

Nov. 14, 1967

AKIRA NIKI ET AL  
SWASH PLATE COMPRESSOR FOR USE IN AIR CONDITIONING  
SYSTEM FOR VEHICLES  
Filed Oct. 22, 1965

3,352,485

FIG. 1

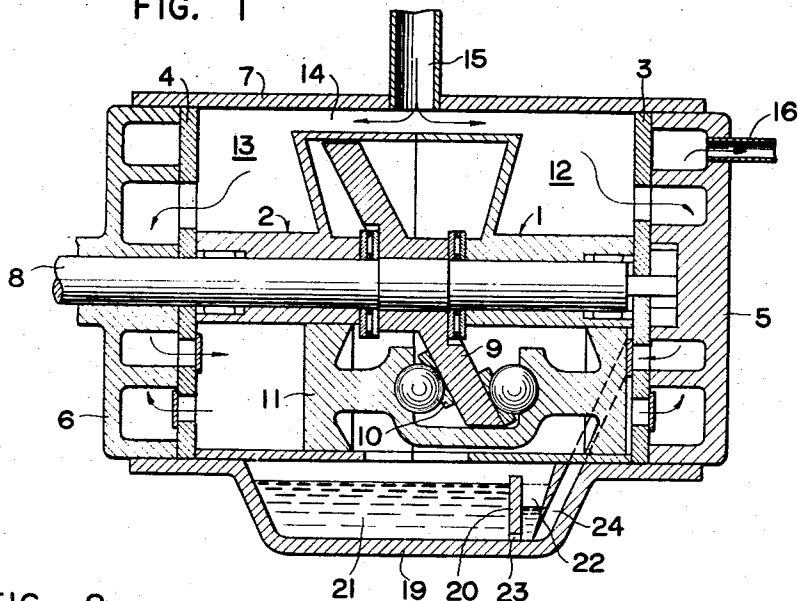


FIG. 2

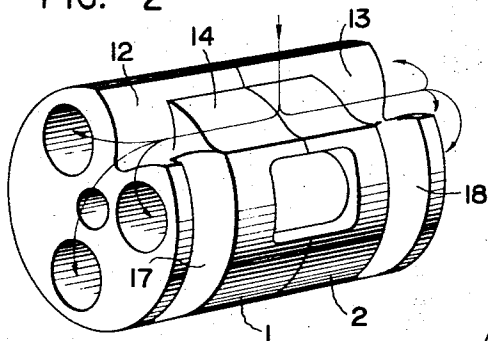


FIG. 3

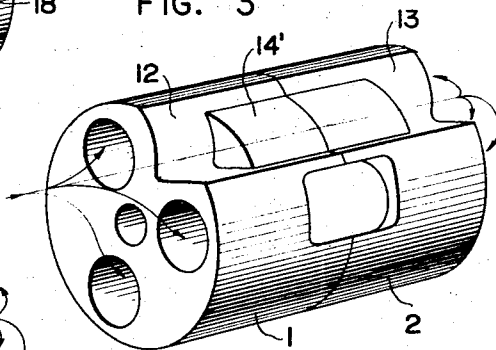
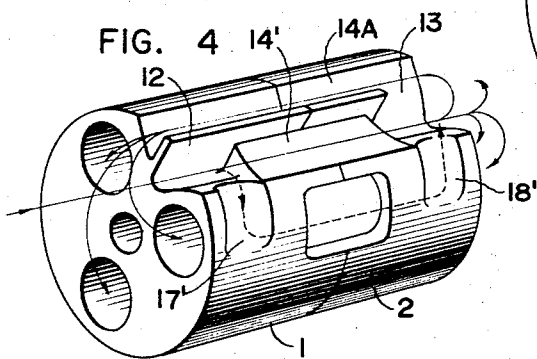


FIG. 4



Akira Niki,  
Shōzō Nakayama and  
Takeshi Toriyama,  
Inventors

By Wendeloth, Lind & Ponack,  
Attorneys

1

2

3,352,485

## SWASH PLATE COMPRESSOR FOR USE IN AIR CONDITIONING SYSTEM FOR VEHICLES

Akira Niki, Kariya, Shōzō Nakayama, Chita-gun, and Takeshi Toriyama, Kariya, Japan, assignors to Toyota Automatic Loom Works, Ltd., Kariya, Aichi Prefecture, Japan

Filed Oct. 22, 1965, Ser. No. 501,378

2 Claims. (Cl. 230—186)

### ABSTRACT OF THE DISCLOSURE

A multi-piston, double acting, single swash plate refrigerant gas compressor for use in an air-conditioning system for vehicles, in which there is provided an improved construction for separating oil from refrigerant gas, the improved construction comprising a pair of cylinder blocks connected in series, an outer cylindrical casing enclosing said cylinder blocks, cylinder heads disposed within opposite ends of said outer casing, valve plates interposed between said cylinder heads and said cylinder blocks, the remote end portions of said pair of cylinder blocks each having a chamber therein, the adjacent portions of said cylinder blocks each having a longitudinal suction channel being aligned and connecting said chambers, said outer casing having an inlet port therein opening into said longitudinal suction channel, an oil sump beneath the cylinder blocks, and said cylinder blocks each having a circumferential oil return channel thereon and extending between the chamber in the cylinder block and the oil sump for leading the oil separated from the refrigerant gas directly into said oil sump.

This invention relates to a swash plate type compressor for use in an air conditioning system for vehicles and the like.

An object of this invention is to provide a swash plate compressor for handling the gaseous refrigerant (such as  $\text{CF}_2\text{Cl}_2$ ) coming from an evaporator of the air conditioning system, wherein any lubricant oil mixed with the gaseous refrigerant may be effectively separated, thereby maintaining good refrigerating efficiency of the air conditioning system.

In the accompanying drawings:

FIGURE 1 is a longitudinal sectional view of the compressor constructed according to this invention;

FIGURE 2 is a perspective view of the cylinder blocks according to this invention; and

FIGURES 3 and 4 show in perspective views two examples of construction of the cylinder blocks proposed by the prior art.

In the conventional swash plate compressor for use in air conditioning system for a vehicle, it has been the practice to provide means for separating oil from the refrigerant gas handled by the compressor. In such a compressor in general the refrigerant gas returned from the evaporator is sucked in through the inlet port in the rear housing (rear cylinder head) and is passed directly or indirectly to each of the rear and front cylinder blocks. In such case, the refrigerant gas sucked into the front cylinder block 2 (FIGS. 3 and 4) is subject to oil separating action in chambers 13 and 12 formed in the front and rear cylinder blocks 2 and 1 respectively. In the rear cylinder block 1, however, there is a tendency of the returning refrigerant gas being sucked thereinto without to be subjected to effective oil separation, so that the discharge gas from the compressor still contains considerable amount of lubricating oil. This results, in a decrease of the refrigerating efficiency of the air conditioning system. To overcome the above mentioned defect, it has also been proposed to provide a double channel 14A

(FIG. 4) for the purpose of attaining good oil separation from the refrigerant gas sucked into the rear cylinder, and to provide oil return channels 17' and 18' in communication with the bottom portion of said chambers 12 and 13, respectively. The above mentioned improvements, however, still have the following disadvantages, viz. (1) the sucking channel becomes longer, decreasing the suction efficiency, and (2) due to the increased resistance of the double channel 14A there is produced a pressure difference between the chambers 12 and 13, so that the sucked-in refrigerant gas tends to pass mainly through the oil return channel 17' associated with the rear cylinder block and tends to counter flow through the return channel 18' as shown in dotted line in FIG. 4 and, as a result, the refrigerant gas is liable to blow off a mist of lubricating oil in the swash plate chamber.

Now, referring to FIGURES 1 and 2, in which an embodiment of the present invention is shown, the reference numerals 1 and 2 denote a pair of cylinder blocks having three cylinder bores, the rear cylinder block 1 and the front cylinder block 2 being connected in series and enclosed in an outer cylindrical casing 7. 3 and 4 are valve plates, and 5 and 6 are cylinder heads or housings mounted at the ends of the pair of cylinder blocks 1 and 2, respectively. A drive shaft 8 is directly connected to the driving part of a vehicle engine. Said drive shaft 8 carries a swash plate 9 securely mounted thereon. Both surfaces of the swash plate engage with pistons 11 through the intermediary of shoes 10 or the like. 12 and 13 denote chambers formed in the rear end portion of the rear cylinder block 1 and on the front end portion of the front cylinder block 2, respectively, and said chambers 12 and 13 are in communication with each other through a suction channel 14. Said suction channel 14 is in communication with an inlet port 15 which is provided in the outer casing 7. 16 is a discharge port connected to the rear cylinder head 5. The cylinder blocks 1 and 2 are provided with the oil return channels 17 and 18, respectively, arranged circumferentially and in communication with the bottom portion of said chambers 12 and 13, respectively, and at the other ends directly communicated with the oil sump 19.

According to the feature of the present invention, contrary to the conventional manner, the refrigerant gas coming from the evaporator of the air conditioning system is not introduced into the rear housing or cylinder head 5, but it is directly introduced into the said suction channel 14 through the inlet port 15, where the stream of refrigerant gas is divided into two streams toward the chambers 12 and 13 and is introduced into the cylinders 1 and 2 respectively. The refrigerant gas introduced from the inlet 15 impinges upon the wall of the suction channel 14 and the flow is deflected into two opposite ways, so that it will be understood that the oil is separated by the action of inertia. Coming into the chambers 12 and 13 which have larger cross sectional areas than the suction channel 14, relatively heavy oil particles commingled with the refrigerant gas are effectively separated by gravity due to the retardation of the speed of the running stream. The separated oil passing through the circumferential channels 17 and 18 will be directly sent by gravity into the oil sump 19 and collected therein. The refrigerant gas substantially free of oil in the above manner is introduced into the cylinders and, after being compressed, is discharged through the discharge port 16 provided in the rear cylinder head or housing 5, and it is introduced into the cycle of the refrigeration system.

In FIG. 1, the oil sump 19 is provided with a partition wall 20 dividing the sump into two chambers, the main sump 21 and the small feeding sump 22, which are in communication through an orifice 23 provided at the bottom portion of the partition wall 20. The bottom of the

feeding sump 22 is connected by means of an oil conduit 24 to the inlet port of an oil feed pump (not shown). When the compressor is not in operation, the same oil level is maintained in the main and small sumps 21 and 22. Upon starting the operation of the compressor and consequently of the oil pump driven thereby, oil in the small feed sump 22 is sucked by said oil pump through a conduit 24 and, as far as the quantity of oil fed to the oil pump from the sump 22 is maintained equal to the quantity of oil fed to the sump 22 through the orifice 23, the oil level of the sump 22 is still maintained same as the oil level of the main sump 21. When the feeding capacity of the oil pump increases beyond a predetermined value upon increase of the operative speed of the compressor, it will result in lack of oil in the small feed sump 22. As a result, the conduit 24 will tend to suck-in the air, and the oil feed action of the oil pump will be stopped. As soon as the feed sump 22 is again filled with oil, the oil pump will again start its operation of feeding oil. Thus, it will be noted that the amount of oil fed to the compressor is automatically controlled.

Contrary to the conventional arrangement in which the refrigerant gas returned from the evaporator is sucked in through the inlet port in the rear cylinder head and is passed directly or indirectly to each chamber in the rear and front cylinder blocks, according to the present invention said refrigerant gas from the evaporator is sucked in through the inlet port 15 in the outer casing 7 into the channel 14 connecting the chambers 13 and 12 causing the impingement of the gas against the wall of said channel and deflecting the flow of the gas in two opposite directions, and it will be understood that the most effective oil separation can be attained thereby.

What we claim is:

1. A swash plate type compressor for use in an air-conditioning system for vehicles and the like, comprising a pair of cylinder blocks connected in series, an outer cylindrical casing enclosing said cylinder blocks, cylinder

heads disposed within opposite ends of said outer casing, valve plates interposed between said cylinder heads and said cylinder blocks, the remote end portions of said pair of cylinder blocks each having a chamber therein, the adjacent portions of said cylinder blocks each having a longitudinal suction channel therein, the suction channels being aligned and connecting said chambers, said outer casing having an inlet port therein opening into said longitudinal suction channel, an oil sump beneath the cylinder blocks, and said cylinder blocks each having a circumferential oil return channel thereon and extending between the chamber in the cylinder block and the oil sump for leading the oil separated from the refrigerant gas directly into said oil sump.

2. A swash plate type compressor as claimed in claim 1, wherein the oil sump has a partition dividing the sump into two sump portions, the main sump portion and a small feed sump portion, said partition wall having an orifice in the bottom thereof, and oil feed pump adapted to be driven from a compressor drive shaft, and an oil conduit connecting said small sump portion and said pump.

#### References Cited

##### UNITED STATES PATENTS

|           |         |                   |         |
|-----------|---------|-------------------|---------|
| 1,052,569 | 2/1913  | Cherry            | 103—173 |
| 2,070,880 | 2/1937  | Blum              | 103—173 |
| 2,323,802 | 7/1943  | Dick et al.       | 230—207 |
| 2,527,657 | 10/1950 | Rowledge et al.   | 230—206 |
| 2,828,907 | 4/1958  | Oehrli            | 230—207 |
| 2,835,436 | 5/1958  | Steinhagen et al. | 230—186 |
| 2,877,946 | 3/1959  | Garrison et al.   | 230—207 |
| 2,956,730 | 10/1960 | Hamilton et al.   | 230—206 |
| 3,057,545 | 10/1962 | Ransom et al.     | 230—186 |
| 3,208,667 | 9/1965  | Boettcher         | 230—207 |

DONLEY J. STOCKING, *Primary Examiner*.

W. J. KRAUSS, *Assistant Examiner*.