United States Patent

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[54] HERMETIC COMPRESSOR OIL COOLING SYSTEM

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[52] **U.S. Cl.** **417/372,** 417/415, 417/902, 310/54

[51] **Int. Cl.** **F04b 17/00,** F04b 35/00, F04b 39/02, H02k 9/00, H02k 9/20

[58] **Field of Search** 417/415, 410, 372, 902; 310/54

[56] **References Cited**

UNITED STATES PATENTS

2,435,108	1/1948	Touborg	417/372 X
3,075,106	1/1963	Chi	310/54 X

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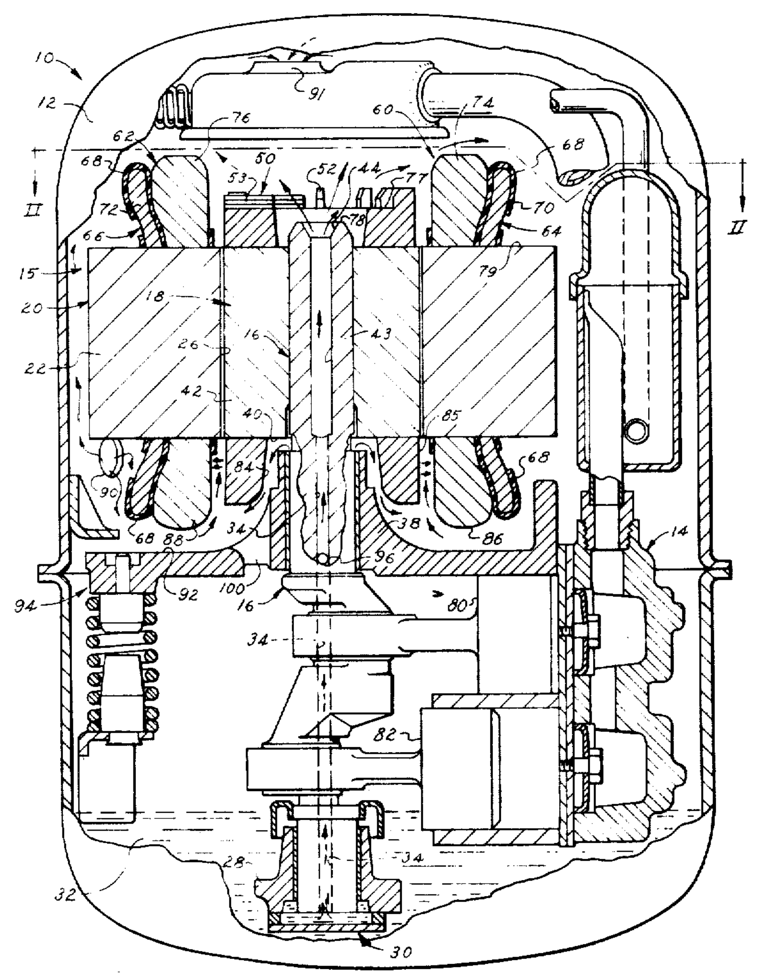
[57] **ABSTRACT**

A hermetic motor-compressor unit of the vertical shaft type having an electric motor mounted above and driving the gas pump of the unit. The motor has its main stator winding wound radially inwardly of the auxiliary or start winding so that the end turns of the main winding are directly in the path of the lubricating oil which is flung from the outlet or outlets of a crankshaft oil passage fed from an oil pump in the sump of the compressor. The relatively cool oil thus directly impinges against and drains downwardly along the main winding to thereby effect more efficient cooling of the motor.

7 Claims, 3 Drawing Figures



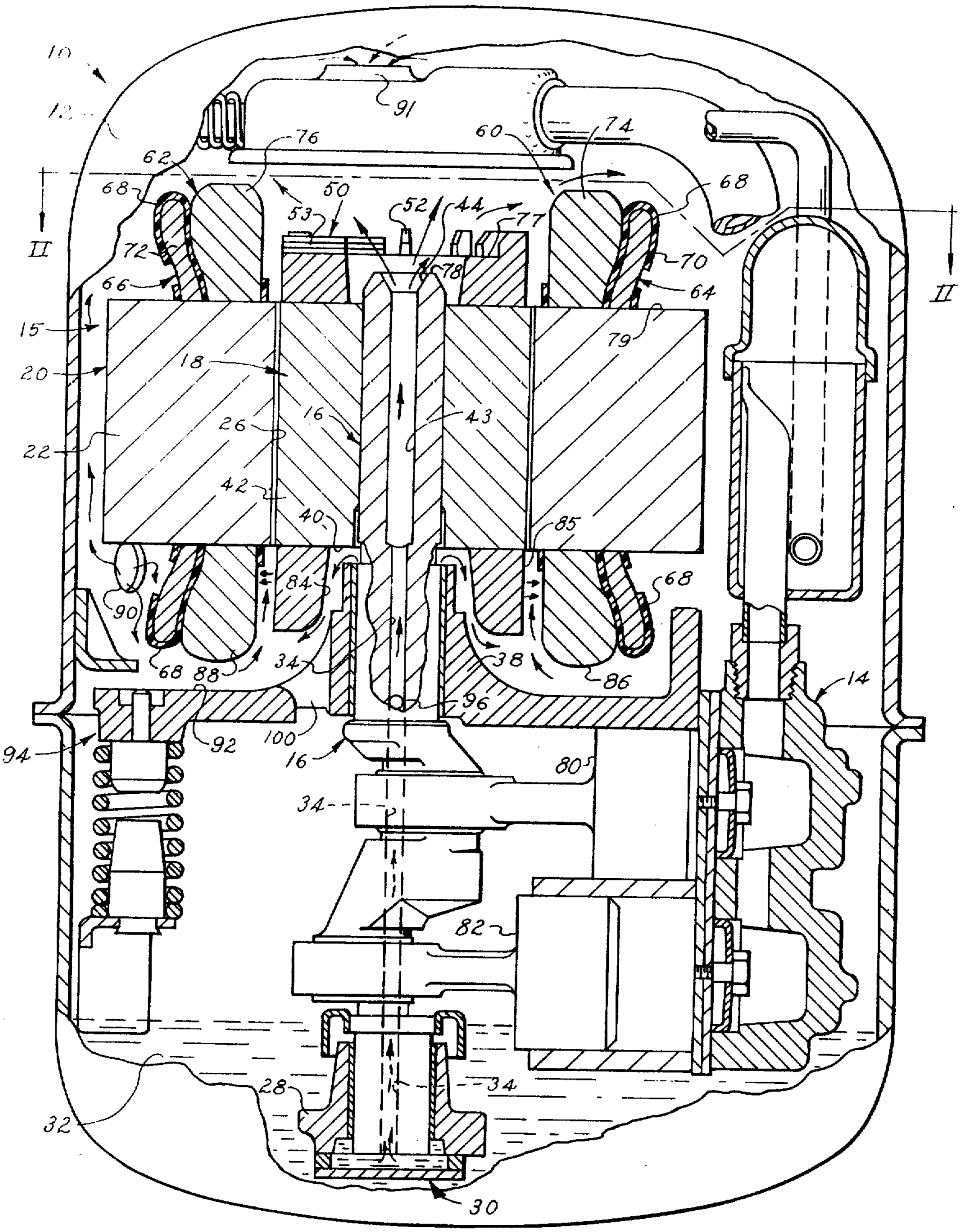


FIG. 1

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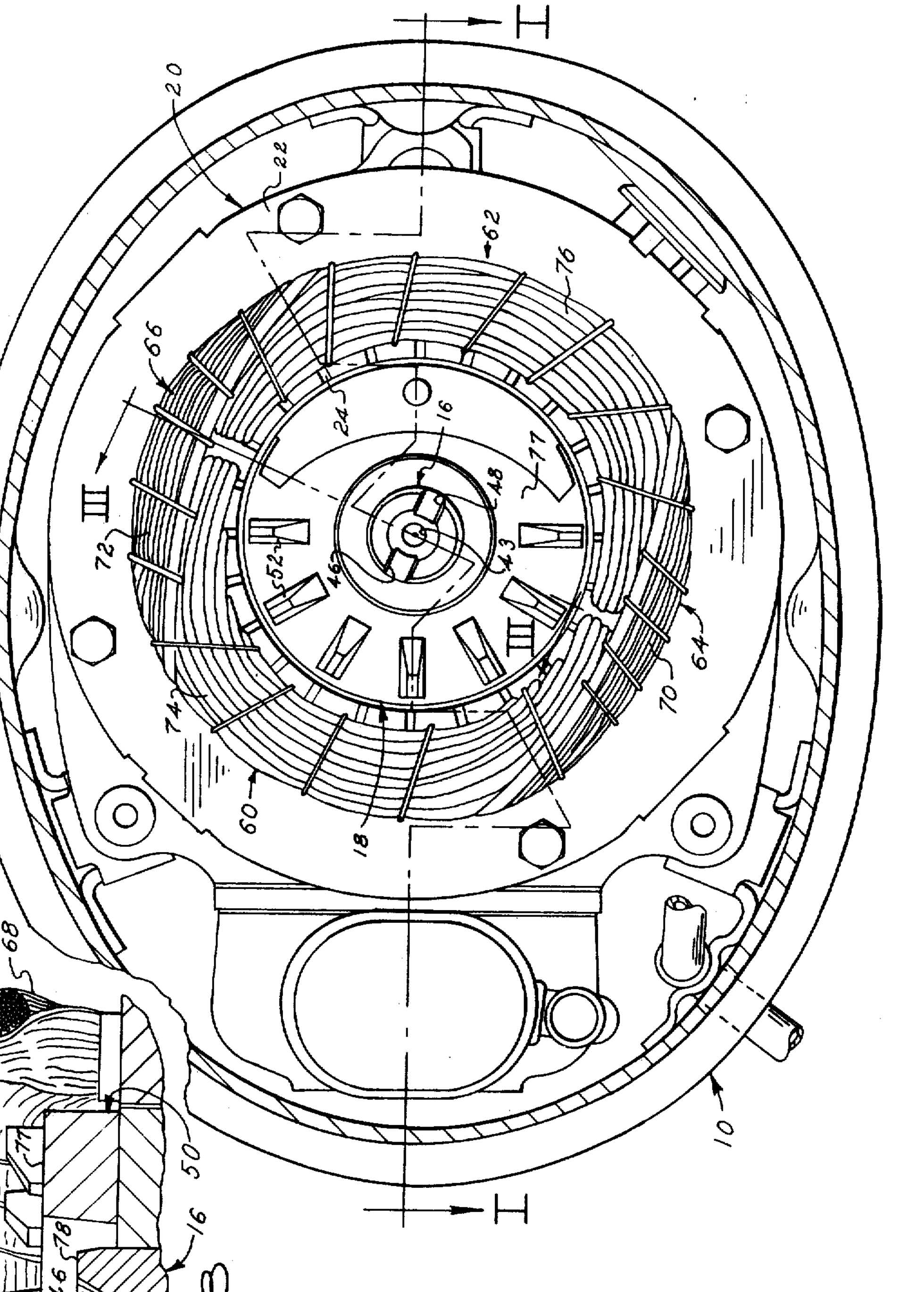

FIG. 2

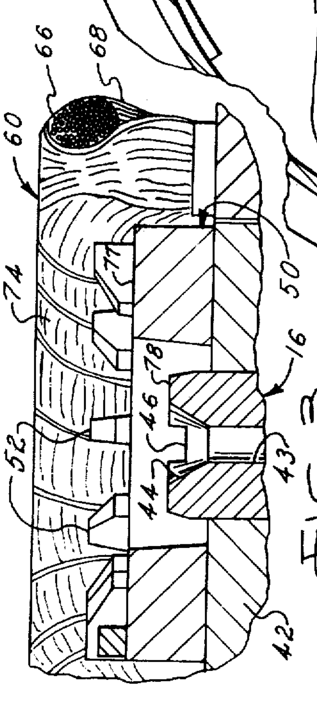

FIG. 3

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HERMETIC COMPRESSOR OIL COOLING SYSTEM

This invention relates to hermetic compressors and more particularly to an improved oil cooling system for the electric motor of the compressor.

Cooling of hermetic refrigeration motors is important to the efficiency and life of the compressor. In the past, two methods which have been used generally to cool hermetic motors are oil recirculation and refrigerant gas circulation, usually augmented by some type of centrifugal pump and/or fan within the unit. Also, it has been conventional practice to employ in hermetic compressors electric motors which are wound with the main winding or windings of the stator radially outwardly of the start winding or windings and these windings have been separated by various types of insulation. Hence when the oil and refrigerant gas delivered from the centrifugal device or devices impinges upon the windings, very little of this cooling medium reaches the main windings because it is blocked by the start windings and by the insulation between start and main windings.

The problem of motor cooling becomes most critical for those models of hermetic compressors designed for use in low temperature applications because of the poor conductivity of the low density refrigerant gas which is relied upon in part to effect cooling of the motor winding by conducting motor heat to the hermetic casing of the compressor. In such applications, the liquid oil contained in the hermetic casing must be relied upon more heavily to effect cooling of the winding. Hence it is important that this oil be circulated in the most efficient manner possible relative to the principal heat source which, during normal or running operation of the compressor, comprises the main winding of the motor stator. At this time the stator start winding does not generate any significant amount of heat.

Accordingly, it is an object of the present invention to provide an improved hermetic compressor construction wherein the cooling oil delivery system and motor windings are arranged relative to one another to promote more efficient cooling of the motor without increasing the cost of the compressor, thereby improving the operational efficiency of the compressor.

Other objects, features and advantages of the present invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a vertical sectional view taken on the line I—I of FIG. 2 illustrating an exemplary but preferred embodiment of a hermetic compressor constructed in accordance with the present invention, a portion of the hermetic casing and refrigerant intake being shown in side elevation.

FIG. 2 is a horizontal sectional view taken on the line II—II of FIG. 1.

FIG. 3 is a fragmentary vertical sectional view taken on the line III—III of FIG. 2.

Referring in more detail to the accompanying drawings, FIG. 1 illustrates a twin cylinder hermetic compressor **10** which, except for the stator winding and oil circulating structure, is conventional and well-known in the art. For example, compressor **10** may comprise a 1970 Model AH compressor constructed commercially by Tecumseh Products Company of Tecumseh, Michigan, assignee of the present invention, and sold under the trademark TECUMSEH. Accordingly, compressor **10** has the usual two-part hermetically sealed steel casing **12**, a twin cylinder refrigerant gas pump **14** and superposed electric motor **15** resiliently suspended as a unit in the casing, a one-piece vertically oriented crankshaft-motor shaft **16** and a rotor **18** of motor **15** secured to the upper end of shaft **16** for rotating the same. A stator **20** of motor **15** is suitably supported stationarily on pump **14** and has a conventional laminated core **22** with axial slots **24** (FIG. 2) opening to the inner periphery **26** of the stator in which are wound the main or run winding(s) and start or auxiliary winding(s) of the electric motor in a manner described in more detail hereinafter. Preferably motor **15** is a single-phase alternating current induction type commonly employed in hermetic compressors and may be either the two-pole type shown herein or a four-pole type, with the stator windings wound in a distributed manner in slots **24**.

Shaft **16** is journalled at its lower end in a bearing **28** to which is attached a stationary portion of a centrifugal oil pump **30** of conventional construction which in a well-known manner cooperates with radial passages in the pump and lower end of shaft **16** to pump oil from the liquid refrigerant-oil sump **32** at the bottom of the casing **12** into and upwardly through a central oil-conducting passageway in shaft **16**. This passageway includes a passage **34** extending upwardly coincident with the axis of shaft **16** to a point above the upper end of an inboard bearing **38** and about even with the lower surface **40** of the rotor core **42**. The oil passageway also includes a slightly larger diameter passage **43** communicating at its lower end with the upper end of passage **34** and extending upwardly in shaft **16** coincident with the axis thereof to an outwardly flared outlet at the upper end of the shaft formed by the beveled surface **44**, as best seen in FIG. 3. A pair of diametrically opposite radial slots **46** and **48** are formed across the upper end of shaft **16** (FIG. 2). The upper end of rotor **18** preferably has an end ring **50** provided with a series of upright radially extending blades **52** which rotate with rotor **18** and are arranged in a semi-circular row concentric with the upper end of shaft **16**, the blades being juxtaposed to the usual balancing counterweight **53**.

The main or run winding of stator **20** in the two-pole version illustrated herein consists of a left winding **60** and a right winding **62** (as viewed in FIG. 2) electrically interconnected as one main or run winding and an auxiliary or start winding consisting of a left winding **64** and a right winding **66** (as viewed in FIG. 2) also electrically interconnected as one winding. In accordance with one feature of the present invention, the start windings **64** and **66** are wound in their respective core slots **24** prior to the winding of run windings **60** and **62** so that the start windings are disposed radially outwardly of the run windings as best indicated in FIG. 1. A sheath **68** of Mylar or other suitable electrical insulating material is then placed around the exposed end turns of start windings **64** and **66** to insulate them from the main windings **60** and **62** which are wound against but radially inwardly of the start windings. The start and run windings may be wound in distributed fashion through the same slots **24** in which they have hitherto been wound in previous compressor motors of this type by suitable automatic winding machines well known in the art. Hence the upper end turns **70** and **72** of start windings **64** and **66** respectively and the upper end turns **74** and **76** of run windings **60** and **62** respectively are arranged as shown in FIGS. 1, 2 and 3 with end turns **74** and **76** disposed radially inwardly of end turns **70** and **72** and projecting axially slightly thereabove. In addition, the run winding end turns **74** and **76** project axially beyond the end surface **77** of ring **50** by a distance about equal to the axial projection of the upper ends of blades **52** from the upper end surface **79** of core **22**. In the example illustrated herein, the upper end surface **78** of shaft **16** is located about one-fourth inch below surface **77**, but it is to be understood that end surface **78** may be generally flush with surface **77** or even project thereabove by as much as five-eighths inch.

In operation of compressor **10**, when the start and run windings of the motor are energized rotor **18** is rotated to drive shaft **16** which in turn produces reciprocation of the pistons **80** and **82** of the compressor in the usual manner. Rotation of shaft **16** causes pump **30** to pump oil from the sump **32** upwardly in passage **34** as indicated by the arrows in FIG. 1. Some of the lubricating oil flowing up passage **34** is diverted to lateral oiling passages (not shown) in shaft **16** which feed oil to the connecting rod and piston wrist pin bearings in the usual manner. Another such oiling port **96** (FIG. 1) diverts a portion of the oil from passage **34** and feeds it to helical external passages (not shown) in the portion of shaft **16** passing through bearing **38** for lubrication of this bearing. A portion of the oil stream is thus diverted from passage 34 and is eventually flung radially outwardly from the upper end of bearing 38 as indicated by the arrows in FIG. 1. The oil leaving the upper end of bearing 38 impinges against the inner peripheral surface 84 of the lower end ring 85 of rotor 18 which is formed as a series of fan blades. Surface 84 is thus interrupted so that the oil is dispersed and thrown off outwardly between the fan blades and radially outwardly against the lower end turns 86 and 88 of run windings 60 and 62 respectively, to thereby help cool the run windings. This oil cooling augments the cooling effect of the refrigerant gas entering the casing at inlet port 90. The whirling rotor 18 and the suction at intake 91 induces a flow of refrigerant gas downwardly and inwardly through the annular space between end turns 86 and 88 and the upper surface 92 of crankcase 94 of compressor 14 which produces a gas flow upwardly through the cylindrical clearance space between rotor 18 and the inner periphery 26 of core 22.

The remainder of the oil which is pumped past port 96 flows up passage 34 and then up passage 43 to the upper end outlet 44 of shaft 16 from which it is flung radially outwardly by the centrifugal action of the whirling shaft. The oil is further impelled by blades 52 which act not only as a centrifugal fan on the refrigerant gas but also fling off any oil striking the blades so that there is a constant cone-like spray of oil leaving blades 52 and being flung against as well as over the encircling upper end turns 74 and 76 of run windings 60 and 62. This oil drains by gravity down over the motor windings and stator and finds its way back to the sump 32, some oil draining along the inner wall of the casing 12 and some draining through the oil return opening 100 in the top wall 92 of the crankcase 94. As the oil drains back, it is cooled by contact with the casing walls and by the incoming refrigerant gas (in the disclosed example of a "low side" casing) so that the temperature of the oil in the sump 32 remains relatively cool compared to the running temperature of the motor windings.

Because the oil flow and oil cooling rate remain relatively constant compared to the density of the refrigerant gas in the casing, the circulating oil provides an effective cooling medium in the compressor which can be relied upon to significantly reduce the temperature of the run windings 60 and 62 of the electric motor. Since run windings 60 and 62 are located radially inward of the start windings 64 and 66, the flow of cooling oil to the run windings is not obstructed and hence the run windings are subjected to a much heavier oil flow over a greater portion of their area. Although the start windings 64 and 66 receive less cooling oil, this does not pose a problem because these windings are in many applications only fully energized for a relatively brief period at compressor start-up, and in most applications do not constitute the primary source of motor heat during running of the compressor. The compressor cooling system of the present invention thus significantly reduces the average operating temperature of the electric motor of the compressor for any given load. Hence compressor 10 is able to run under a more severe loading for a longer period of time, thereby increasing the capacity rating of the compressor without a corresponding increase in the size or cost of the compressor.

I claim:

1. In a motor-compressor unit having a hermetically sealed casing with communicating motor and compressor chambers, an electric motor arranged in the motor chamber comprising a stator core having run and start windings wound thereon, a rotor disposed within said stator and a motor shaft carrying said rotor for rotation therewith, said motor shaft being drivingly connected to a gas pump of said compressor and having an oil conducting passageway extending axially therethrough, and means for supplying oil from a casing sump to said passageway in said shaft in response to rotation of said rotor, the improvement wherein said start windings are disposed radially outwardly of the portion of said run windings adjacent thereto, said shaft having outlet means connected to said passageway and oriented relative to said run windings such that oil leaving said passageway via said outlet means is directed toward said run windings to effect cooling of the same.

2. The compressor as set forth in claim 1 wherein said run windings have end turns projecting axially beyond at least one axial end face of said stator core and said outlet means comprises at least one outlet located axially between said end face of said core and the axially outermost portion of said end turns.

3. The compressor as set forth in claim 2 wherein said rotor has a plurality of blades thereon disposed radially between said shaft and said end turns of said run windings and located in the path of oil flow from said one outlet to said end turns.

4. The compressor as set forth in claim 2 wherein said shaft is oriented upright, said motor is disposed above said gas pump and said sump is disposed below said gas pump.

5. The compressor as set forth in claim 4 wherein said one outlet is located at the upper end of said shaft and said end turns comprise the upper end turns of said run windings.

6. The compressor as set forth in claim 5 wherein said outlet means includes a second outlet leading from said passageway to a space in said motor chamber below said rotor and stator core, said run windings having lower end turns projecting beneath said stator core into the path of oil emerging from said second outlet.

7. The compressor as set forth in claim 1 wherein said run and start windings are wound in distributed fashion through a plurality of said slots on said core such that said run winding has first and second end turns projecting respectively axially beyond the axially opposite ends of said stator core and each of said end turns is arranged as an annulus concentrically encircling said shaft, and said outlet means comprises first and second outlets oriented to direct oil from said passageway radially outwardly toward said first and second end turns respectively.

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