The present invention relates to compression type refrigerating machines, wherein the motor compressor unit is arranged standing in an enclosure and the joint shaft drives an oil pump for lubricating the bearings and the movable parts of the compressor and for cooling the unit.

It is an object of the invention to provide a simplified and robust oil pump of relatively small output for lubrication, using a movable element arranged in a motor-driven system on a higher level than the motor, and for cooling the entire system.

It is a further object of the invention to provide an oil pump of the aforesaid type comprising means for effecting a quick raising of the oil level in the system thus preventing the movable element from running dry.

It is yet another object of the invention to provide improved lubricating and cooling means for an enclosed motor compressor unit of the type having the compressor arranged above the motor for use in refrigerating machines.

It is known to position the oil pump at the lower end of the vertical shaft just above the oil sump, and to press the oil supplied by the pump through the hollow shaft to the bearings and to the compressor arranged above the motor, and furthermore to allow the oil to be discharged and distributed at the upper end of the shaft, and thus in flowing downward to remove heat from the flooded portions. In this arrangement, the oil pump operates practically merely as a pressure pump.

In view of the outputs of such small oil pumps usually constructed as rotary piston pumps being small per se, it means a movable element arranged in the motor, that their work is divided as far as possible uniformly between suction and pressure. In motor compressors of the above mentioned known types of construction, having the compressor arranged above the motor, the oil pump therefore has been positioned between the motor and compressor and connected as a rotary piston, the piston being formed by an eccentric section cut into the joint motor and compressor crank shaft. In this arrangement, the oil is fed to the oil pump through a special suction pipe outside the bearing end plate and enters the oil pump space from the outside adjacent a slide running on the eccentric and is pressed into a pressure channel extending on the other side of the slide for further distribution. This type of connection of the suction and pressure pipes is a peculiarity of all known rotary piston pumps.

This oil suction conduit which must be passed outwardly by the stator in the space between the latter and the enclosing casing in the case of a vertical arrangement of the motor compressor shaft, shows various disadvantages. On the one hand, an increased spaced, and, on the other hand, a comparatively long pipe line is required which deteriorates the efficiency of the pump. Moreover, the additional pipe line renders assembly more difficult and often is a cause for unsatisfactory operation due to faulty connections.

The present invention solves the problem of eliminating these deficiencies of motor compressors having an oil pump in the described arrangement, by providing, as a main feature of the invention, that the vertical motor compressor shaft is provided with a bore extending from the bottom up to the level of the eccentric and thus serves as a suction line for the oil, and by the further feature that the pump space is connected to this bore in the shaft by one or more radial or approximately radial bores.

When oil is led to the pump in the manner contemplated by the invention and in contradistinction to the usual fixed arrangement of the suction line on rotary piston pumps, the oil suction bore is constantly conducted across the pressure channel connection during the rotation of the shaft and thus of the eccentric. However, when the angle position of the bores relative to the dead centers of the eccentric is such that the incoming flow of oil back into the suction line does not occur. This offset angle, however, must also be selected sufficiently large to enable sufficient oil supply since on account of the small eccentricity of such rotary pistons the entrance cross-section into the crescent-shaped pump space would be too small in case of too small an angle.

The radial oil supply from the hollow shaft serving as suction line shows, apart from the advantage of a simple construction not affected by failures and which does not require special pipe connections and therefore no additional assembly work, the further advantage of savings in material by elimination of the suction pipe line and, functionally the advantage of aiding the suction effect by the centrifugal forces exerted on the oil by the rotating shaft, whereby the oil is pressed through the radial bores into the pump space.

The use of the shaft as a suction line furthermore offers the advantages of improving the suction effect of the pump in a simple manner and of preventing the same from running dry by providing that a predetermined small oil supply remains in the shaft at standstill. This may be effected in various ways as shown by the embodiments of the invention subsequently described. The construction and arrangement of the radial bores may also be effected in several ways.

The invention will be better understood by the description of a preferred embodiment thereof and some variations of the same, following hereinafter in connection with the accompanying drawings in which:

FIGURE 1 shows schematically in a partially cross sectional view a motor compressor for refrigerating machines having a hermetically sealed enclosure and being provided with the oil pump arrangement according to the invention;

FIGURE 2 is a view in partially longitudinal section of the upper portion of the joint motor compressor shaft and oil pump arrangement according to the invention; FIGURE 3 is a cross sectional view along line III—III in FIGURE 2;

FIGURE 3a is a sectional view along line IIIa—IIIa of FIGURE 3, but the shaft removed for the sake of clarity;

FIGURE 4 shows another preferred embodiment of the oil pump arrangement according to the invention comprising a suction pipe; FIGURE 5 shows a further embodiment of the oil pump arrangement according to the invention; FIGURE 6 shows the same embodiment as in FIGURE 2, but with a different arrangement of the radial bores forming part of the oil conduit through the motor compressor shaft;

FIGURE 7 illustrates the same embodiment as in FIGURES 2 and 6, but with yet another arrangement of the radial bores;

FIGURE 8 shows the lower portion of the motor compressor shaft comprising a suction pipe in an arrangement somewhat different from that of FIGURE 4; and FIGURE 9 shows yet another arrangement of the suction pipe in the bore of the motor compressor shaft.

Referring now to the drawings more in detail, FIGURE 1 illustrates a conventional motor compressor unit for
refrigerating machines in which reference numeral 1 designates the hermetically sealed enclosure of the unit. This enclosure 1 has a portion or the oil sump 17 and, above the same, the motor 2 consisting of the rotating motor part 5 and the stator 4. The compressor 3 is supported on the bearing end plate or shield 6, which also bears, above the motor 2, the compressor 3. The latter comprises, apart from the conventional cylinder member, a movable part in the form of compressor piston 9 which is reciprocated by the crank 8, which crank is rotatably disposed on the upper end of the joint shaft 7 of the compressor motor unit 3, 2. This shaft is housed in a vertical bore in the bearing shield 6. The crank 8 may be connected with the compressor piston 9 in a conventional manner, for instance, by a Scotch yoke 10.

The joint shaft 7 comprises in and on it, the oil pump arrangement according to the invention. The oil pump in turn comprises the eccentric section 15 of the shaft 7 as acting as a rotary piston, and the slide 16 cooperating therewith. The suction pipe 11 extends from the interior of the hollow portion of shaft 7, to be described in detail in FIGURES 2 to 9, into the oil sump 17.

Referring now to FIGURES 2 and 3, these figures show the upper portion of the joint compressor motor shaft 7 with the head flange 8a bearing the crank 8. The shaft 7 is eccentrically recessed along a limited portion of its length. This eccentric section of shaft 7 is designated by 15 and forms the rotary piston of the oil pump.

The bearing end plate 6 serves as the pump housing for the oil pump arrangement, and bears in it a wall a transversely movable abutment means in the form of a slide 16 which is biased inwardly into contact with the surface of the eccentric section 15 of shaft 7 by a spring ring 16a. In doing so slide 16 protrudes into the crescent-shaped oil pump space between the inner wall 16a of the pump housing and the outer wall 15a of eccentric section 15.

According to another main feature of the invention, shaft 7 is provided with an axial bore 18 extending from the lower shaft end upwardly slightly above the level of the upper end of the eccentric 15. The wall of the bore 18 in the eccentric section 15 of the shaft is provided with three radial bores 19 lying one above the other and which connect the inside of the shaft with the crescent-shaped pump space 20, which space is divided by the contact area between the eccentric 15 and the slide 16 into a pressure and a suction space. These bores are arranged under such an angle relative to the dead center position 2 of the rotary piston, i.e., the line of contact between the outer eccentric wall 15a and pump housing wall 6a, respectively, where the slide 16 contacts the eccentric 15, so that on the one side sufficient oil supply is possible and on the other side oil does not flow back into the hollow shaft. Tests have shown that a lager angle of 60-120° is suitable, an angle of approximately 80° yielding the most favorable effect.

The bearing 6 is formed with a vertical groove 6a in the region of the place at which the slide passes through the bearing. This groove which preferably tapers downwardly as shown in FIGURE 3a, is somewhat ahead of the slide with respect to the direction of rotation of the shaft 7, and serves to lubricate the bearing as well as to supply oil to storage chamber b formed at the top. A horizontal channel c places this chamber b in communication with a passage d through the wall of the compressor cylinder 11. The piston 9 is formed with an angular groove 6 and the wall of the cylinder 11 is formed with a second passage f which is in alignment with the first-mentioned passage d. The parts a through e thus form an oil outlet means which permit the flow of oil from the pump chamber of the pump space to the compressor, the arrangement of the parts being such that any excess of oil is allowed to bleed from the cylinder 11 by way of the passage f.

If desired, a vertical bore g is provided for lubricating the crank 8.

In FIGURE 4 there is shown a preferred embodiment of means provided for the formation of a small oil supply in the shaft. Variations of these means are shown in FIGURES 5, 8 and 9. The radial bores may be selected differently also with respect to their number, arrangement and cross-section, as shown in the last mentioned figures. Thus, it is possible to arrange one or more bores 19 horizontally, other bores 19a in inclined position, and that preferably rising from the inside outwardly as shown in FIGURE 5. A plurality of bores 19a, 19b and 19c (FIGURE 6) may also be arranged offset with regard to their angular position, either in the same horizontal plane as in FIGURE 6 or in different planes, as shown by the arrangement of bores 19d, 19e, 19f and 19g in FIGURE 7. Of course, in all these embodiments, all the bores must be arranged within the range of the above mentioned laging angle.

FIGURE 4 differs from FIGURE 2 mainly by the feature, that a long tube 21 which serves as oil suction line, is inserted in bore 18 of the hollow shaft 7, which tube 21 projects from the shaft at the bottom and extends into the oil sump 17. The outlet opening 24 through which this tube 21 leaves the shaft 7, is sealed in any conventional manner, e.g., by a resilient and well sealing cap 22, which is brazed to the tube 21 and prevents the oil assembling in the space 18b between the tube 21 and the wall of the shaft bore 18 cannot escape. This space 18b forms an oil reservoir; on restarting the machine, the oil is pressed therefrom into the pump space 20 by centrifugal forces. The upper end of the tube 21 lies approximately at the level of the uppermost bore 19. The lower orifice of the oil suction pipe may also be closed in known manner by a filter 14.

FIGURE 5 shows a modification of the aforesaid oil reservoir comprising a short tube narrower than bore 18 in form of a tubular rivet 12 which is inserted in the bore 18 of the hollow shaft 7; the lower end thereof is held on a shoulder 26 in the shaft bore 18 by means of a locking disc 27 and the upper end lies approximately in the level of the radial bores. In this way, a small cup-shaped space 18b is formed in the shaft wherein a part of the oil resides when the machine is stopped. When restarting the machine, this oil rest is centrifuged through the radial bores, particularly through the inclined bores 19c, due to the centrifugal forces, into the pump space 20 and causes an improved seal between the eccentric 15 and bore 18 of the bearing member 6 as well as between the eccentric 15 and the slide 16. In this manner, the suction effect of the oil is improved and quickly initiated lubricating oil circulation is obtained on restarting after prolonged standstill.

In all embodiments above described the bore of the shaft and the inserted tube were arranged coaxially. In order to increase the pumping effect, the shaft may also be bored eccentrically and the oil suction pipe 21 may be conducted eccentrically in the shaft so that the eccentric bore 30 is contacted thereby along the line of greatest wall thickness at 30a. Such an arrangement is shown schematically in FIG. 8. This already results in a substantial increase of the oil quantity centrifuged from the oil reservoir formed in the hollow shaft.

In order to avoid eccentric bore 30 of the shaft, the oil suction pipe 21 itself may be conducted eccentrically in the eccentric bore 18 of the shaft as shown in FIGURE 9. The best efficiency is obtained in this embodiment, if the bore of the shaft is simultaneously made as large as possible taking into account the mechanical strength needed therefor. In this manner, not only a larger eccentricity of the oil suction pipe resting on one side on the wall of the eccentric, but an increased suction effect therein, but a larger oil reservoir is also caused. The larger oil supply together with the increased cen-
trifugal force obtained by the larger bore of the shaft result in a correspondingly larger output.

In the embodiment shown in FIGURE 9 the suction tube 31 is of relatively small diameter compared with that of bore 18 of shaft 7, and is introduced in this bore 18 centrally from the bottom end thereof and then bent in such a manner that it extends upwardly contacting the inner wall of bore 18 at 18c.

In both the embodiments of FIGURES 8 and 9, the bores 30 and 18 respectively, are sealed at their lower end by a sealing ring 28 pressed into the orifice of the bore, and connected thereto in the same manner as shown in FIGURE 4.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

1. An oil pump arrangement for use in compression type refrigeration machines comprising an enclosure, an oil sump in the bottom portion thereof, a motor having a rotor, bearing means in said enclosure and formed with a vertical bore, a compressor mounted at least partially inside said enclosure on said bearing means above said motor, and a shaft disposed in said vertical bore of said bearing means, said shaft carrying said rotor and being power-transmittingly connected to said compressor for actuating the latter during operation of said motor, which arrangement comprises a rotary piston being a recessed section of said shaft at a portion of its length which is above the point at which said shaft carries said rotor and below the point at which said shaft is power-transmittingly connected to said compressor, a pump space provided between said rotary piston and the wall of said bore, suction means for lifting oil from said bore and an oil passage and at least partially inserted therein so that the upper rim of said pipe is in approximately the same axial position as said radial conduit means and sealing means for sealing off tightly at the bottom end of said shaft for the interspace between the outer wall of said pipe and the wall of said axial passage so that a reservoir is formed in said shaft which reservoir constitutes said small oil supply in case of standstill of the machine.

2. An oil pump arrangement for use in compression type refrigeration machines comprising an enclosure, an oil sump in the bottom portion thereof, a motor arranged in said enclosure, said motor having a rotor, bearing means in said enclosure and formed with a vertical bore, a compressor mounted in said enclosure on said bearing means above said motor, and a shaft disposed in said vertical bore of said bearing means, said shaft carrying said rotor and being power-transmittingly connected to said compressor for actuating the latter during operation of said motor, which arrangement comprises a rotary piston in the form of a recessed section of said shaft located at a portion of its length which is above the point at which said shaft carries said rotor and below the point at which said shaft is power-transmittingly connected to said compressor, said piston and the wall of said bore to said pump space between themselves, inwardly biased transversely movable abutment means extending into said pump space and contacting said piston so as to divide said pump space into suction and pressure chambers, intake means permitting the flow of oil from said oil sump to the axial position of said piston, said intake means comprising an axial passage in said shaft which extends from the bottom end thereof to the axial position of said piston and conduit means which are substantially radial to the axis of said shaft passage and pass through the wall of said shaft so as to place said axial passage in communication with said suction chamber of said pump space, said conduit means being disposed at a lagging angle of 60° to 120° relative to the dead center of said rotary piston in said pump space, storing means comprising an oil suction pipe being said radial conduit means and inserted therein so that the upper rim of said pipe is approximately at the same axial portion as said radial conduit means, said oil suction pipe terminating adjacent the lower end of said axial shaft passage, thereby forming an interspace between the outer wall of said pipe and the wall of said axial passage so that a reservoir is formed in said shaft, which reservoir maintains an oil supply when the machine is idle, sealing means for sealing the interspace between the outer wall of said pipe in the bottom end of said axial shaft passage, and oil outlet means permitting the flow of oil from said oil passage into said pump space to said compressor, whereby oil is pumped from said oil sump to said compressor part of the way by suction and the remainder of the way by pressure.

3. An oil pump arrangement for use in compression type refrigeration machines comprising an enclosure, an oil sump in the bottom portion thereof, a motor having a rotor, bearing means in said enclosure and formed with a vertical bore, a compressor mounted in said enclosure on said bearing means above said motor, and a shaft disposed in said vertical bore of said bearing means, said shaft carrying said rotor and being power-transmittingly connected to said compressor for actuating the latter during operation of said motor, which arrangement comprises a rotary piston being a recessed section of said shaft at a portion of its length which is above the point at which said shaft carries said rotor and below the point at which said shaft is power-transmittingly connected to said compressor, a pump space provided between said rotary piston and the wall of said bore, suction means for lifting oil from said oil sump to the axial position of said rotary piston comprising an axial passage extending in said shaft coaxially with the central axis of the latter from the bottom end of the latter to the axial position of said rotary piston, conduit means substantially radial to the central axis of said shaft passage through the wall of said shaft, said conduit means connecting said axial passage of said pump space and being disposed as a lagging angle of 60° to 120° relative to the dead center position of said radial position of said rotary piston in said pump space, said conduit means comprising a plurality of radial bores which are arranged vertically one above the other, storing means comprising an oil suction pipe being narrower than said axial shaft passage and inserted in the latter coaxially, with so that the upper rim of said pipe is approximately at the same axial position as said radial conduit means, said oil suction pipe projecting from the lower end of said axial shaft passage and extending with its lower orifice into said oil sump, and sealing means for sealing the interspace between the outer wall of said pipe in the bottom end of said axial shaft passage, said means comprising a resilient sealing cap tightly surrounding said suction pipe and enclosing the end of said shaft.

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