July 11, 1972 SEIJI AKAIKI ET AL 3,676,024
APPARATUS FOR SEPARATING LUBRICANT FROM A REFRIGERANT LUBRICANT MIXTURE IN A RECIPROCATING TYPE AUTOMOTIVE AIR CONDITIONER COMPRESSER
Original Filed July 1, 1969 4 Sheets-Sheet 1

Fig. 1

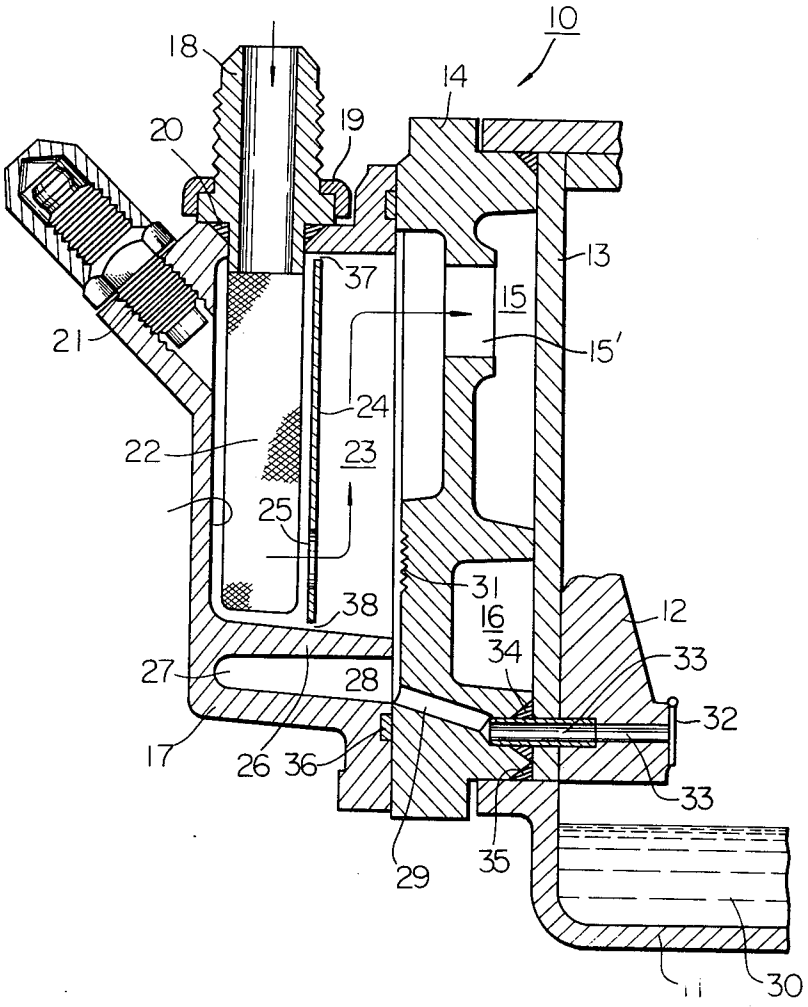

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Fig. 2

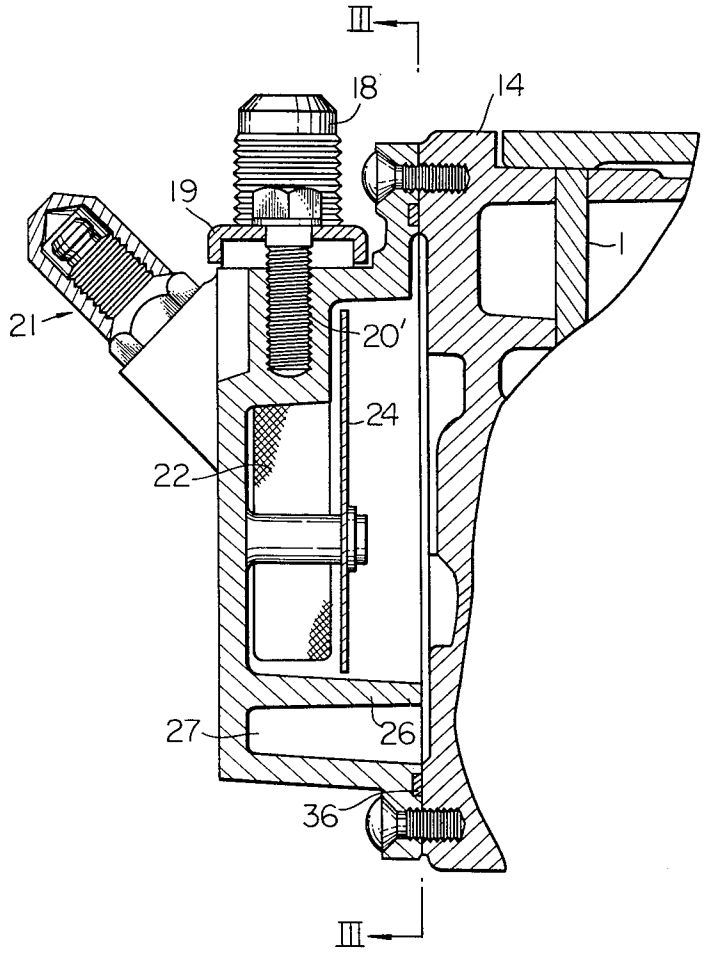


Fig. 3

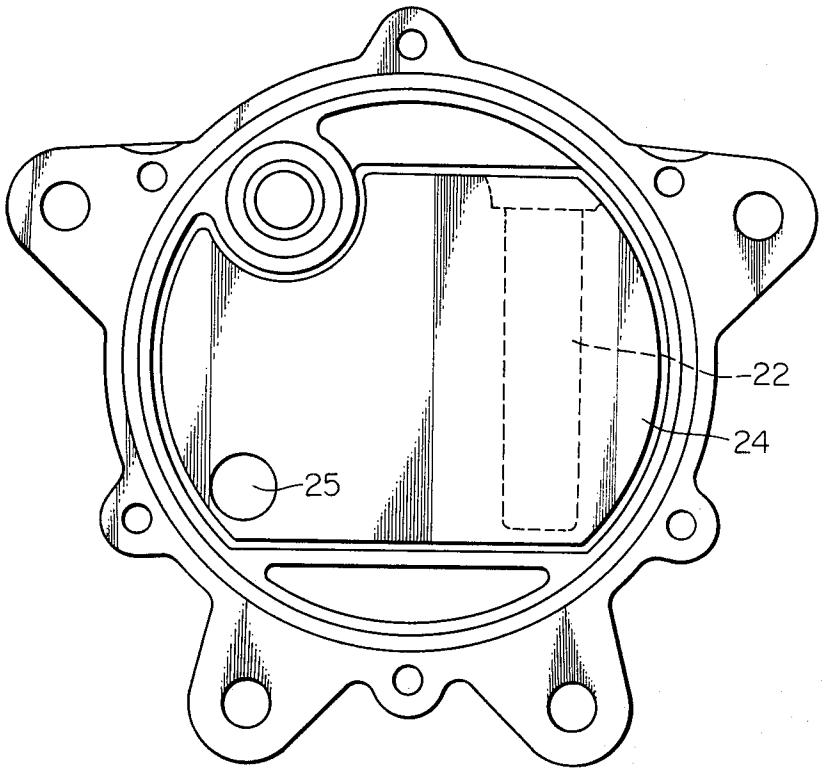
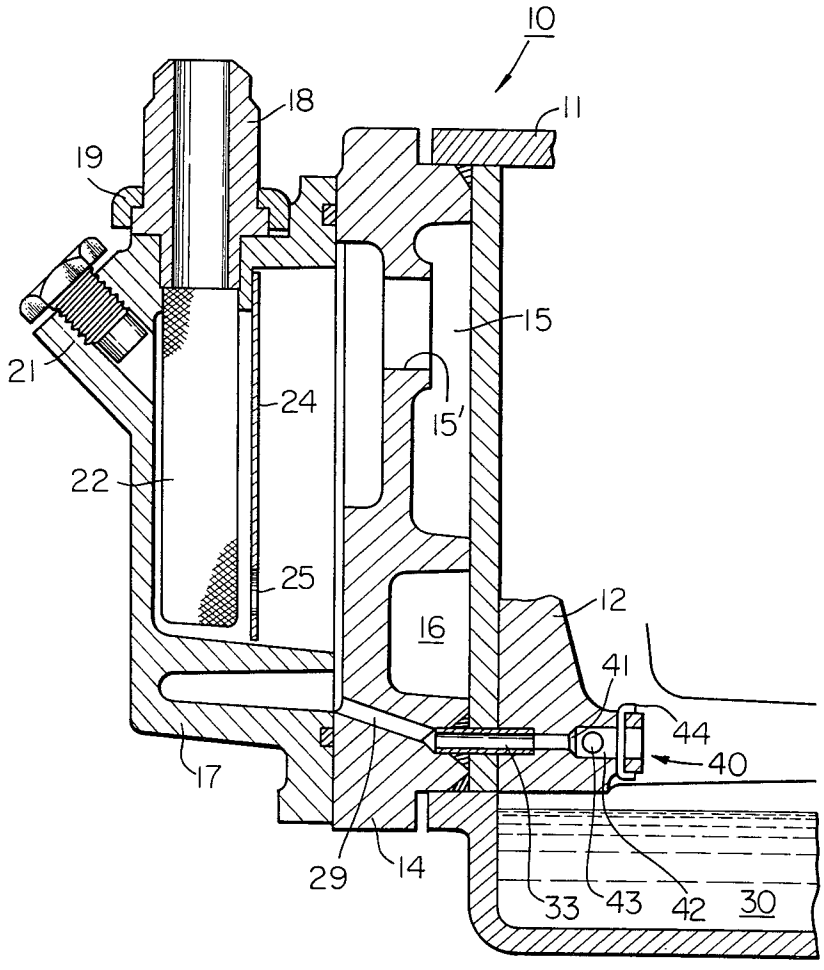


Fig. 4



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3,676,024

APPARATUS FOR SEPARATING LUBRICANT FROM A REFRIGERANT LUBRICANT MIXTURE IN A RECIPROCATING TYPE AUTOMOTIVE AIR CONDITIONER COMPRESSOR

Seiji Akaike, Atsugi, and Akira Morinaga, Aiko Atsugi, Japan, assignors to Nissan Motor Company, Limited, Yokohama, and Atsagi Motor Parts Company, Limited, Atsugi, Japan

Continuation of application Ser. No. 838,104, July 1, 1969. This application Mar. 2, 1971, Ser. No. 120,362

Int. Cl. F04b 39/02

U.S. Cl. 417—372 7 Claims

ABSTRACT OF THE DISCLOSURE

Disclosed herein is an apparatus for separating lubricant from a refrigerant-lubricant mixture circulating in a reciprocating type automotive air conditioner. The apparatus includes a strainer mounted within a first chamber for separating the lubricant from the mixture, a pair of spaced passages for the lubricant and refrigerant, respectively, and for interconnecting the first chamber with a second separating chamber, a partition for keeping the separated oil isolated from the mixture, a passage provided between the second separating chamber and a recess provided by the partition, and a lubricant passage for passing the lubricant from the recess to the oil reservoir of the compressor.

This application is a continuation of Ser. No. 838,104 filed July 1, 1969 now abandoned.

This invention relates to apparatus for separating a lubricant from a refrigerant-lubricant mixture which circulates in a reciprocating type automotive air conditioner compressor, and more particularly to improvements of the refrigerant circulating system of the device for effectively separating the lubricant from the mixture at the suction portion of the compressor.

In a conventional reciprocating type compressor using a swash plate for driving a piston to circulate refrigerant for an air conditioner, lubricating oil for the compressor is forced to circulate in a circulating system, and some of the oil is drawn into the refrigerating cycle and mixes with the refrigerant. Thus, the content of the lubricant contained in the refrigerant-lubricant mixture tends to increase cummulatively, with a resultant decrease in the refrigerating capacity of the compressor, and also a decrease in the amount of oil in the compressor lubrication system, thereby causing insufficient lubrication, and burning or damaging of frictional elements in the compressor.

Furthermore, during operation of the compressor, blow-by gas leaks through the gap between the piston and the cylinder of the compressor, thus causing the pressure in the oil reservoir chamber to increase. In order to balance this pressure build-up with the pressure of the suction chamber, a balancing hole is conventionally provided between the oil reservoir chamber and the suction chamber. When the compressor is starting, or when its operation is fluctuating abruptly, a sudden pressure difference is created between the oil reservoir chamber and the suction chamber, and this produces foam in the mixture of the refrigerant gas and the lubricant within the oil reservoir chamber, with the result that the foamed mixture tends to flow to the suction chamber through the balancing hole. Thus, the refrigerating efficiency of the compressor decreases, and also the amount of the lubricant oil in the compressor lubrication system decreases, causing insufficient lubrication of the compressor as previously described.

The compressor for an automobile air conditioner is required to be compact so as to fit in the small space under the hood of the automobile, particularly in the case of a compact car, and in the modern automobile designs which tends to have low profiles. Accordingly it is difficult to provide the aforementioned balancing hole at a substantially elevated position from the oil surface, and when the automobile runs on steep grades, or starts or stops abruptly, the surface of the lubricant in the oil forms ripples which causes an oil flow back into the suction chamber through the balancing hole.

It is an object of this invention to eliminate these and other disadvantages of such a conventional compressor, and to provide a system for separating lubricant from a refrigerant-lubricant mixture.

One advantage of the present invention is that a plate is provided in the suction passage of the compressor for providing spaced passages for the lubricant and refrigerant. This plate has a hole for causing an accelerated flow of the mixture to be ejected therethrough at high speed, and to collide on a corrugated wall formed on the inner wall of the suction passage for further separating the lubricant from the mixture. This separation of the lubricant by means of the corrugated wall is caused by the differences in the specific gravity and adhesion between the refrigerant and the lubricant, whereby the lubricant flows downward on the corrugated wall.

Another advantage of the present invention is that the thus separated lubricant is fed to the oil reservoir of the compressor through a check valve or a device having a tapered expanding portion and an expanded passage provided with a ball so as to prevent the counterflow of lubricant to the suction portion of the compressor. This arrangement allows a counterflow feed of the refrigerant to the cylinder of the compressor, but prevents the counterflow of the lubricant from the oil reservoir to the suction chamber as otherwise would be caused by the blow-by gas pressure inside the casing.

The features and advantages of the present invention will become apparent from the following description when read in conjunction with the accompanying drawings, in which:

FIG. 1 is a sectional view of the suction portion of a compressor for an automobile air conditioner constructed in accordance with the present invention;

FIG. 2 is a sectional view similar to FIG. 1 but taken in a different section;

FIG. 3 is a sectional view taken along the line III—III of FIG. 2; and

FIG. 4 is a sectional view similar to FIG. 1 but showing the suction portion of the compressor having means for preventing the counterflow of the lubricant from the oil reservoir to the suction portion of the compressor.

Reference is now made to FIGS. 1 and 2, which show the suction portion of a reciprocating type compressor for an automobile air conditioner constructed according to the present invention, and including apparatus **10** for separating lubricant from a refrigerant-lubricant mixture in the compressor. The compressor and apparatus include a casing **11**; a cylinder **12**; a valve plate **13**; a cylinder head **14** disposed in sealed contact with the valve plate **13** and inserted into the end of the casing **11**, and including a suction chamber **15**, a discharge chamber **16**, and a suction port **15'**; a head cover **17** provided in sealed contact with the cylinder head **14**; a suction connector **18**; a retainer **19** for the suction connector **18**; a packing **20** sealably provided between the head cover **17** and the suction connector **18**; a plurality of bolts **20'** for connecting the suction connector retainer **19** to the head cover **17**; a check joint **21** for supplying a refrigerant or for checking the pressure of the refrigerant gas in the suction chamber

15; a strainer 22 disposed within an oil separating chamber 23 for separating the lubricant from the mixture; a plate 24 fixed adjacent to the strainer 22 in the oil separating chamber 23 for providing upper and lower passages for the refrigerant and lubricant respectively, said plate being formed with a hole 25 for providing an accelerated flow of the mixture toward the cylinder head 14; a partition 26 provided in the head cover 17 for providing a recess 27 for keeping the separated oil isolated from the mixture flow in the oil separating chamber 23 means providing a passage between the oil separating chamber 23 and the recess 27 such as, for example, a gap 28 provided between the head cover 17 and the cylinder head 14, or a hole (not shown) formed in the partition 26; and a lubricant passage 29 for passing the lubricant from the recess 17 to the oil reservoir 30 of the compressor.

Preferably, the sectional area of the strainer 22 is larger than the area of the suction connector 18; and the hole 25 in the plate 24 is bored in the opposite corner from the strainer 22 at the lowermost point of the plate 24, as best seen in FIG. 3.

A corrugated wall 31, formed for example by zigzag or horizontal ridges on the inner wall of the oil separating chamber 23, separates the lubricant from the mixture ejected through the hole 25 of the plate 24, due to the adherence of the lubricant on the corrugated wall 31.

This system 10 further comprises a check valve 32 provided at the outlet 33 of the passage 29 for preventing the counterflow of the oil and blow-by gas from the oil reservoir 30 to the oil separating chamber 23.

Also, a rigid tubular member 33 in the lubricant passage 29 positions the cylinder head 14 with respect to the cylinder 12; and, packing 34 sealingly connects the tube 33 with the cylinder head 14 and the valve plate 13, a packing 35 sealingly connects the cylinder head 14 with the end of the casing 11, and a packing 36 sealingly connects the head cover 17 with the cylinder head 14.

In the operation of the system thus constructed in accordance with the present invention, the refrigerant-lubricant mixture gas is taken in through the suction connector 18, and then expanded while passing through the strainer 22 to cause the flow rate of the mixture to decrease, so that the lubricant is separated from the mixture through the screen of the strainer 22 due to the difference in the specific gravity between the two components of the mixture. The thus separated refrigerant gas then flows through the gap 37 between the top wall of the oil separating chamber 23 and the plate 24, while the thus separated lubricant flows through the gap 38 between the bottom wall of the oil separating chamber 23 and the plate 24, whereas the remaining unseparated portion of the mixture is ejected through the hole 25 and inpinges on the corrugated wall 31 formed on the inner wall of the oil separating chamber 23, to cause the lubricant contained in the mixture to be separated therefrom due to its difference in specific gravity and viscosity with respect to the refrigerant, with the result that the lubricant adheres to the corrugated wall 31 of the oil separating chamber 23 and then flows down the wall. The separated refrigerant gas flows upward in the oil separating chamber 23, continuing to expand therein to slow down its flow rate, so that the separated lubricant flows downward to the partition 26. Thus the separated refrigerant flows into the suction chamber 15 of the compressor, while the separated lubricant, dropped on the partition 26, flows through the gap 28 between the partition 26 and the wall of the cylinder head 14 to the recess 27 and further through the lubricant passage 29, the tube 33, and the check valve 32 to the oil reservoir 30 when the check valve 32 opens due to a pressure drop in the oil reservoir chamber. When the pressure in the oil reservoir chamber momentarily increases due to the blow-by gas entrained therein by the abrupt change of the operation of the compressor, the check valve 32 closes to prevent the counterflow of the lubricant oil.

Reference is now made to FIG. 4, which shows different means 40 for preventing the counterflow of oil. The device 40 includes a tapered expanding passage 41 formed inside the passage 29, an expanded passage 42 connected with the tapered expanding passage 41, a ball 43 disposed within the expanded passage 42 and so constructed as to allow the counterflow of the refrigerant and to prevent the counterflow of the lubricant back to the oil separating chamber 23 due to the blow-by gas pressure in casing 11. A ball stopper 44 is disposed at the end of the oil reservoir side for preventing the ball 43 from falling in the casing 11. The diameter of the ball 43 is smaller than the diameter of the expanded passage 42, and in operation, when the pressure in the oil reservoir chamber increases as previously described, the refrigerant gas tends to flow through the device 40, the tube 33 and the passage 29, and since the viscosity of the refrigerant gas is small the ball 43 remains in the expanded portion and is not urged up to the tapered passage 42 to close the port of the tapered passage 42 so that the refrigerant gas flows through the gap between the ball and the inner wall of the expanded passage 42 to the oil separating chamber 23, and accordingly to the suction chamber 15 of the compressor. On the other hand, if the lubricant oil or the mixture approaches the device 40 as for example under the force of the blow-by gas pressure, the passage is blocked since the viscosity of the oil or mixture is large enough to close the port of the tapered passage by floating the ball 43 in the direction of potential counterflow. If the lubricant oil is again disposed at its normal level, however the weight of the ball 43 causes it to return to the expanded passage 42, thereby causing the gap to open between the ball 43 and the wall of the expanded passage 42 with the result that the refrigerant gas may pass therethrough.

What we claim and desire to secure by Letters Patent is:

1. Improved lubricant separating apparatus in a reciprocating automotive air conditioner compressor including a cylinder and a lubricant reservoir, a cylinder casing supporting said cylinder, a rear cylinder heat fixed on said cylinder casing, a valve plate intermediate the cylinder and cylinder head, and means on said cylinder head defining spaced suction and discharge chambers between said cylinder head and valve plate, a rear cover fixed on said cylinder head to form a lubricant separating chamber therebetween, said lubricant separating chamber communicating with said suction chamber through a suction port formed in said cylinder head, and a suction connector connected to the rear cover in communication with said lubricant separating chamber for passing thereinto a mixture of refrigerant and lubricant: wherein the improvement comprises, in combination, plate means mounted vertically within said lubricant separating chamber providing thereabout passages for lubricant and refrigerant for defining two substantially separate sections, one section communicating with said suction connector and the other communicating with said suction port; a strainer vertically mounted in said one section and connected to said suction connector for primarily separating a portion of lubricant from said mixture as the mixture passes through said strainer, said strainer being larger in cross sectional area than an internal passage of said suction connector, thereby permitting said mixture to expand within said strainer and said one section so that said lubricant and relatively lighter refrigerant separate from each other, said lubricant occupying the lower portion of said one section; said plate means having an opening formed in its lower portion for providing communication between said sections for accelerating mixture flow of the mixture passing through said opening from said one section to said other section; a partition disposed within said lubricant separating chamber and extending from said rear cover toward said cylinder head, said partition being spaced below the lowermost edge of said plate to provide

a gap therebetween to permit the flow of said separated lubricant from said one section to said other section; and a lubricant passageway provided in said rear cylinder head and extending in communication between said other section and said lubricant reservoir for passing the lubricant separated from said mixture in said sections into said lubricant reservoir, whereby the lubricant separated from said mixture in said separating chamber is drawn into said reservoir and the rest of said mixture is drawn into said suction chamber through said suction port.

2. Improved lubricant separating apparatus as set forth in claim 1, in which said cylinder head is provided with a corrugated surface portion within said other section, and said plate means opening is aligned with said corrugated surface to discharge said mixture from said first section at right angles against said corrugated surface.

3. Improved lubricant separating apparatus as set forth in claim 1, in which the uppermost edge of said plate means is spaced from an upper wall of said lubricant separating chamber to permit the flow of refrigerant over said uppermost plate edge from said one section to said other section.

4. Improved lubricant separating apparatus as set forth in claim 1, in which the upper surface of said partition slants downwardly toward said cylinder head.

5. Improved lubricant separating apparatus as set forth in claim 1, in which said lubricant passageway slants downwardly in said rear cylinder head.

6. Improved lubricant separating apparatus as set forth in claim 1, further comprising valve means connected to said lubricant passageway to permit the passage of lubricant into said reservoir from said other section, and to

block the flow of lubricant from said reservoir toward said other section.

7. Improved lubricant separating apparatus as set forth in claim 1, in which said lubricant passageway has an expanded portion spaced from said other section and a tapered portion at the upstream end of said expanded portion, and further comprising valve means including a ball disposed within said expanded portion for movement therein, said ball when spaced from said tapered portion and thereby permitting the flow of gaseous fluid through said passageway, and being movable into said tapered portion to block the flow of lubricant from said reservoir toward said other section.

References Cited

UNITED STATES PATENTS

1,458,702	6/1923	Hanson et al.	230—206
1,463,990	8/1923	Wilson	55—Agg
1,948,180	2/1934	MacLachlan	55—464
2,306,813	12/1942	King	230—206
2,572,952	10/1951	Rymal	230—206
2,776,542	1/1957	Cooper	62—469
2,818,210	12/1957	Philipp	230—206
3,171,589	3/1965	Cramer et al.	230—206
3,217,978	11/1965	Harlin	230—206

BERNARD NOZICK, Primary Examiner

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