Nov. 29, 1966 R. E. COMSTOCK ETAL 3,288,357

REFRIGERATION MOTOR-COMPRESSOR

Filed Aug. 31, 1961 2 Sheets-Sheet 1

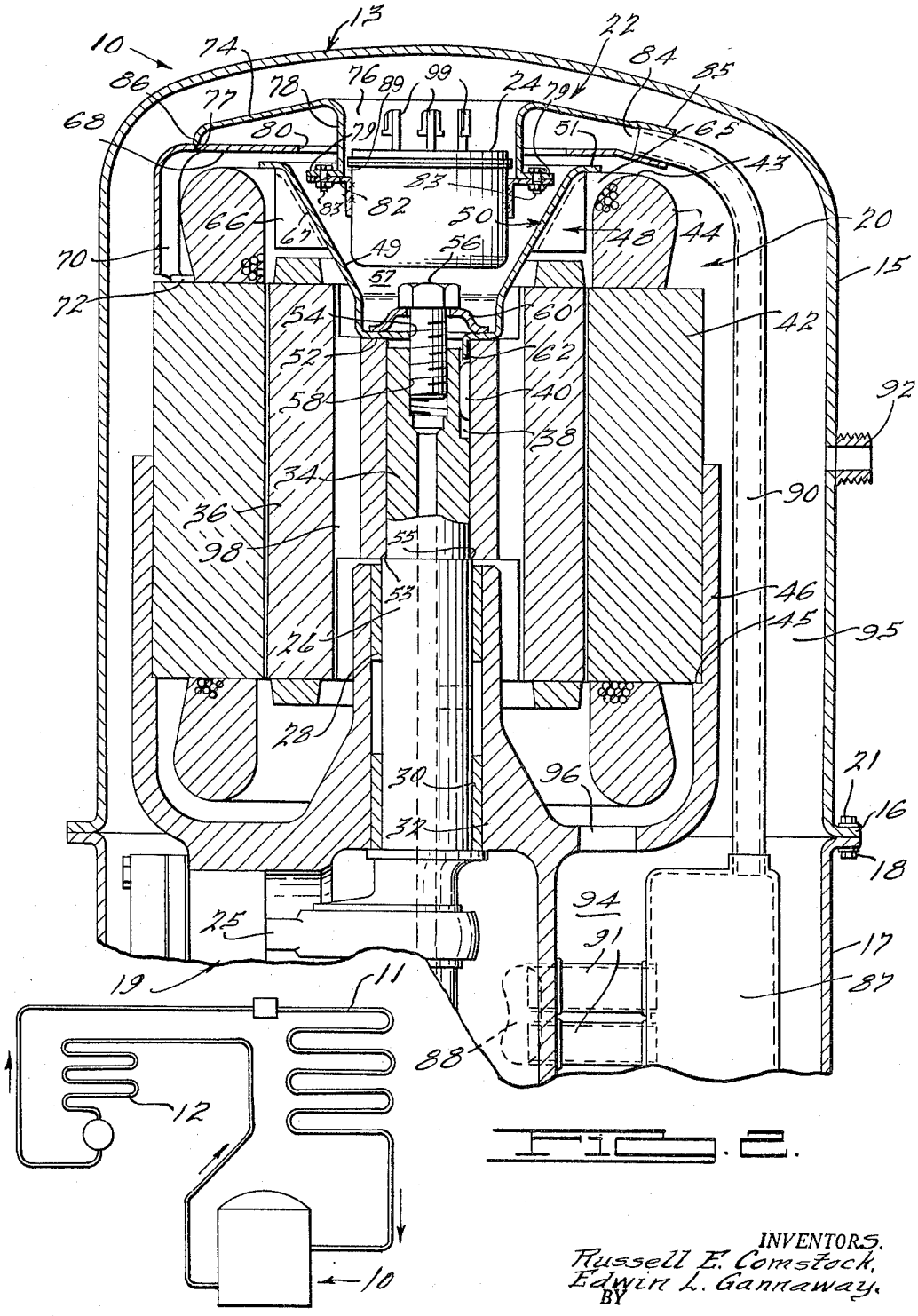


FIG. 2.

FIG. 1.

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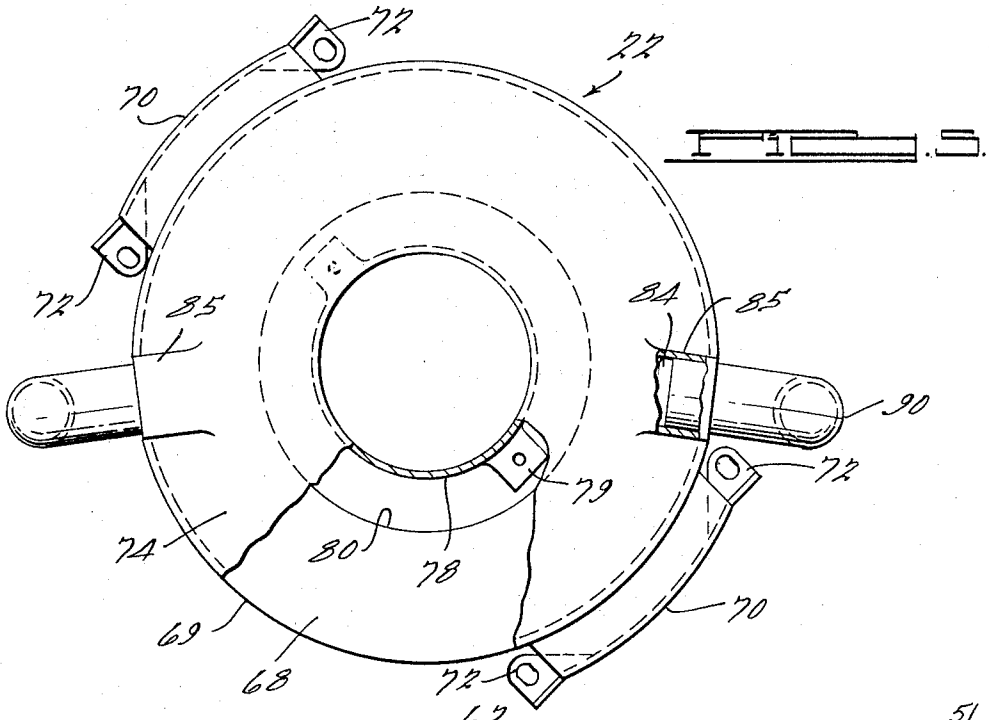


FIG. 5.

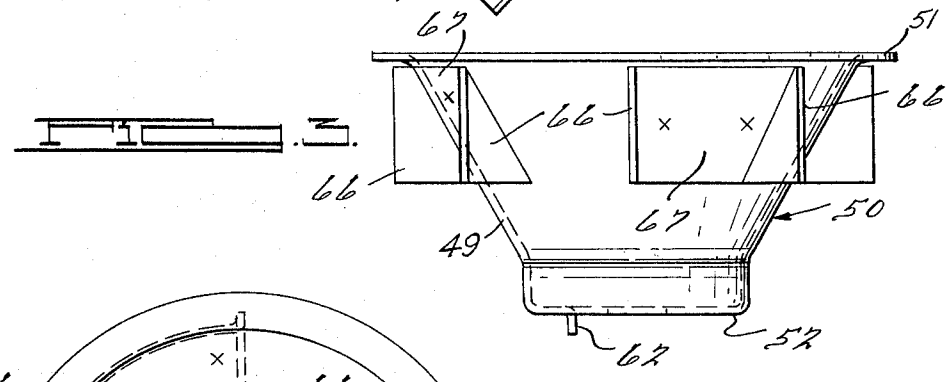


FIG. 3.

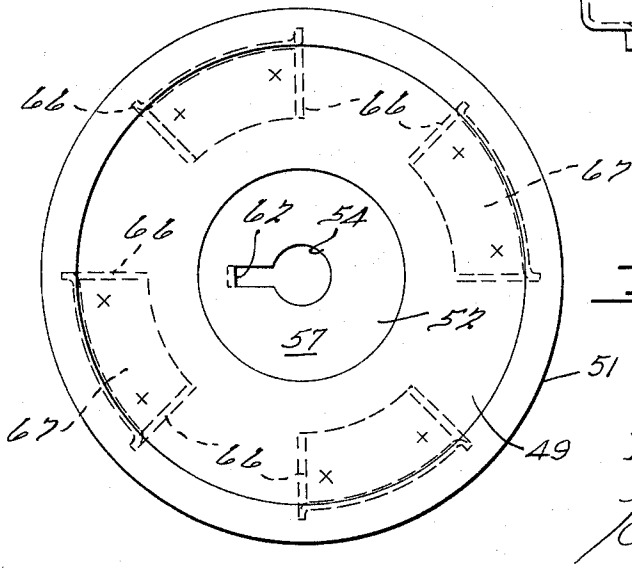


FIG. 4.

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REFRIGERATION MOTOR-COMPRESSOR

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5 Claims. (Cl. 230—208)

This invention relates to hermetic motor-compressor units, particularly for refrigeration service, and particularly concerns improved means for separating the refrigerant gas from entrained liquids, muffling the suction of the compressor, cooling the motor and protecting the unit against overload damage.

Heretofore various types of devices have been employed in gas compressors for separating liquid, particularly liquid refrigerant, from the refrigerant gas so that the liquid is not drawn into the intake or suction ports of the compression unit to thereby cause slugging of the liquid in the compression chamber and consequent noise and possible damage to the compression unit and its valves. Some of these types of devices have utilized the centrifugal slinging effect of a centrifugal impeller which acts to impart angular and linear velocities to the gas and any liquid entrained therewith to sling the liquid from the general vicinity of the dry gas intake manifold of the compressor. These devices, however, have not realized the fullest advantage from the concept of centrifugal separation of the liquid from the gas. Applicants, on the other hand, have taken considerably increased advantage of the phenomena of centrifuging by a special location of the inlet port of the dry gas manifold with respect to the discharge port of the centrifuging device, and also by the provision of means to significantly increase the centrifuging effect of the centrifuging device. Moreover, the structure of applicants' dry gas manifold and centrifuging device and their location relative to the motor has made it possible to position a motor protector unit in a most advantageous and efficient position.

It is a general object, therefore, of this invention to provide in combination with a compressor and its driving motor an improved centrifuging or liquid separating device and a dry gas manifold so positioned with respect to each other that the possibility of liquid entering the dry gas manifold is greatly reduced to thereby increase the efficiency and anti-slugging characteristics of the compressor.

Another object is to provide a liquid separating device and dry gas manifold means having a minimum number of moving parts and unique structure for baffling the flow of liquid into the manifold.

A further object is to provide an improved centrifuging or separating impeller for use in conjunction with a gas compressor motor and dry gas manifold for effectively eliminating liquid from the compressor feed gas.

Another object is to provide a dry gas manifold of simple lightweight construction having improved suction noise muffling structure.

A further object is to provide means for increasing the motor cooling effect of the refrigerant gas by causing an increased flow rate of this gas past portions of the motor.

Another object is to provide an improved economical liquid separating device and dry gas manifold structure which is adapted for general use with compressors and motors of the general type shown herein.

Another object is to provide a liquid separating device so positioned in a hermetic compressor shell that the separating device will tend to break the foam which often rises in the shell particularly at the start of the motor by means of the liquid being thrown against the foam head. This function is very significant in order to prevent foam from rising to the level of the inlet port of the dry gas manifold.

A further object is to provide a dry gas manifold for the disclosed general types of gas compressors, which manifold is provided with means for carrying a motor protector in relatively close proximity to the compressor intake gas flow and the motor to thereby effectively increase the sensitivity of the protector to changes in temperature of the motor and refrigerant gas.

Another object is to provide a novel arrangement of compressor drive motor, dry gas intake manifold, and liquid separating device which allows gas flow to the separating device and manifold to take place substantially directly from the return gas inlet in the compressor shell and also through and between portions of the motor to thereby significantly improve the cooling effect of the refrigerant gas on the motor.

A further object is to provide a motor protector unit so positioned with respect to applicants' improved dry gas manifold and centrifuging device that the protector unit will be cooled by the refrigerant gas and thereby sense the adequacy of the motor cooling by the gas so that when the system is operating improperly and the motor temperature rises the protector will likewise sense this condition.

Another object is to provide means for cooling the motor protector unit while the refrigeration system is operating properly and allowing rapid heating of the protector unit when the rotor of the compressor is locked.

Further objects and advantages of the present invention will become apparent from the following description and drawings in which:

FIGURE 1 represents a basic refrigeration system in which applicants' invention could be utilized;

FIGURE 2 represents a cross sectional view of a compressor and electric driving motor, wherein an exemplary form of applicants' invention is shown;

FIGURE 3 is a side plan view of the impeller of applicants' centrifuging or separating device;

FIGURE 4 is a top plan view of applicants' impeller; and

FIGURE 5 is a top plan view of applicants' dry gas manifold with portions of the top 74 of the manifold broken away to show underlying portions.

Referring to FIGURE 1 of the drawing in which an exemplary form of a basic refrigeration system is shown, the compressor and motor unit generally designated 10 is connected to an evaporator 11 and a condenser 12 in a conventional manner. This unit comprises a shell generally designated 13 containing the compressor and motor, and is conveniently formed by an upper section 15 and a lower section 17 with mating flanges 16 and 18 respectively, sealed and locked together by welding or other suitable means such as bolts 21. This shell 13 encloses a compressor fragmentarily shown at 19 which may be of any well known structure such as that shown in FIGURE 1 of Patent No. 2,898,072. The shell 13 also encloses an electric motor 20 for driving the compressor 19, a manifold 22 for receiving low pressure refrigerant gas to be compressed by the compressor 19, and a motor protector unit 24 for controlling the electric motor 20 in response to predetermined operating conditions. The compressor shaft on which the piston connecting rods 25 are mounted is shown at 26 rotatably mounted in bushings 28 and 30 within the motor and compressor housing or support 32. The compressor shaft 26 is preferably integrally formed with the motor driveshaft 34 which is locked to the motor armature 36 by keyway 38 in shaft 34 and key 40 integral with armature 36. The driving motor stator stack 42 and its windings 44 are supported by the shoulder 45 on the outer flange 46 of the housing 32.

Applicants' centrifuging device or impeller generally designated 48 comprises a substantially conical-shaped

body 50 having a wall portion 49 connected to a base portion 52. In the illustrated embodiment, the wall portion 49 diverges outwardly of the base 52 and the upper edge thereof is directed radially outwardly to form a circular lip 51. The wall portion 49 and base 52 form a well 57 located in heat transfer relationship with the motor 20 by means of a bolt 56 directed through an aperture 54 in the base 52 into threaded engagement with a bore 58 in the shaft 34. A suitable spring-type generally conical-shaped washer 60 may be provided intermediate the bolt head and base 52 to bear against the portions of base 52 positioned on one end of the armature 36 to thereby bias a portion 53 on the other end of the armature against a shoulder 55 on the shaft 26 to positively position the armature longitudinally on shaft 26 as bolt 56 is tightened. This washer also acts as a locking or rotation preventing means for the bolt 56. A tab 62, which may be an integral part of the base 52, is directed outwardly therefrom into the keyway 38 in shaft 34 for preventing rotation of the impeller 48 with respect to the shaft 34 and motor armature 36. The outer edge or lip 51 of body 50 defines, in cooperation with the top portion 43 of the stator windings 44, an annular discharge port means shown at 65.

Located on the underside or motor side of the impeller body 50 is a plurality of fins or projections 66 preferably equidistantly circumferentially spaced from each other to prevent unbalance of the impeller. These fins may be of any shape so long as they present sufficient surface area extending generally transversely to the direction of rotation of the impeller to effectively move the refrigerant gas through the port means 65 at the desired rate. These fins may be provided with securing flanges 67 corresponding substantially to the curvature of the underside of body 50 to present a proper means for welding or otherwise securing them to said body. Moreover, a pair of fins 66 may be formed from the ends of each one of said securing flanges as shown in FIGURE 3.

Manifold 22 comprises a spider-like supporting plate forming a lower wall portion 68 of the manifold and is provided with legs 70 spaced around the periphery thereof. These legs are provided with a pair of spaced lugs 72 through which suitable securing means such as screws may be passed and threadably received into the top stator stack 42 for stationarily securing the lower wall portion 68 and the entire manifold 22 thereto. An upper manifold wall portion 74 having a centrally disposed downturned flange 78 forming a tubular portion 76 is secured at its outer edge 77 by welding or other means to the top of the lower wall portion 68 adjacent its periphery 69 to form a substantially gas-tight seal between the upper and lower wall portions 74, 68 of the manifold. The manifold 22 further comprises a gas inlet port or orifice 80 in the lower wall portion thereof, preferably located centrally thereof, and outlet ports 84, best shown in FIGURES 2 and 5, located at the peripheral portions 86 of the manifold 22. In the preferred embodiment, the ports 84 may conveniently be formed from adjacent portions of the upper and lower wall portions 74 and 68 of the manifold by suitable forming of such adjacent portions to provide hollow embossments 85 therein. Each of the outlet ports 84 communicates with a primary sealed container-like muffler 87 and intake or suction ports 88 in the casing of the compressor 19 through conduits 90 and conduits 91, respectively. The ports 88 communicate in a conventional fashion with inlet valves (not shown) to the cylinders of the compressor 19. The number of ports 88 in the compressor and their size, and the size of the manifold 87, can vary to a greater or lesser degree in a given compressor construction in accordance with a desired gas flow rate therethrough.

In accordance with one of the features of the present invention, the flange 78 on the upper manifold wall portion 74 extends through the orifice in the lower wall portion 68 and is provided with tabs 79 formed from bottom edge portions of flange 78 and supports tabs 82 by any suitable means such as by bolts 83 or by welding. Tabs 82 are secured to the outer shell of the motor protector unit 24 which as shown is positioned well down into the conical recess or well 57 formed by the conical wall portion 49 of the body 50 of the centrifuging impeller. Tabs 82 and 79 space the motor protector shell from portion 76 to form an annular opening 89 between the inner surface of the tubular portion 76 and the protector 24 communicating with the well 57.

The protector 24 may be a conventional electrical switching structure common to refrigeration compressor drive motors, which protector is responsive to temperature by means of a bimetal switch and a heater unit, for example, and turns off electrical current to the motor when the motor becomes excessively heated through excessive friction or locking of the motor armature and/or when excessive current is flowing to the motor. Terminals 99 on the protector are used to make the electrical connections between the operating parts of the protector switching device and the motor. One type of motor protector which may be used is the "Klixon Hermetic Motor Protector" manufactured by Texas Instruments Incorporated.

During normal compressor operation, low pressure refrigerant gas will pass through an inlet line 92 in the shell 13 and enter a space 95 in the casing between the upper section 15 thereof and the outer flange 46 of the compressor support 32. Such low pressure refrigerant gas may have a certain amount of unevaporated refrigerant entrained therein as fine liquid particles. Moreover, lubricant circulated by conventional lubricant systems in compressors of the illustrated type also becomes entrained in such low pressure refrigerant gas in a space 94 enclosed by the lower section 17 of the shell 13.

In order to insure efficient, substantially noiseless operation and avoid damaging the compressor 19, it is necessary to separate such liquid particles from the low pressure refrigerant gas before it is drawn into the inlet ports 88 of the compressor. In other words, it is desirable to provide means in conjunction with the motor compressor unit for producing a relatively dry gas zone adjacent the inlet orifice 80 in the manifold 22.

In accordance with certain of the principles of the present invention, such particles are separated from gas in the spaces 94 and 95 by the impeller 48 working in conjunction with the manifold 22. More particularly, during compressor operation the impeller 48 is driven by the motor armature 36 to draw the liquid gas mixture from the spaces 94, 95 through an aperture 96 in a lower portion of the compressor housing 32, passageways 98 directed through the motor armature 36, and the space between the rotor 36 and the stator 42 into the vicinity of the impeller 48. The radially outwardly diverging wall portion 49 of the impeller 48 deflects the liquid gas mixture radially outwardly of the base portion 52 of the impeller 48 and the liquid gas mixture is then centrifugally acted upon by the fins 66 on the impeller to impart relatively high angular and linear velocities to the mixture as it passes across such fins. Eventually the mixture is thrown by the centrifugal forces acting thereon through the discharge port 65 formed by the lip 51 of the impeller and the top portion 43 of the stator windings 44. Since the liquid particles in the mixture are considerably heavier than the individual gas molecules therein, they are thrown out through the port 65 with a substantially greater momentum than the individual gas molecules to beyond the exterior portions of the stator windings 44 where gravitational forces act thereon to draw the liquid particles downwardly through the space 94 and the space 95 to the bottom of the shell 13 which may as is usual in compressors of this class serve as a reservoir for a conventional compressor lubri-

cating system. There is little or no tendency for the liquid particles to migrate into the uppermost space within the shel 13 once they have been discharged out of the opening 65 since they are too heavy to be carried along by any gas streams circulating in that region.

As the impeller 48 is pumping the liquid gas mixture from the space 95 and out of the discharge port 65, the compressor 19 is being driven to produce a pressure drop in the suction ports 88 and a pressure zone in the manifold 22, which is relatively lower than the pressure at the annular discharge opening 65 from the rotating impeller 48. The pressure differential between the annular opening 65 and the inside of the muffler 22 is sufficient to overcome the relatively low momentum of the dry gas passing through the annular opening 65 and will thereby cause such dry gas to pass from the annular opening 65, through the inlet orifice 80, the outlet ports 84, the conduits 90, the muffler 87, the conduits 91 and thence through the suction ports 88 of the compressor and into the compressor cylinders where the dry gas is compressed and returned into the refrigerant system in a conventional fashion.

While the pressure differential between the annular opening 65 and the manifold 22 will normally only selectively suck the relative low momentum dry gas molecules into the manifold 22, any tendency for liquid particles to be drawn into the manifold is further reduced by locating the inlet orifice 80 radially inwardly of the annular port 65. Accordingly, the underside of the lower wall portion 68 of the muffler will act as a baffle deflecting such stray liquid particles back into the fluid passing radially outwardly of the annular opening 65 to insure that the heavier liquid particles will not be sucked into the manifold along with the comparatively low momentum dry gas molecules. A certain amount of dry gas will pass radially outwardly of the exterior portions of the stator winding 44 along with the liquid particles. Such gas will tend to rise into the uppermost space in the shell 13 as the heavier liquid particles fall under the influence of gravity toward the bottom of the shell 13.

In accordance with certain other of the principles of the present invention, the manifold 22 in conjunction with the primary muffler 87 materially improves the muffling characteristics of motor-compressor units of the illustrated type. This is in part due to the fact that the inlet orifice 80 of the manifold has a considerable cross-sectional area and thereby does not restrict the gas flow between the annular opening 65 and the muffler 22 in a manner which might produce any significance noise. Moreover, any noise generated by the pistons and valves of the compressor 19 which is not muffled by the muffler 87 will be further muffled within the manifold 22 since the outlets 84 therefrom are located within its interior. The combined muffling effects of the manifold 22 and the muffler 87 provide a motor-compressor unit with heretofore unknown quietness of operation.

Another aspect of the present invention attributable to the improved separating system occurs under conditions of operation in which a foam tends to rise within the shell 13. For example, under certain conditions, when a motor-compressor unit of the illustrated type is initially started, a foam may rise in the space 95 in the shell 13 sufficiently to enter the inlet orifice 80 of the manifold 22 and be drawn therefrom into the compressor 19 to adversely affect the operation thereof. In the present invention, such foam is substantially reduced by the liquid particles which are separated by the impeller 48. Such particles tend to break any foam rising in the shell as they fall downwardly into the space 95 between the shell and the compressor housing 46. Furthermore, any foam from the space 95 which reaches the level of the inlet orifice 80 will be thrown radially outwardly thereof by the high velocity lip 51 on the impeller 48.

In accordance with certain other of the principles of the present invention, the gas flow through the inlet orifice 80 in the manifold 22 produces a low pressure region within the well 57 formed by the wall portions 49 of the impeller 48. The pressure differential between the uppermost region in the shell 13 and the well 57 will produce a flow of cool, dry refrigerant gas through the annular opening 89 between the inside surface of the tubular portion 76 and the protector unit 24 and thence through the inlet orifice 80 into the manifold 22. The motor protector unit 24 is, accordingly, cooled to a variable degree depending on refrigerating system operating conditions. Accordingly, when refrigerant gas is lost from the refrigeration system through leakage or otherwise, the gas flow produced by such a pressure differential across the protector unit 24 is reduced so that the protector will no longer be cooled to a desired degree and will, therefore, respond to the condition and halt current flow to the motor. Another advantage of the present invention is observed under certain abnormal operating conditions which cause the rotor 36 of the compressor motor to lock while it is energized, as for example, under conditions in which the starting voltage is relatively low. Such a locked rotor will rapidly heat to a temperature level capable of seriously damaging the motor. It will be observed, however, that the protector 24 is located in close proximity to the inside surface of the wall portion 49 which is in turn in direct contact with the motor armature or rotor 36. Conductive heat from the rotor 36 will, accordingly, heat the wall portions 49 and thence heat the atmosphere in the well 57 to produce a stack effect or convective currents through the annular opening 89 in the manifold 22 which heat the protector 24 sufficiently to halt the flow of current to the motor before it is overheated.

While it will be apparent that the embodiment of the invention herein disclosed is well calculated to fill the objects of the invention, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. In a refrigeration motor-compressor assembly including an electric motor-driven compressor, means for inhibiting the entry of the heavier components of a non-homogeneous fluid into the inlet of the compressor without unduly restricting the entry of lighter components, comprising stationary wall portions defining a generally closed stationary inlet chamber adapted to be interposed between a compressor inlet and the source of fluid therefor, said well portions defining a stationary axially directed annular inlet orifice, a deflector driven by the motor and rotatable upon a vertical axis substantially perpendicular to the plane of and concentric with said orifice, said deflector including an annular member of greater diameter than and diverging outwardly toward and substantially covering said orifice and having a radially outwardly extending rim portion below and proximate to but spaced from said wall portions and cooperating therewith to define an annular radially directed substantially unobstructed inlet area to said aforementioned annular orifice, said inlet area being located radially outwardly of said orifice and bounded on one side by said stationary wall portions and on the other side by said rotatable deflector, whereby upon rotation of said deflector, fluid approaching said orifice is guided outwardly and away from said orifice by said annular member and can only enter said orifice by substantially reversing its outward motion and first flowing inwardly through said annular inlet area.

2. A refrigeration motor-compressor as defined in claim 1 in which said annular member has means on the exterior thereof for increasing the momentum of the heavier and lighter components of a fluid in direct relationship to their mass for inhibiting reversal of the outward motion of the heavier components therein inwardly through said annular inlet area without obstructing either said radially directed inlet area or said orifice.

3. A motor-compressor as defined in claim 1 in which

said annular member is hollow to define a well interiorly communicating with said orifice, said generally closed inlet chamber having a tubular portion thereon directed through and defining the inner periphery of said annular orifice and projecting into said well, and said tubular portion having means therein for locating a temperature responsive motor protector radially inwardly of the inside surface thereof to form an opening between said tubular portion and the motor protector for circulating fluid across the motor protector to control the energization of the compressor-motor in accordance with motor-compressor operating conditions.

4. A motor-compressor as defined in claim **1**, said orifice having a cross-sectional area substantially greater than the cross-sectional area of said annular inlet area thereby eliminating any noise-producing fluid flow restriction at said orifice.

5. A motor-compressor as defined in claim **1** in which said annular member is hollow to define a well interiorly communicating with said orifice, said generally closed inlet chamber having a tubular portion thereon directed through and defining the inner periphery of said annular orifice and projecting into said well, and said tubular portion having means therein for locating a temperature responsive motor protector therein and within said annular member and close to the rotor in position to be contacted by fluid entering said inlet area to control the energization of the compressor-motor in accordance with motor-compressor operating conditions.

References Cited by the Examiner

UNITED STATES PATENTS

1,447,916	3/1923	Watkins	230—134
1,947,016	2/1934	Mallory	230—207
1,963,401	6/1934	Clason	55—407 X
1,967,034	7/1934	Lipman	230—207
2,172,729	9/1939	Chilton	55—406 X
2,228,364	1/1941	Philipp	230—206 X
2,468,384	4/1949	Tyskewicz	181—40
2,484,554	10/1949	Concordia et al.	230—134
2,757,858	8/1956	Smith	230—207
2,825,318	3/1958	Mansfield	55—100 X
2,936,845	5/1960	Miller et al.	181—40
3,081,935	3/1963	Geisenhaver	230—206
3,104,051	9/1963	Henning et al.	230—206

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