Jan. 2, 1962 J. M. WELLBORN ETAL 3,015,222

REFRIGERANT COMPRESSOR

Filed April 6, 1959

5 Sheets-Sheet 1

Fig. 10.

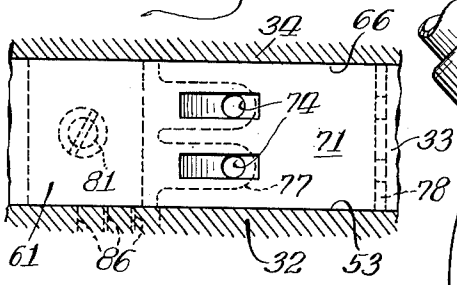


Fig. 9.

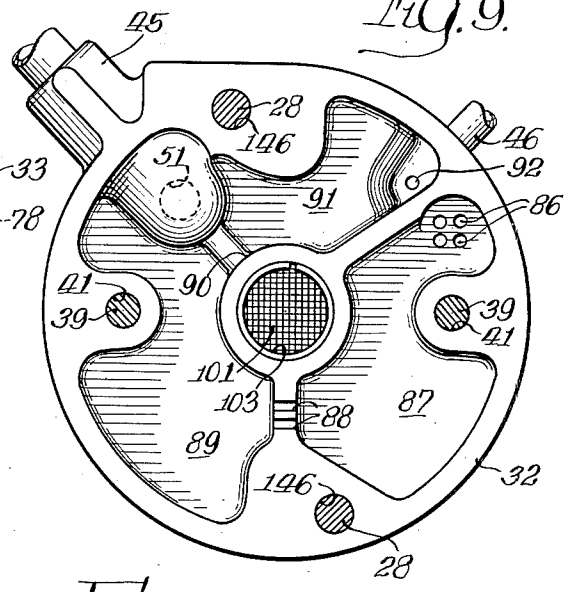
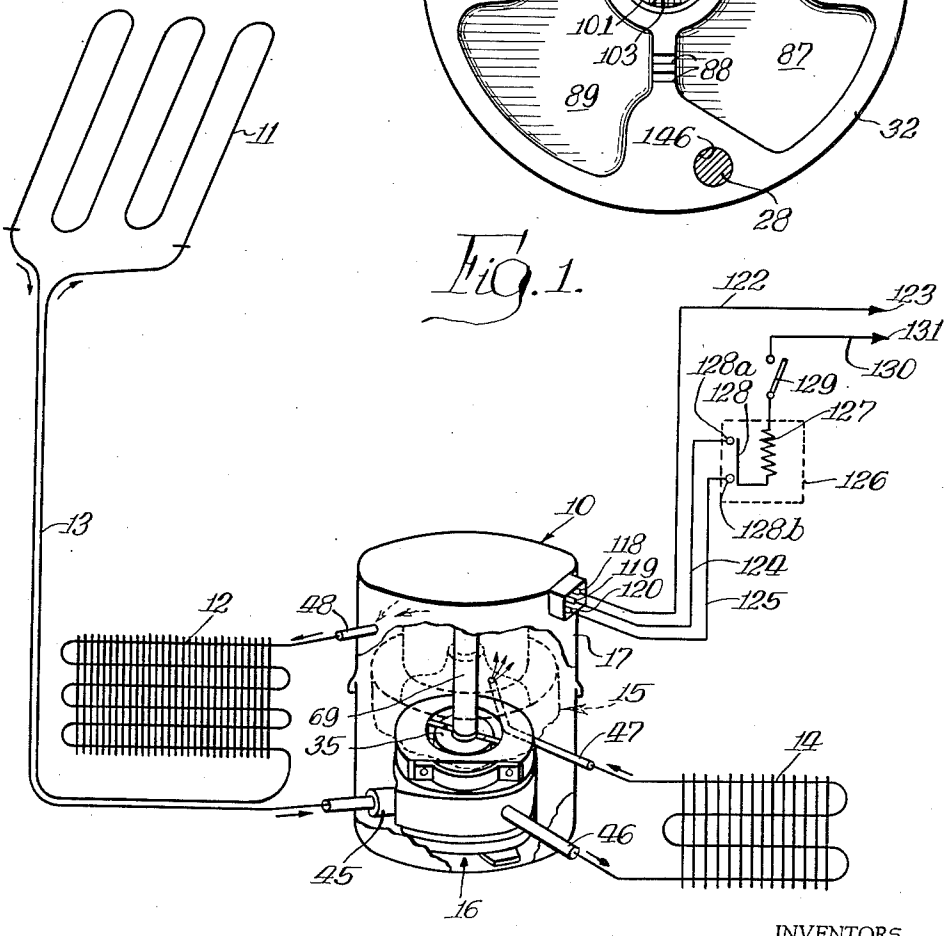


Fig. 1.



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REFRIGERANT COMPRESSOR

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Fig. 2.

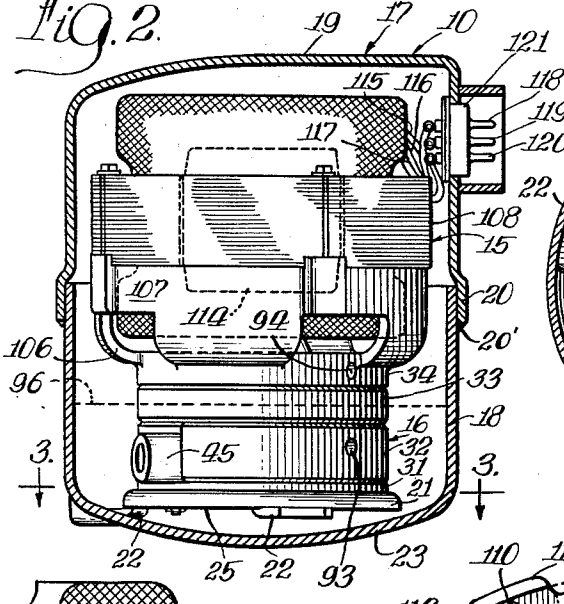


Fig. 3.

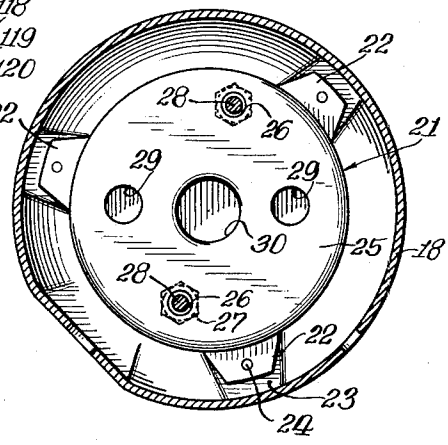


Fig. 4.

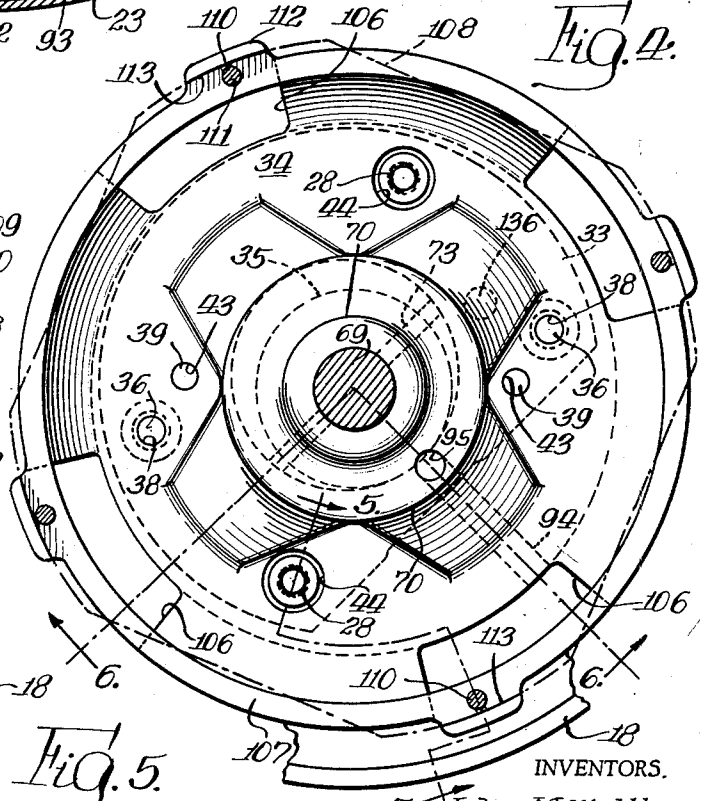
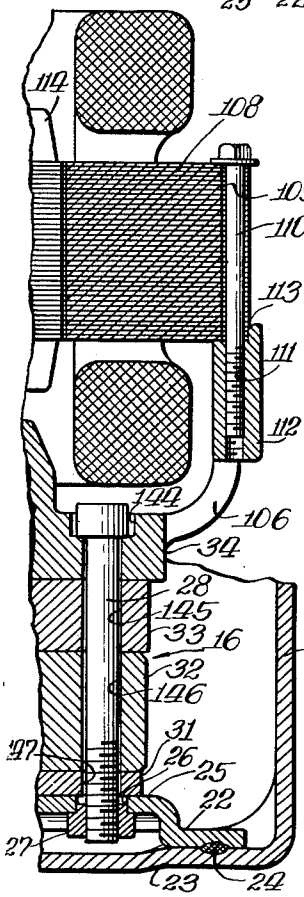


Fig. 5.



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REFRIGERANT COMPRESSOR

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Fig. 6.

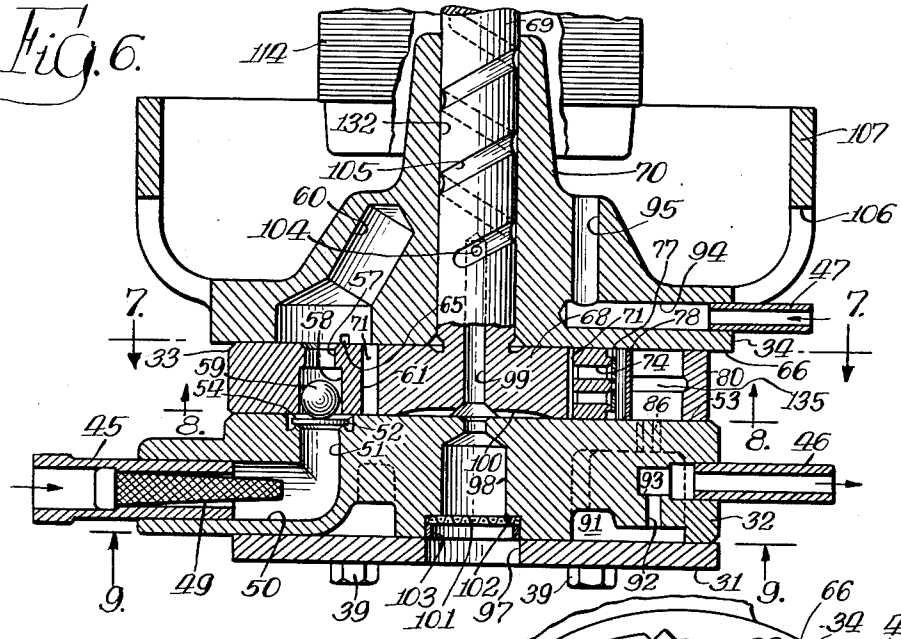
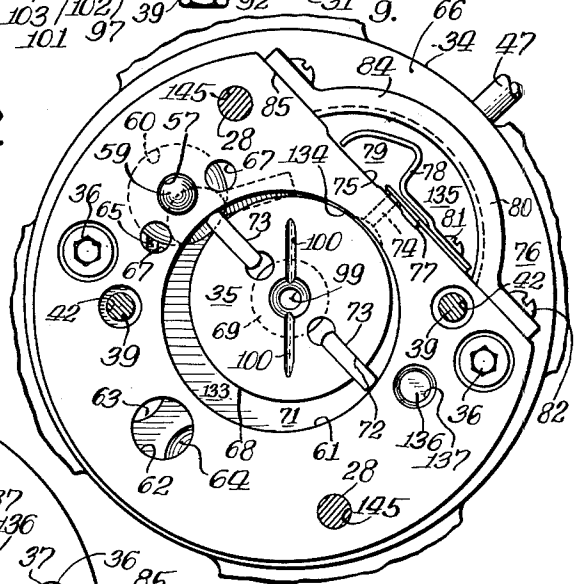


Fig. 8.



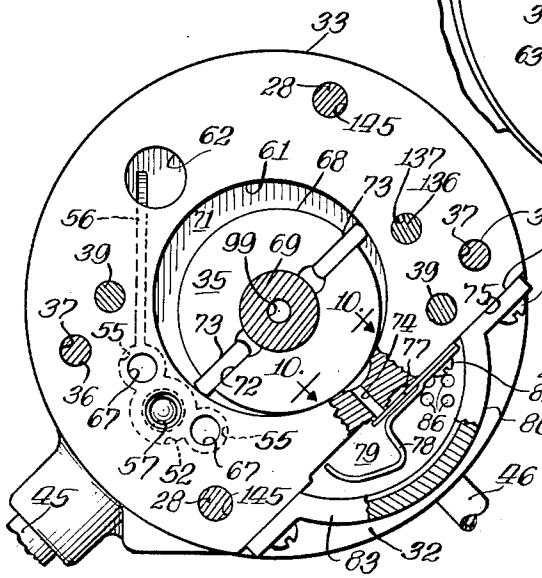


Fig. 7.

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REFRIGERANT COMPRESSOR

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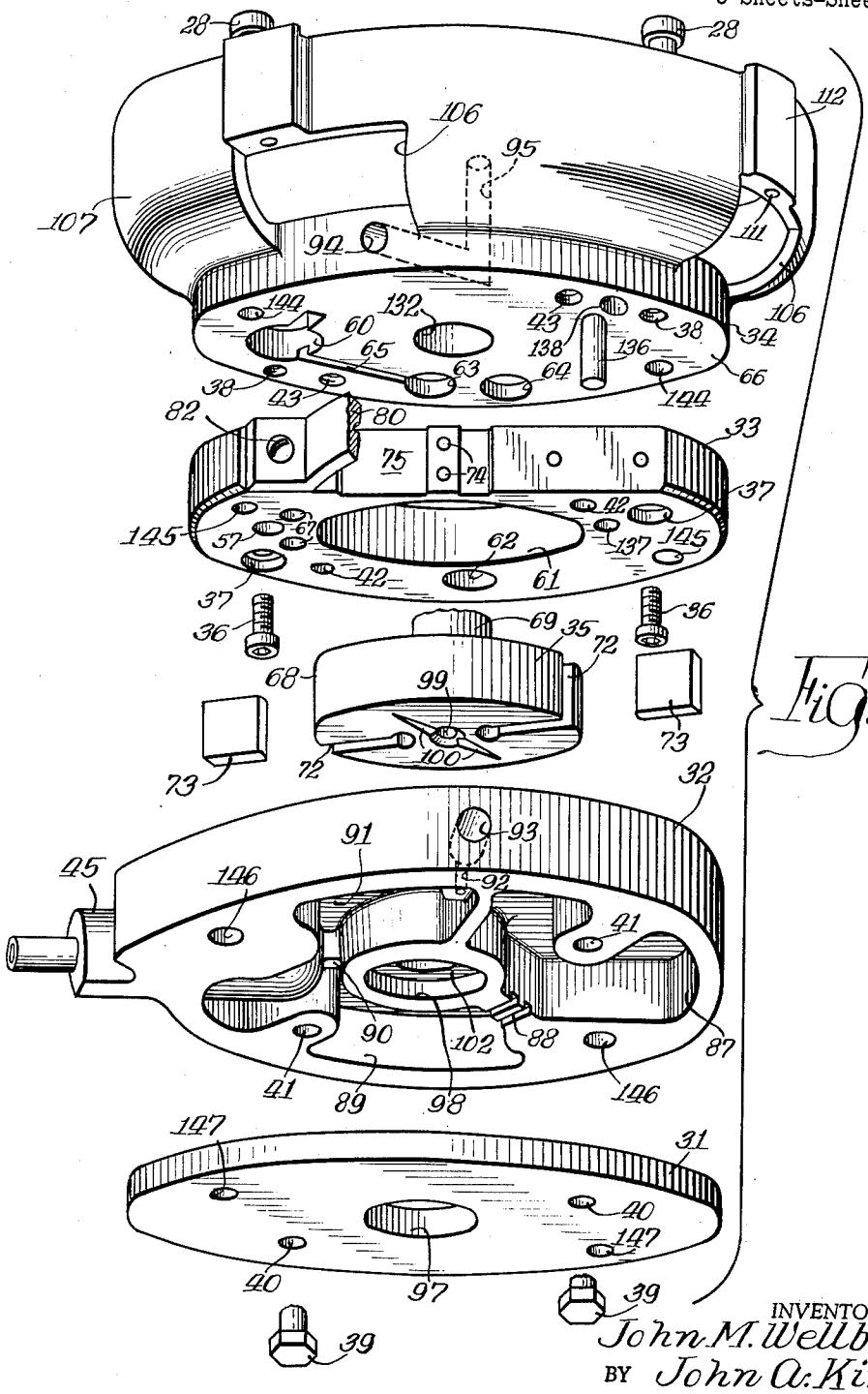


Fig. 11.

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REFRIGERANT COMPRESSOR

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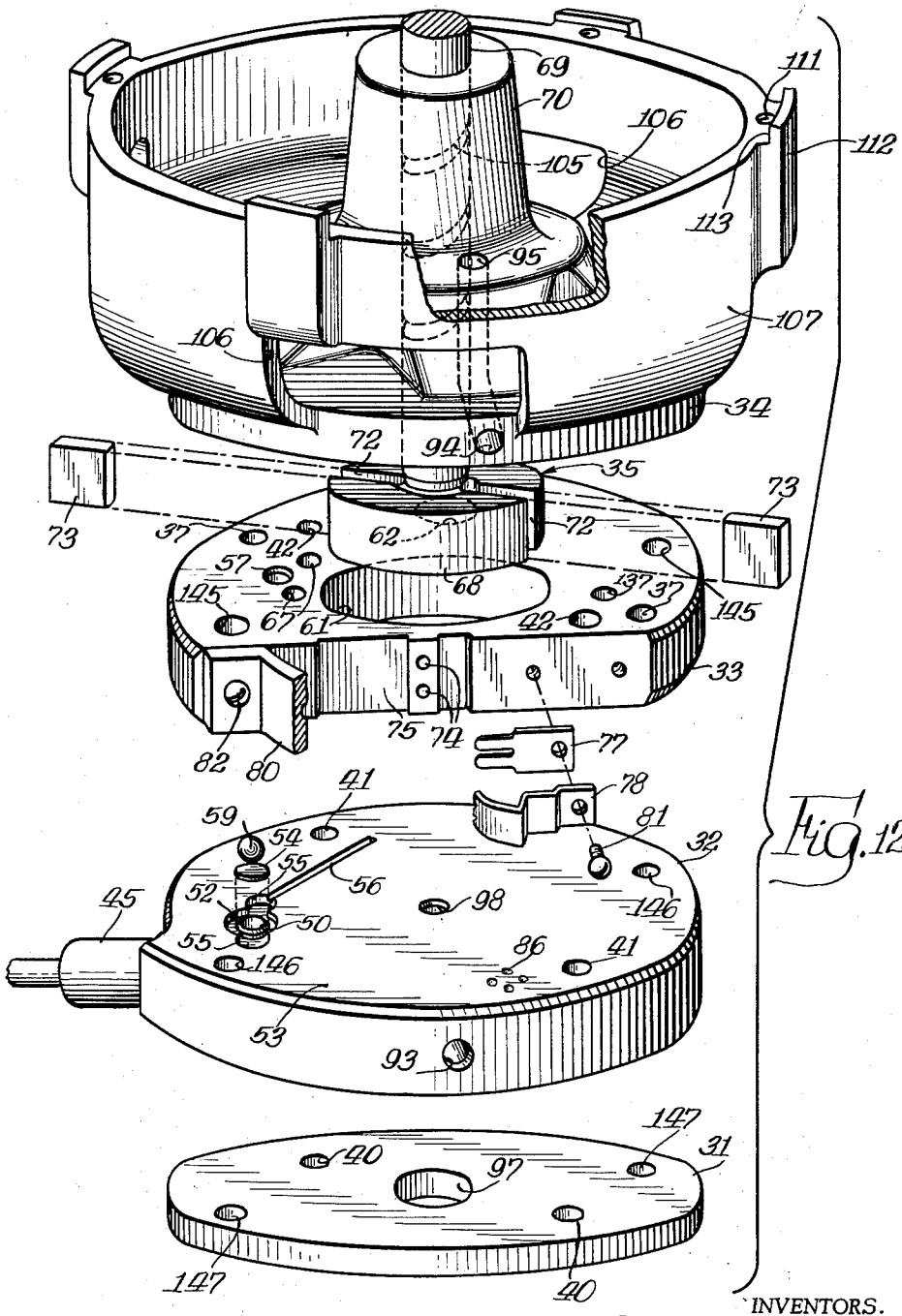


Fig. 12.

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3,015,222

REFRIGERANT COMPRESSOR

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Filed Apr. 6, 1959, Ser. No. 804,174
2 Claims. (Cl. 230—139)

This invention relates to compressors and in particular to compressors as may be used in refrigeration systems.

In one form of conventional refrigeration system, a motor operated compressor receives gaseous refrigerant under a low pressure from the cooling evaporator, compresses the gaseous refrigerant, and delivers it to a condenser wherein it is cooled to the liquid state, in which liquid state the refrigerant is delivered to the evaporator wherein it evaporates to effect the desired cooling operation of the refrigeration system. To permit the compressed refrigerant to effect a desirable cooling of the motor-compressor prior to its delivery to the condenser, a precooler may be provided through which the compressed refrigerant may be passed from the motor-compressor and redelivered thereto prior to its delivery to the condenser.

The principal feature of this invention is the provision of a new and improved compressor for use in a refrigeration system.

Another feature of the invention is the provision of such a compressor having an operably associated motor and new and improved means for supporting and enclosing the motor-compressor combination.

A further feature of the invention is the provision of such a motor-compressor having new and improved means for cooling bearing means thereof.

Still another feature of the invention is the provision of such a motor-compressor having new and improved means for muffling pulsations of the refrigerant flow.

A still further feature of the invention is the provision of such a motor-compressor having new and improved means for removing heat therefrom during a compressing operation.

A yet further feature is the provision of such a motor-compressor wherein a portion of the lubricating oil is arranged to effect such heat removal.

Other features and advantages of the invention will be apparent from the following description, taken in connection with the accompanying drawings wherein:

FIGURE 1 is a diagrammatic view of a refrigeration system having a motor-compressor embodying the invention.

FIGURE 2 is a vertical elevation of the motor-compressor, the housing thereof being shown in diametric section.

FIGURE 3 is a transverse section thereof taken substantially along the line 3—3 of FIGURE 2.

FIGURE 4 is an enlarged plan view of the compressor portion thereof, the superposed motor portion thereof being outlined in broken lines.

FIGURE 5 is an enlarged, fragmentary vertical section of the motor-compressor taken substantially along line 5—5 of FIGURE 4.

FIGURE 6 is a vertical section of the compressor portion thereof taken substantially along line 6—6 of FIGURE 4.

FIGURE 7 is a transverse section taken substantially along the line 7—7 of FIGURE 6.

FIGURE 8 is a transverse section taken substantially along the line 8—8 of FIGURE 6.

FIGURE 9 is a transverse section taken substantially along the line 9—9 of FIGURE 6.

FIGURE 10 is a fragmentary, enlarged vertical section taken substantially along the line 10—10 of FIGURE 7.

FIGURE 11 is an exploded, upwardly looking isometric view of the compressor portion.

FIGURE 12 is an exploded, downwardly looking isometric view of the compressor portion.

In the exemplary embodiment of the invention, as disclosed in the drawings, a motor-compressor generally designated 10 receives hot, low pressure refrigerant from an evaporator 11, compresses the refrigerant and delivers it to a condenser 12 wherein the refrigerant is cooled and liquified. From the condenser 12, the liquid refrigerant passes through a capillary tube 13 wherein the pressure of the liquid is reduced to lower the temperature thereof. The cold liquid refrigerant is then delivered to the evaporator wherein it vaporizes to effect the desired refrigerating functioning of the sytsem.

To improve the efficiency of the motor-compressor 10, a precooler 14 is associated therewith to pre-cool the compressed refrigerant prior to its delivery to condenser 12. As will be brought out in greater detail subsequently, the motor-compressor is arranged to utilize the pre-cooled refrigerant, prior to its delivery to condenser 12, to cool the motor-compressor.

Referring now more specifically to FIGURES 1, 2 and 5, motor-compressor 10 comprises a motor portion generally designated 15, a compressor portion generally designated 16, and a housing generally designated 17. Housing 17 comprises an upwardly opening, cup-shaped lower member 18 and a corresponding downwardly opening, cup-shaped upper member 19, each of which may be formed as by stamping. The lower edge 20 of upper housing member 19 is radially enlarged to have an inside diameter slightly greater than the outside diameter of the lower housing member 18 and permit a telescopic mounting of edge 20 over the upper end of lower housing member 18. The housing is hermetically sealed by seam welding, at 20', lower edge 20 to lower housing member 18 subsequent to the proper mounting of motor 15 and compressor 16 therein.

Motor 15 and compressor 16 are solely supported within housing 17 on a mounting plate 21. The mounting plate is provided with three depending and laterally extending legs 22 which are secured to the bottom 23 of the lower housing member 18 by projection welds 24 to space a circular mid-portion 25 of the mounting plate above the inner surface of bottom 23. As best seen in FIGURES 3 and 5, mid-portion 25 of the mounting plate is provided with a pair of diametrically related holes 26. A nut 27 is secured to the underside of mid-portion 25 in coaxial alignment with each hole 26 for cooperation with an elongated bolt 28 for securing the compressor 16 to the mounting plate. The mid-portion 25 of the mounting plate is further provided with a second pair of diametrically opposed holes 29 diametrically related substantially at right angles to the holes 26, and a central, downwardly extruded hole 30 which provides rigidity to the center of mid-portion 25 and permits circulation of lubricating oil downwardly through the mounting plate.

As best seen in FIGURES 2, 5, 6, 11 and 12, compressor 16 includes four generally cylindrical members, including a coverplate 31, a rear head 32, a cylinder 33, and a front head 34. Within cylinder 33 is a rotary pump 35 which effects desired compression of the refrigerant gas.

The coverplate 31, rear head 32, cylinder 33, and front head 34 are retained in stacked association by three sets of threaded members. More specifically, a pair of short screws 36 extends through counterbored holes 37 in cylinder 33 and are threaded into aligned threaded holes 38 in front head 34 to secure cylinder 33 in underlying juxtaposed relationship with front head 34. Coverplate 31 and rear head 32 are secured to the assembled cylinder 33 and front head 34 by means of long screws 39

which extend upwardly through aligned holes 40 in coverplate 31, holes 41 in rear head 32, holes 42 in cylinder 33, and threaded holes 43 in front head 34. The heads of screws 39 are freely received in holes 29 of the mounting plate 21 to permit coverplate 31 to be facially juxtaposed to the upper surface of the mounting plate. The assembled coverplate, rear head, cylinder and front head are secured to the mounting plate 21 by the bolts 28 which extend downwardly through aligned counterbored holes 144 in front head 34, holes 145 in cylinder 33, holes 146 in rear head 32, holes 147 in coverplate 31, and holes 26 in mounting plate 21, to have threaded engagement with the nuts 27 secured to the underside of the mounting plate. Thus, cylinder 33 and front head 34 may be subassembled by means of screws 36, the subassembly of cylinder 33 and front head 34 may be subassembled with rear head 32 and coverplate 31 by means of screws 39, and the assembly of coverplate 31, rear head 32, cylinder 33 and front head 34 may be secured to the mounting plate 21 by means of bolts 28. Proper alignment between cylinder 33 and front head 34 is provided by means of an alignment pin 136 mounted in hole 137 in cylinder 33 and hole 138 in front head 34.

Low pressure refrigerant gas enters compressor 16 through a suction inlet 45, is compressed in the compressor, passes therefrom through a first outlet 46 to the pre-cooler 14 where it is cooled and partially condensed, and returns to the compressor from pre-cooler 14 through a second inlet 47. The compressed, pre-cooled refrigerant passes from the motor-compressor through an outlet 48 to the condenser 12. Each of the inlets and outlets 45 through 48 is sealed to the housing 17 where it passes therethrough to maintain the hermetically sealed enclosure of the motor-compressor.

As best seen in FIGURE 6, the refrigerant gas passes from inlet 45 through an elongated filter screen 49 into a passage 50 within rear head 32. The inner end 51 of passage 50 extends upwardly to open through a recess 52 in the upper surface 53 of the rear head 32. A check valve 54 is seated in recess 52 to preclude reverse flow of refrigerant gas through passage 50. A pair of diametrically opposed shallow circular recesses 55 overlap recess 52 and an elongated shallow slot 56 extends laterally across surface 53 from one of the recesses 55. As best seen in FIGURE 6, cylinder 33 is provided with a hole 57 aligned with passage end 51 and having a radially enlarged lower portion 58 in which is received a check valve ball 59 riding on top of the check valve 54 and free to move a limited distance vertically within hole 57. In front head 34, directly above hole 57, is a chamber 60 which radially inwardly overlaps a central cylindrical chamber 61 of cylinder 33 in which the rotary pump is disposed.

Thus, the low pressure refrigerant gas may flow from inlet 45 through passage 50 past check valve 54, through hole 57, and through chamber 60 into the pumping chamber 61. To preclude surging of the gas as it is delivered to chamber 61, a number of chambers is associated with these delivery passages to chamber 61. More specifically, the surge precluding chambers include the recesses 52 and 55 which are associated with passage end 51 and slot 56 which extends from one of the passages 55. The distal end of slot 56 underlies a hole 62 in cylinder 33 which communicates with a pair of downwardly opening chambers 63 and 64 in upper head 34. Chamber 63 communicates with chamber 60 through a downwardly opening shallow slot 65 in the lower surface 66 of upper head 34. Also communicating between recesses 55 and chamber 60 is a pair of holes 67 extending through cylinder 33 adjacent hole 57. Thus, these various chambers provide an important unloading function in the starting of the compressor. During the first few rotations of the pump 35 the valve 54 is held closed by the balance-out pressure established within the chambers during the preceding off cycle. This provides a substantially higher back pressure which allows for easier starting because of the reduced load on the motor. After the first few rotations, the higher pressure gas has been swept out of the chambers and valve 54 opens.

As best seen in FIGURES 1, 6, 7, 8 and 12, pump 35 comprises a rotor 68 carried on the inner end of a shaft 69 which is journalled in a bore 132 in a hub portion 70 of front head 34. Pump chamber 61 is eccentrically related to the axis of shaft 69 so that the annular space 71 between the rotor and the wall of chamber 61 varies substantially in width, as best seen in FIGURE 6. Rotor 68 is provided with a pair of diametrically opposed radially outwardly opening slots 72 in which a pair of blades 73 is slidably received. As the rotor 68 turns, blades 73 are urged outwardly by the centrifugal force and by oil and gas pressure into contact with the wall of chamber 61. Due to the eccentric relationship of the rotor and chamber wall, the refrigerant gas which enters annular space 71 in a large width portion 133 thereof communicating with chamber 60 is compressed between the blades 73 as the rotor rotates to dispose this gas in an opposite narrow width portion 134 of the annular space (approximately 180°).

The compressed refrigerant gas leaves space portion 134 of pump chamber 61 through a pair of small, radially extending holes 74 opening outwardly through a chordal surface 75 of cylinder 33. In the segmentally cylindrical space 76, extending outwardly from surface 75, is provided a discharge valve 77 controlling the holes 74, a muffler 78 which defines with surface 75 a muffler chamber 79 outwardly of valve 77, and an arcuate enclosure member 80.

Discharge valve 77 comprises a bifurcated stamping releasably covering the outer ends of holes 74 to preclude gas flow from chamber 79 backwardly through holes 74. Muffler 78 comprises a sheet metal stamping and is secured to cylinder 33 by suitable means such as a screw 81 which also extends through discharge valve 77 to secure the discharge valve to the cylinder. Enclosure member 80 preferably comprises a casting secured to the cylinder 33 by a suitable means such as screws 82 and has its upper surface 83, lower surface 84 and end surfaces 85 machined to have substantial sealing engagement with front head surface 66, rear head surface 53 and cylinder chordal surface 75, respectively, to define an enclosed space 135.

The high pressure gas discharged from holes 74 passes through chamber 79 and enclosed space 135 wherein it is muffled, and from space 135 through four small holes 86 into a downward opening chamber 87 in rear head 32. From chamber 87 the compressed gas flows through a pair of shallow slots 88 to a second downwardly opening chamber 89 in the rear head. From chamber 89, the gas flows through a restricted passage 90 to a third downwardly opening chamber 91 and then outwardly from rear head 32 through an L-shaped passage including a small vertical hole 92 and a larger horizontally extending hole 93 from which the pre-cooler outlet 46 extends.

The purpose of the successive holes, chambers and slots between the pump chamber 61 and the pre-cooler outlet 46 is to smooth out the pulsations in the compressed refrigerant gas. A first smoothing effect is obtained in the chamber 79 defined by the muffler 78. A further smoothing effect is obtained in the four holes 86 which preferably have a cumulative area of approximately 75% of the cumulative area of the two discharge holes 74. In addition, the provision of a plurality of holes 74 and 86 permits each hole to have a relatively small diameter and long peripheral length thereby further smoothing the gas pulsations. Further smoothing of the gas flow is effected by permitting it to expand from the four small holes 86 into the relatively large chamber 87. A restriction of the gas flow passage is then effected by the slots 88 which are sumulatively preferably approximately 80% of the cumulative area of holes 86. The flow of refrigerant gas from

chamber 89 to chamber 91 is substantially unrestricted by the relatively large passage 90 but flow is again restricted by the relatively small cross section holes 92 and 93. Chamber 91 is formed very shallow at the point where hole 92 connects to provide an oil scavanging action. Thus, oil is always swept through and out of the chambers 87, 89 and 91, and an oil level is not accumulated any deeper than the depth of chamber 91.

As discussed briefly above, the pre-cooled refrigerant gas re-enters motor-compressor 10 through inlet 47. As best seen in FIGURES 6 and 12, inlet 47 is connected to front head 34 in communication with a passage 94 which opens at its inner end 95 upwardly through hub portion 70 of the front head. In discharging from the passage portion, 95, the pre-cooled refrigerant gas cools the hub 70 which serves as the bearing for shaft 69 and also cools the motor portion 15 of the motor-compressor in passing from passage portion 95 to outlet 48 in the upper end of the housing 17. This cooling of the bearing and motor substantially increases the efficiency of the motor-compressor permitting it to be small in size while yet assuring extended trouble-free operation.

The instant invention further comprehends a novel utilization of the lubricating oil of the motor-compressor to effect a further cooling thereof. As seen in FIGURE 2, lower housing member 18 is filled with a body of suitable lubricating oil 96 to a level at approximately the vertical mid-portion of cylinder 33. As the high pressure refrigerant fluid is discharged into housing 17 from passage portion 95, the interior of the housing is under a substantial pressure. This substantial pressure forces the oil upwardly through hole 31 in the mid-portion 25 of the mounting plate 21, through a superposed aligned hole 97 in coverplate 31, and through a stepped bore 98 in rear head 32 to chamber 61 of cylinder 33 wherein both low pressure and high pressure conditions prevail. Rotor 68 is provided with a downwardly opening recess 99 overlying and communicating with bore 98, and a pair of diametrically opposed, downwardly opening radial grooves 100 extending from recess 99 partially outwardly to the outer periphery of rotor 68. A filter screen 101, held against a shoulder 102 of bore 98 by a split ring 103, filters the lubricating oil passing upwardly through bore 98 to recess 99 and grooves 100. As rotor 68 rotate at a substantial speed, the lubricating oil is thrown out through grooves 100 under rotor 68 and into annular space 71 where it is entrained with the refrigerant gas and passes therewith from chamber 61 through holes 74. The oil so carried with the refrigerant gas removes a substantial amount of heat from the motor-compressor to the pre-cooler 14. The entrained oil is cooled along with the compressed refrigerant gas in pre-cooler 14 and is returned to the motor-compressor through passage 94 to provide improved cooling of the motor-compressor. It has been found that such use of the lubricating oil to augment the pre-cooled refrigerant cooling of the motor-compressor substantially increases the total cooling effect obtainable, and thus substantially increases the efficiency of operation of the motor-compressor.

Shaft 69 is further lubricated by lubricating oil passing upwardly through recess 99 and outwardly through a radial hole 104 at the upper end thereof into a spiral groove 105 in the periphery of the shaft 69 which extends upwardly of hub 70 of the front head 34. Thus, the lubricating oil is urged upwardly through groove 105 by the centrifugal force thereof, spills onto the top of hub 70, and flows downwardly therefrom through a plurality of large openings 106 in the bottom of an annular upwardly extending flange 107 of front head 34.

As discussed briefly above, motor 15 is carried by compressor 16 so that substantially the sole support of the motor-compressor combination is by means of mounting plate 21. As best seen in FIGURES 1, 2, 4 and 5, motor 15 includes a stator 108 having four spaced holes 109 adjacent the periphery thereof through which are passed bolts 110 threadedly engaging corresponding threaded bores 111 in four enlargements 112 of front head flange 107. Each of enlargements 112 is rabbeted at its upper end 113 to center accurately the stator 108 relative to the axis of the compressor 16. The armature 114 of motor 15 is press fitted to the upper end of shaft 69. To assure a proper air gap between the armature and stator, holes 109 are preferably slightly larger in diameter than screws 110 so that some slight adjustment of the positioning of the stator relative to the armature may be made during the assembly of the motor-compressor. Further, to assure correct electrical positioning of the stator relative to the compressor assembly, a suitable electro-sensing element (not shown) may be attached to shaft 69 prior to the mounting of the armature thereon, and the compressor assembly rotated to determine the correct electrical position of the stator. After this position has been determined, the armature 114 may be press fitted onto shaft 69 accurately in the position determined.

Motor 15 may be a split phase induction type motor using a three-wire connection for operation. The three motor leads 115, 116 and 117 are connected respectively to terminals 118, 119 and 120 of a glass fused terminal block 121 which extends through and is hermetically sealed to housing upper member 19. As illustrated schematically in FIGURE 1, terminal 118 may be connected through a lead 122 to one side 123 of a suitable alternating current power supply. Terminals 119 and 120 may be connected through leads 124 and 125 respectively to a starting relay 126 having a thermoelectric heating element 127 controlling a switch 128. Thus, leads 124 and 125 are each energized when the compressor motor is caused to start. When the motor reaches optimum operating speed, the heating element 127 causes switch 128 to break from contact 128*a*, which de-energizes the start winding connected from lead 124. However, the run winding remains energized through lead 125 and contact 128*b*. A single pole, single throw switch 129 is in series with thermoelectric element 127 to control the connection of starting relay 126 through a lead 130 to the other side 131 of the power supply. Switch 129 may be of the manually operable or thermostatically controlled type as desired.

Summary of Operation

Motor-compressor 10 comprises a rugged, hermetically sealed unit providing improved, trouble-free operation in a conventional household refrigerator. The motor-compressor receives low pressure, gaseous refrigerant from the evaporator 11 of the refrigerator, compresses the gaseous refrigerant in the pump chamber 61 by means of the eccentric rotary pump 35, and passes the compressed, high pressure refrigerant together with entrained lubricating oil through an improved muffling structure to a pre-cooler 14 exteriorly of the motor-compressor. The pre-cooled, high pressure refrigerant gas, with the entrained lubricating oil, is then returned to the motor-compressor to discharge within housing 17 of the motor-compressor against the hub 70 comprising the means for journalling the rotor shaft 69. This provides an improved cooling of the compressor substantially increasing the efficiency of operation thereof. The pre-cooled, high pressure refrigerant gas then flows around the motor 15 absorbing heat and exits from housing 17 through an outlet 48 in the upper portion thereof for delivery to a suitable condenser 12 wherein the refrigerant is liquefied and delivered to the evaporator in the conventional manner.

Motor 15 is carried by compressor 16 and compressor 16 is carried in housing 17 solely by means of the mounting plate 21. Thus, assembly of the motor in the motor-compressor 10 is facilitated and a stable air gap between the armature 114 and stator 108 thereof is maintained even when the motor-compressor receives such rough treatment as being dropped. By so mounting the motor on the compressor, the stator is precluded from

driving the housing. Further, the rigid mounting of the compressor solely on the mounting plate 21 substantially precludes transmission of vibrations to without the motor-compressor 10.

The improved motor-compressor design further provides for flexibility of capacity. Thus a substantial range of capacity, such as from one-ninth horsepower up to one-quarter horsepower, may be obtained merely by suitable change of the diameter of the pump chamber 61 and the corresponding motor capacity.

While we have shown and described one embodiment of the invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as defined in the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a compressor apparatus, structure comprising: a housing having a first inlet for passing inwardly evaporated refrigerant, a first outlet for delivering outwardly compressed refrigerant for precooling thereof, a second inlet for passing inwardly precooled refrigerant, and a second outlet for passing outwardly the precooled refrigerant; a motor-compressor in said housing and having a bearing; means for conducting evaporated refrigerant to said motor-compressor for compression thereof; means for conducting the compressed refrigerant from the motor-compressor to said first outlet; and means for conducting the precooled refrigerant firstly directly against said bearing to cool the same and then around said motor-compressor to said second outlet.

2. In a compressor apparatus, structure comprising: a housing having a first inlet for passing inwardly evaporated refrigerant, a first outlet for delivering outwardly compressed refrigerant for precooling thereof, a second inlet for passing inwardly precooled refrigerant, and a second outlet for passing outwardly the precooled refrigerant; a motor-compressor in said housing and having a bearing with a bore therethrough; means for conducting evaporated refrigerant to said motor-compressor for compression thereof; means for conducting the compressed refrigerant from the motor-compressor to said first outlet; and means for conducting the precooled refrigerant from said second inlet firstly through said bore to contact directly the bearing portion defining said bore to cool the bearing and then around said motor-compressor to said second outlet.

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