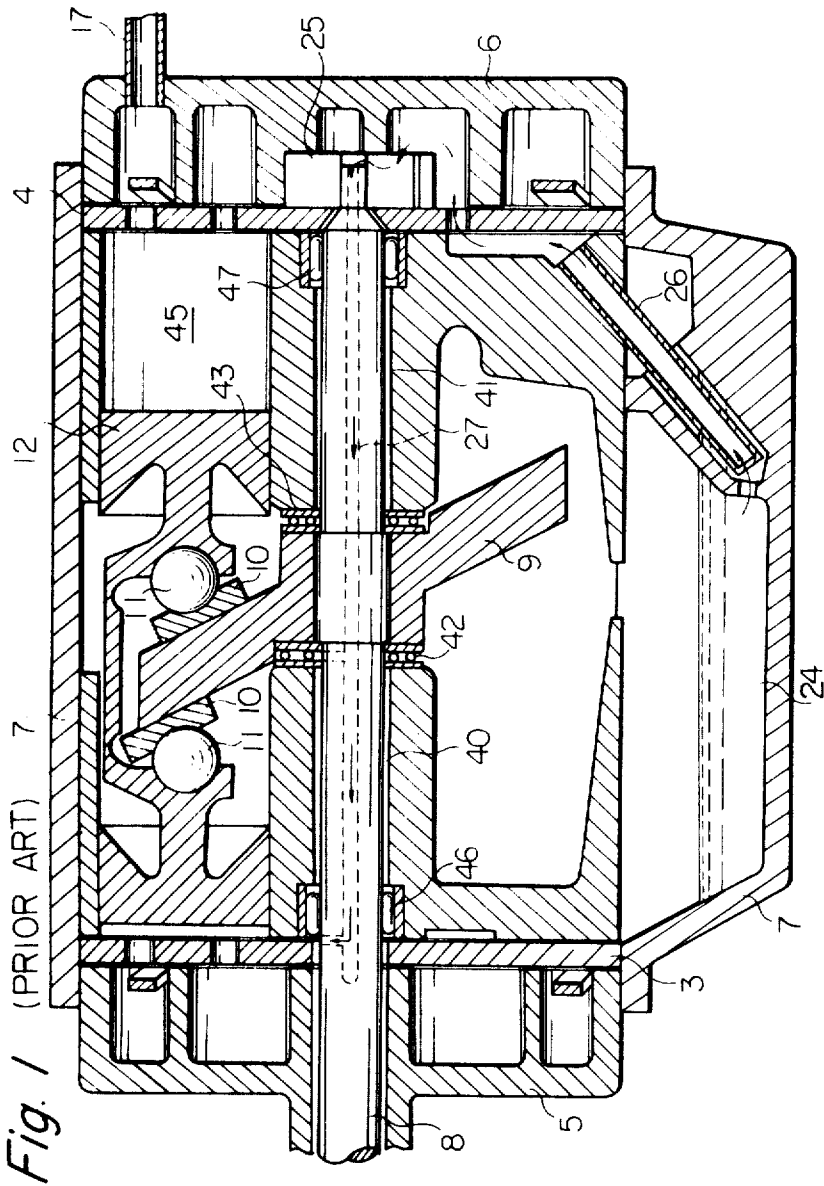


Fig. 2

(PRIOR ART)

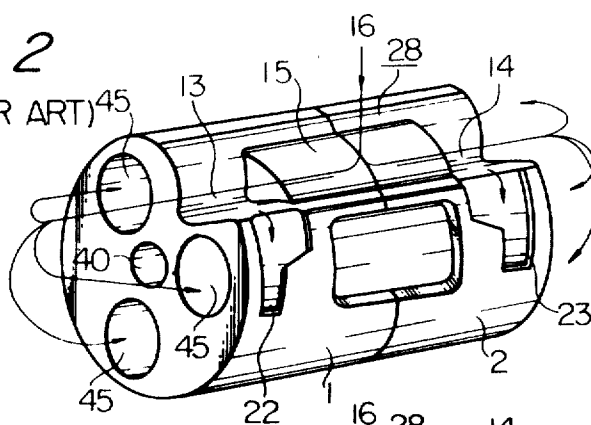


Fig. 3

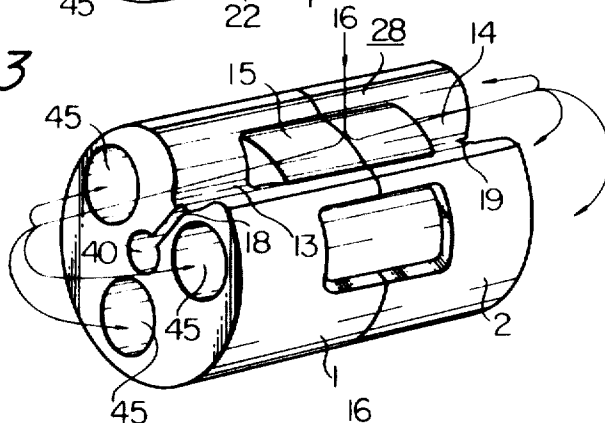


Fig. 4

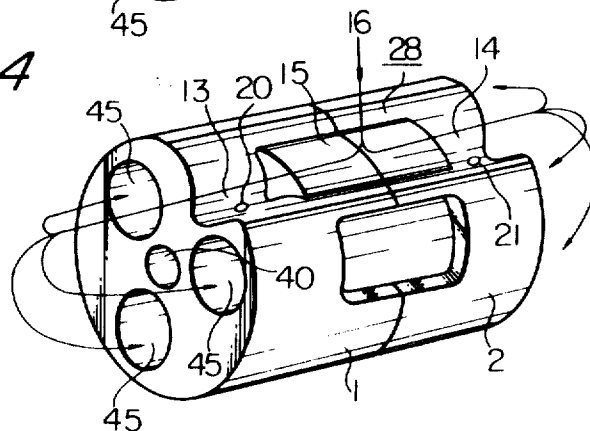


Fig. 5

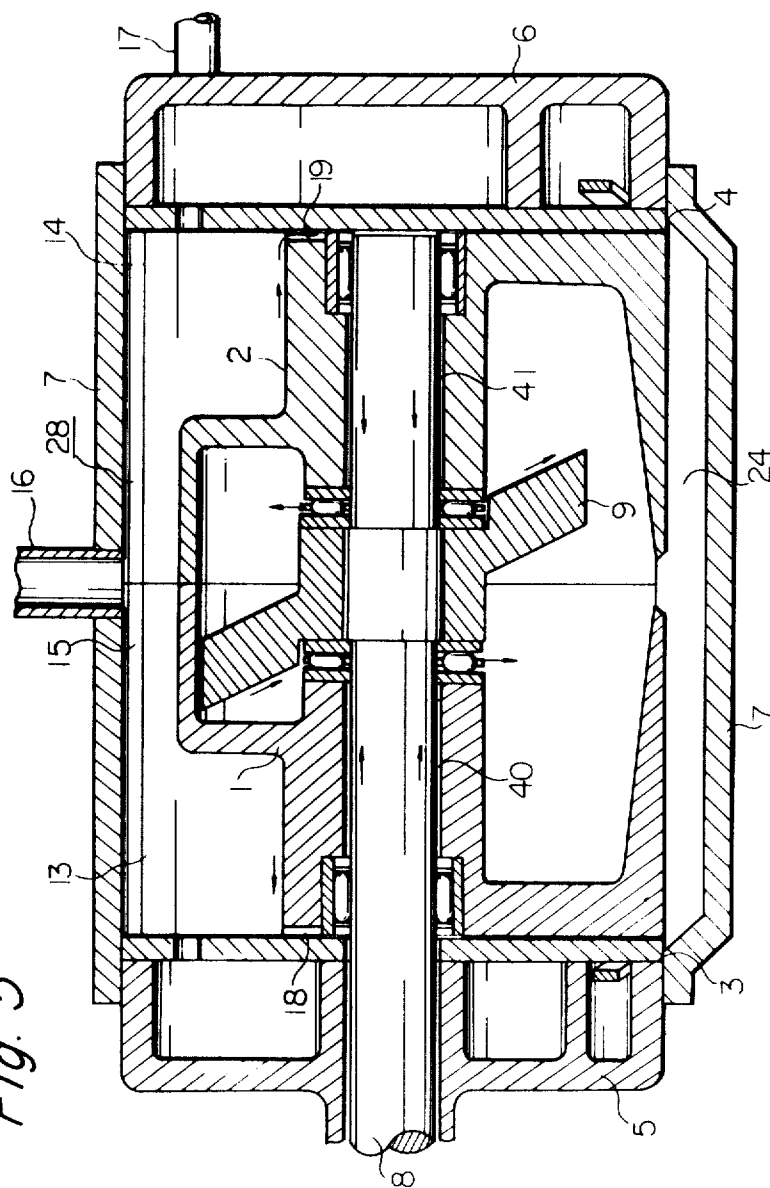


Fig. 6

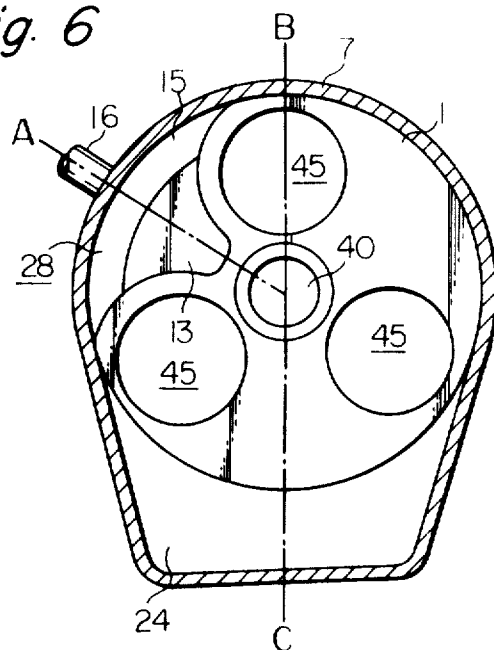
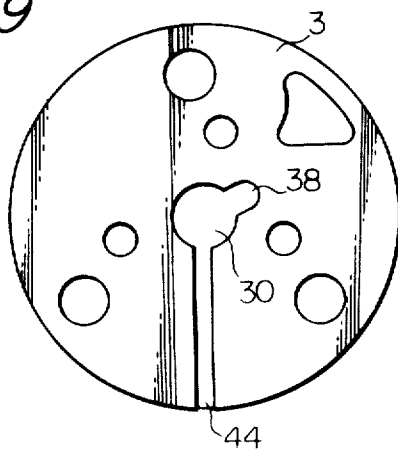
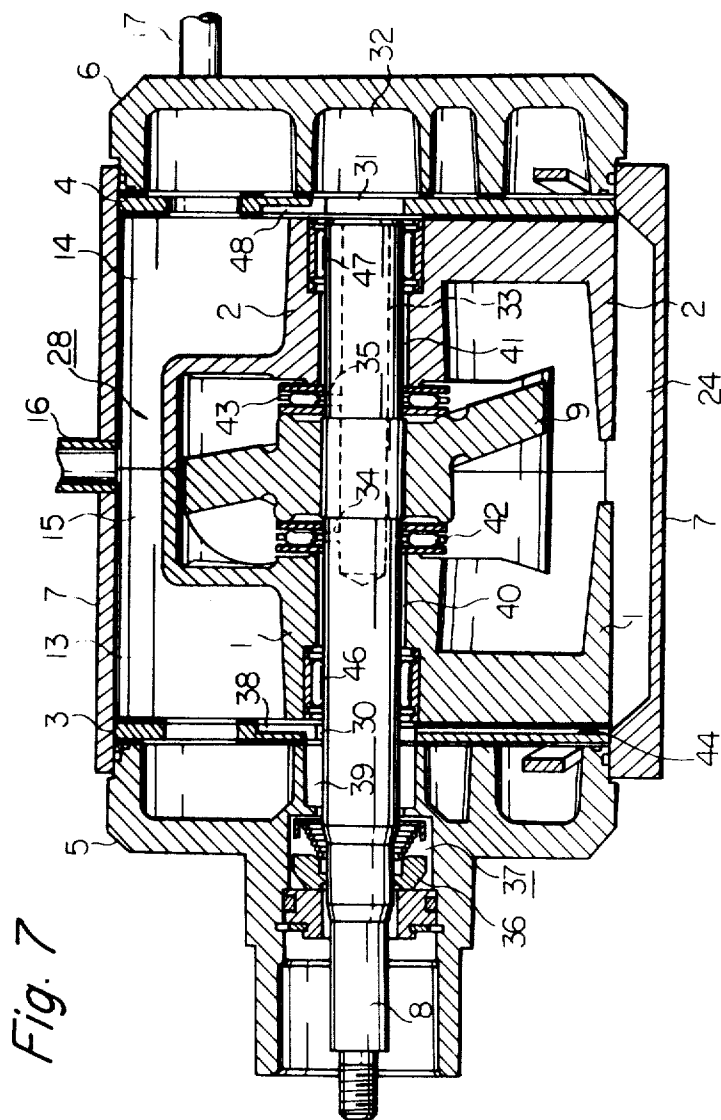


Fig. 9





APPARATUS FOR LUBRICATING A ROTARY SWASH PLATE TYPE COMPRESSOR

The present invention relates to an improvement of a rotary swash-plate type compressor mainly adapted to be used for the air conditioning of a vehicle, and more particularly relates to a novel apparatus for lubricating a rotary swash-plate type compressor in which the oil pump for distributing lubricating oil has been eliminated by directly leading the lubricating oil separated from the refrigerant drawn from a refrigerating circuit, into several slidably moving and rotating sections in the rotary swash-plate type compressor (hereinafter, referred to only as a compressor).

Generally, a compressor of this type includes an oil separating mechanism, because the lubrication for the slidably moving and rotating sections of the compressor are necessarily carried out by using the oil mixed within the refrigerant after separating it, and the oil separating mechanism is usually formed in the suction chambers, that is, the spaces disposed above the drive shaft provided with several slidably moving members such as bearings which should be always in the lubricated state.

The lubricating oil separated from the refrigerant by means of the oil separating mechanism flows down once and is stored in a main oil reservoir disposed at the bottom section of the compressor body. Subsequently, in the conventional lubricating system, the oil stored in the main oil reservoir is pumped up through a suction pipe by the oil pump cooperable with the drive shaft and also capable of distributing the oil in the slidably moving sections through the supply passage bored in the axially central portion of the drive shaft.

However, there are many drawbacks in such a lubricating system including the high cost of the compressor, in that the lubricating oil having once flowed down into the reservoir, must be pumped up again for supply to all sliding sections of the compressor for the purpose of lubrication.

Also, the disposition of the above-mentioned oil pump has not only necessitated much experience and skill to carry out the design, fabricating and assembling operation of incorporating the pump in the compressor but also has necessitated additional driving power to rotate the oil pump during the operation of the compressor.

An object of the present invention is to simplify the lubricating mechanism of a rotary swash-plate type compressor, so that fabricating and assembling operations of the compressor may be simplified and also, so that the entire compressor may be made more compact.

Another object of the present invention is to provide an improved apparatus for lubricating a compressor in which burning of the sliding sections of the compressor at the starting moment of the operation is completely prevented.

Still another object of the present invention is to provide a compressor at low cost due to simplification of the internal mechanism, especially the lubricating mechanism thereof.

Further objects and advantages of the present invention will become apparent from the ensuing descriptions of several preferred embodiments with reference to the accompanying drawings wherein;

FIG. 1 is a vertical sectional view of a compressor according to the prior art;

FIG. 2 is a schematically perspective view of paired cylinder blocks according to the prior art;

FIGS. 3 and 4 are schematically perspective views of preferred embodiments of paired cylinder blocks according to the present invention;

FIG. 5 is a vertical sectional view of a preferred embodiment of the compressor showing the lubricating mechanism thereof;

FIG. 6 is a front view of another embodiment showing a front cylinder block according to the present invention;

FIG. 7 is a vertical sectional view of another embodiment of the compressor according to the present invention taken along the line A—C of FIG. 6;

FIG. 8 is a vertical section view similar to FIG. 7 but taken along the line B—C of FIG. 6; and

FIG. 9 is a rear view of a front valve plate according to a preferred embodiment of the present invention.

Referring now to FIG. 1 and FIG. 2, a conventional swash-plate type compressor is shown in which 1 and 2 are a pair of front and rear cylinder blocks split vertically by a plane normal to the axis of both cylinder blocks 1 and 2 while being arranged face to face in series. At the front and rear end surfaces of the paired cylinder blocks, 1, 2, there are attached front and rear housings 5, 6 also arranged in series in the axial direction via respective valve plates 3, 4 so as to sandwich the entire cylinder blocks 1 and 2.

Also, these cylinder blocks are rigidly combined with each other by a shell 7 while being restricted to a predetermined positional relationship. Drive shaft 8 cooperable with the driving section of the vehicle's engine, is arranged to extend in through-bores 40, 41 bored longitudinally in the central portions of both cylinder blocks 1 and 2, and is rotatably supported by needle bearings 46, 47 mounted at the respective outer ends of said blocks 1, 2, while a rotary swash-plate 9 is keyed on the shaft 8 around the combined portion of cylinder blocks 1 and 2. Three pairs of six cylinder bores 45 in cylinder blocks 1, 2 are located substantially in parallel with the axis of drive shaft 8 and with double acting pistons 12 are slidably inserted therein.

Each of the pistons 12 is provided with head sections at the ends thereof which are slidably fitted within cylinder bores 45 and is provided with a section connecting both heads which is cut away at one side thereof so as to cross over above the outer fringe of swash-plate 9. The cut away portions of pistons 12 are associated with both side faces of swash-plate 9 by means of balls 11 and shoes 10, respectively, so that the rotating motion of swash-plate 9 provides reciprocating motions of pistons 12. The axial thrust load from the pumping action of pistons 12 is assumed by a pair of thrust bearings 42, 43 arranged between end surfaces of boss sections of swash-plate 9 and respective cylinder blocks 1 and 2.

Chambers 13 and 14 located at the front portion of front cylinder block 1 and at the rear portion of rear cylinder block 2, respectively, make use of the spaces disposed above drive shaft 8, each of which is a sectorially formed space enclosed by the walls of shell 7 and the two neighbouring cylinder bores 45. 15 shows a suction passageway axially connecting both chambers 13 and 14 which has a cross sectional area smaller than the cross sectional areas of chambers 13, 14.

The passageway 15 and both chambers 13 and 14 provide a complete suction chamber 28 inside shell 7.

A suction opening 16 for introducing refrigerant into said chamber 28 is connected through shell 7 to passageway 15, while a discharge opening 17 for discharging refrigerant compressed by the compressor is connected to a portion of the rear housing 6. As shown in FIG. 2, lubricating oil supplied to chambers 13 and 14 covered by shell 7 flows down through the passing grooves 22 and 23 channeled at the circumferential surfaces of respective cylinder blocks 1 and 2 and is then stored in oil reservoir 24. The lubricating oil stored in oil reservoir 24 is pumped upwardly by oil pump 25, which cooperates with drive shaft 8 of the compressor, through suction pipe 26, and is then distributed to respective bearings by means of an oil supply passage 27 bored in the center of drive shaft 8.

The present invention will now be illustrated based upon several preferred embodiments shown in the accompanying drawings.

Referring to FIGS. 3, 4 and 5, channels 18, 19 for flowing the lubricating oil downwardly are formed on the end surfaces of front cylinders 1 and 2 with which surfaces valve plates 3, 4 are in contact, respectively. However, channels 18, 19 may be formed on the surfaces of valve plates 3 and 4 or, may be grooved on both facing surfaces of the cylinder blocks and valves. Holes 20, 21 shown in FIG. 4 are formed in cylinder blocks 1 and 2 and illustrate another embodiment instead of the above-mentioned channels. Holes 20, 21 provided for the downward flow of lubricating oil extend from the bottom surfaces of chambers 13, 14 to the upper portions of drive shaft 8.

Now, gaseous refrigerant, evaporated by passing through an evaporator (not shown) circulates in predetermined refrigerating circuits, and then returns to the compressor.

The refrigerant is drawn from suction opening 16 formed to extend through shell 7 into suction passageway 15 and here, it is branched into two separate streams which advance through respective chambers 13 and 14 to be sucked into the bore sections of respective cylinder blocks 1, 2.

During the above-mentioned flowing operation of the refrigerant, the lubricating oil contained in the refrigerant is partially separated on account of the difference between the two inertias, when the gaseous refrigerant directed at the inner wall of passageway 15 turns at right angles while branching into two separate streams.

Also, the oil still remaining in the refrigerant separates into oil particles under the force of gravity while the refrigerant branches flowing into respective chambers 13 and 14 provided with large cross sectional areas, are reduced in speed. The lubricating oil separated from the refrigerants is collected at the bottoms of chambers 13 and 14 and then flows down through channels 18, 19 and into the clearances between drive shaft 8 and bores of respective cylinder blocks 1, 2 so as to lubricate all bearings, while the oil leaking from the bearings lubricates the swash-plate sections (referred to by arrows in FIG. 5). In another embodiment shown in FIG. 4, the oil in chambers 13, 14 flows down through holes 20 and 21 to carry out lubrication of the bearings.

Next, another embodiment will be illustrated.

Referring now to FIG. 6 to FIG. 9, oil grooves 38, 44 are channeled on valve plates 3, such that both ends of both grooves are connected to the through-hole 30 bored at the center of valve plate 3. The other end of

oil groove 38 is connected to the above-mentioned chamber 13, while the other end of oil groove 44 is connected to main oil reservoir 24 disposed at the bottom section of shell 7.

These oil grooves 38, 44 are also connected via through-hole 30 to a supplementary oil reservoir 39 which is connected to sealing chamber 37 formed at the axially central portion of the above-mentioned front housing 5 and having a seal member 36 inside. In the embodiment shown, main oil reservoir 24 is provided by shell 7 which forms the outer periphery of the entire compressor body. However, in the embodiment in which the entire cylinder blocks, 1, 2 form the outer periphery of the entire compressor body, one of the above-mentioned spaces formed inside cylinder blocks 1, 2 which is arranged at a lower part of drive shaft 8 is adapted to be used for the main oil reservoir.

An oil groove 48 provided for passage of lubricating oil is connected to chamber 14 at one end thereof and is connected to through-hole 31 bored at the center of valve plate 4 at the other end thereof.

This oil groove 48 is also connected via through-hole 31 to supplementary oil reservoir 32 which is centrally located with rear housing 6 and opens onto the end of drive shaft 8 having a bottom portion explained hereinafter. The dispositions of the above-mentioned oil grooves 38, 48 and 44 are not limited to the positions shown on valve plates 3, 4. That is, oil grooves 38, 48 and 44 can be disposed at any such position consistent with obtaining the desired operations and effects, where the lubricating oil separated from the refrigerant within chambers 13, 14 is capable of being led into needle bearings 46, 47 and also, supplementary oil reservoirs 32 and 39 formed inside housings 5, 6 through said oil grooves 38 and 48 and moreover, the oil led and stored within supplementary oil reservoir 39 is capable of flowing into main oil reservoir 29. For example, oil grooves 38, 48 and 44 may be disposed on cylinder blocks 1, 2, at the surface of each end thereof to which surfaces valve plates 3, 4 are connectedly attached respectively.

33 shown in FIG. 7 and FIG. 8 is an oil supply passage longitudinally bored inside the above-mentioned drive shaft 8 and part way therealong thus providing the hole with a bottom portion.

The opening of the hole, i.e. the other end, is connected to the above-mentioned supplementary oil reservoir 32. This oil hole is provided with open oil supply inlets 34 and 35 at positions which correspond to the positions where thrust bearings 42 and 43 are arranged, respectively.

The entire arrangement above-mentioned is illustrated based upon the embodiment in which shell 7 forms the outer periphery of the compressor body. However, the arrangement may be applied to the compressor in which the outer periphery thereof is formed by the cylinder blocks, that is to say the above-mentioned shell 7 is completely eliminated.

In the compressor of the present invention having the above-mentioned arrangement, gaseous refrigerant vaporized by an evaporator not shown circulates through a predetermined refrigerating circuit and returns to the compressor so as to be led into suction chamber 28 through suction opening 16 formed to extend through shell 7.

The refrigerant led into suction chamber 28 is directed at the inside wall of suction passageway 15 and

here it is forcibly turned at right angles while branching into two separate streams. This forced alteration of the refrigerant flow brings about a partial separation of the lubricating oil from the refrigerant. The refrigerant is branched in suction passageway 15 into two separate streams which are led into chambers 13, 14 having large cross sectional areas which reduce their flowing speed there so that oil particles having relative large weight are separated from the refrigerant and are deposited in the bottoms of chambers 13, 14.

The respective refrigerant branches in chambers 13, 14 from which the lubricating oil is completely eliminated are drawn into the cylinder bore sections of each cylinder block 1, 2 and after being compressed there, are discharged from discharge opening 17. On the other hand, the separated oil deposited in respective chambers 13 and 14 flows along the bottom surfaces thereof along with the flow of the refrigerant branches, so as to be led and stored in respective supplementary oil reservoirs 39 and 32 of front and rear housings 5 and 6 through the above-mentioned oil grooves 38 and 48. A part of the lubricating oil stored in supplementary oil reservoir 39 lubricates needle bearing 46 as well as seal member 36 set in sealing chamber 37 of the front housing 5. The excess oil remaining in supplementary oil reservoir 39 is led to and stored in main oil reservoir 24 through the above-mentioned oil groove 44.

The lubricating oil stored in supplementary oil reservoir 32 which is formed in rear housing 6, is led into oil hole 33 of drive shaft 8 and then, it is supplied to lubricate thrust bearings 42 and 43 through respective oil supply inlets 34 and 35 by action of the centrifugal force due to the rotation of drive shaft 8. The oil streams in thrust bearings 42 and 43 are directed therefrom by action of the centrifugal force due to both bearings and a part of the flowing oil attaches to swash-plate 9 so that shoes 10 and balls 11 associated with swash-plate 9 may be lubricated, while the other part of the oil is directed along the inner wall of the compressor to flow down along the wall surface into the main oil reservoir 24.

Also, a part of the lubricating oil stored in the above-mentioned supplementary oil reservoir 32 lubricates needle bearing 47, and also thrust bearing 43 via through-bore 41 of cylinder block 2, then flows down into main oil reservoir 24 in the same manner as above.

As will be understood, the existence of both supplementary oil reservoirs 39 and 32 prevents burning of the rotating elements of the compressor such as needle and thrust bearings which might occur at the moment of starting of the operation of the compressor.

Thus, the apparatus according to the present invention is capable of carrying out lubricating operation by using an amount of oil which is proportional to the amount of the refrigerant circulating in a predetermined refrigerating circuit.

At the same time, the apparatus according to present invention eliminates the conventional oil pump so that the effective volume of the rear housing is increased while the drawing distance of the refrigerant is shortened so as to increase the volumetric efficiency of the compressor.

Also, the above-mentioned fact provides a capability of reducing the volume of the housings and the oil reservoir arranged at the bottom portion of the shell with-

out decreasing the compressing efficiency so that a compact compressor can be obtained.

Furthermore the compressor is always equally lubricated at both front and rear sections and also, the lubricating oil reserved in the main oil reservoir is never pumped up because of elimination of the oil pump so that the lubricating oil in the main oil reservoir is never exhausted.

Also, the presence of the supplementary oil reservoirs has the effect of preventing the burning of all sliding and moving sections of the compressor even at the starting moment of its operation.

The invention has been described in detail with reference to several preferred embodiments thereof, but it will be understood that variations and modifications can be further effected within the spirit and scope of the invention.

I claim:

1. An apparatus for lubricating a rotary swash-plate type compressor for compressing refrigerant which has entrained oil therein, said compressor being of the type including a pair of front and rear cylinder blocks which are combined with each other in an axial alignment to form combined blocks having a combining portion therebetween, separate housings mounted at front and end sections of said combined cylinder blocks and separated therefrom by separate respective valve plates, a drive shaft inserted in a shaft-bore formed in said combined cylinder blocks, a suction inlet to said compressor, a swash-plate keyed on said drive shaft in the vicinity of said combining portion and capable of rotating in a unitary state with said drive shaft, and a separate thrust bearing between each cylinder block and said swash-plate around said shaft bore; said apparatus comprising a chamber in each said block extending between said suction inlet and the respective valve plate and positioned to change the direction of refrigerant entering said inlet, first passageways extending from the bottoms of said chambers for directing oil separated in said chambers to said shaft, and second passageways directing oil from said first passageways means to said thrust bearings.

2. An apparatus for lubricating a rotary swash-plate type compressor according to claim 1 characterized in that said first passageways for leading the separated oil comprise oil grooves pierced through the junction-surfaces between said cylinder blocks and said valve plates, and said second passageways comprise the shaft-bore of said combined cylinder blocks.

3. An apparatus for lubricating a rotary swash-plate type compressor according to claim 1 characterized in that said first passageways for leading the separated oil comprise oil channels arranged in said cylinder blocks, and said second passageways comprise the shaft-bore of said combined cylinder blocks.

4. An apparatus for lubricating a rotary swash-plate type compressor according to claim 1 characterized in that said first passageways for leading the separated oil comprise oil channels arranged in said valve plates, and said second passageways comprise the shaft-bore of said combined cylinder blocks.

5. An apparatus for lubricating a rotary swash-plate type compressor according to claim 1 characterized in that said first passageways for leading the separated oil comprise oil grooves pierced through the junction-surface between said rear cylinder block and said corresponding valve plate, and said second passageways

comprise an oil hole longitudinally bored in said drive shaft having an opening at its rear end communicating with said first passageways and open oil inlets located to direct oil from said oil hole to said thrust bearings.

6. An apparatus for lubricating a rotary swash-plate type compressor according to claim 1 characterized in that said first passageways for leading the separated oil comprise oil channels arranged in said cylinder blocks, and said second passageways comprise an oil hole longitudinally bored in said drive shaft having an opening at its rear end communicating with said first passageways and open oil inlets located to direct oil from said oil hole to said thrust bearings.

7. An apparatus for lubricating a rotary swash-plate type compressor according to claim 1 characterized in that said first passageways for leading the separated oil comprise oil channels arranged in said valve plates, and said second passageways comprise an oil hole longitudinally bored in said drive shaft having an opening at its rear end communicating with said first passageways and open oil inlets located to direct oil from said oil hole to said thrust bearings.

8. An apparatus for lubricating a rotary swash-plate type compressor according to claim 1 comprising a supplementary oil reservoir within at least one of said front and rear housings, characterized in that said first passageways for leading the separated oil extend between a chamber and said supplementary oil reservoir and said second passageways extend through an axial through-hole in said corresponding valve plate.

9. An apparatus for lubricating a rotary swash-plate type compressor according to claim 8 comprising a main oil reservoir at the lower portion of said compressor and comprising an oil channel means connecting said supplementary oil reservoir to the main oil reservoir.

10. An apparatus for lubricating a rotary swash-plate type compressor according to claim 8 comprising a main oil reservoir at the lower portion of said compressor and comprising an oil channel means connecting said supplementary oil reservoir to the main oil reservoir said oil channel means extending at least partly in the corresponding cylinder block.

11. An apparatus for lubricating a rotary swash-plate type compressor according to claim 8 comprising a main oil reservoir at the lower portion of said compressor and comprising an oil channel means connecting said supplementary oil reservoir to the main oil reservoir said oil channel means extending at least partly in a valve plate.

12. An apparatus for lubricating a rotary swash-plate type compressor according to claim 1 comprising supplementary oil reservoirs found within said front and rear housings characterized in that said first passageways for leading the separated oil extend via axial through holes in said respective valve plates to said supplementary reservoirs.

13. An apparatus for lubricating a rotary swash-plate type compressor according to claim 12 comprising a main oil reservoir at the lower portion of said compressor, and further comprising an oil channel connecting one of said supplementary oil reservoirs to the main oil reservoir.

14. An apparatus for lubricating a rotary swash-plate type compressor according to claim 12 comprising a main oil reservoir at the bottom portion of said compressor, and comprising oil channels connecting said supplementary oil reservoirs to the main oil reservoir, at least a part of the oil channels being in the corresponding cylinder block.

15. An apparatus for lubricating a rotary swash-plate type compressor according to claim 12 comprising a main oil reservoir at the bottom portion of said compressor, and comprising oil channels connecting said supplementary oil reservoir to the main oil reservoir at least a part of the oil channels being in a valve plate.

16. An apparatus for lubricating a rotary swash-plate type compressor according to claim 1 wherein said chambers have larger cross sectional areas than said suction inlet to said compressor, whereby the running speed of the refrigerant in said chambers is less than in said inlet, and oil remaining in the refrigerant separates into oil particles which fall under the force of gravity to the bottoms of said chambers.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,750,848 Dated August 7, 1973

Inventor(s) Shozo Nakayama

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover sheet [73] Assignee: "Kabushiki Kaisha Toyada, Jidashokki Seisakusko, Archi-ken, Japan" should read -- Kabushiki Kaisha Toyoda Jidoshokki Seisakusho, Aichi-ken, Japan --.

Signed and sealed this 27th day of August 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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