A discharge device for a refrigeration compressor is provided. The device can include a discharge tube connected with the discharge of the refrigeration compressor. A bellows surrounds a perforated portion of the discharge tube. The length of the discharge tube can be minimized to decrease pressure loss. The discharge can be insulated to prevent the distribution of heat to the compressor and/or to allow for the recovery of heat energy later in the refrigeration cycle.
COMPACT DISCHARGE DEVICE FOR THE
REFRIGERATION COMPRESSOR OF AN
APPLIANCE

FIELD OF THE INVENTION

[0001] The present invention relates to a discharge device for a refrigeration compressor and, more specifically, to a device that includes a compact discharge tube and a damper connected to the discharge of the refrigeration compressor of an appliance.

BACKGROUND OF THE INVENTION

[0002] A variety of refrigeration systems have been implemented for appliances such as refrigerators and freezers. One such design utilizes a hermetically sealed refrigeration unit. More particularly, a typical hermetic refrigeration unit includes an electric motor and a positive displacement refrigerant compressor that are sealed within a casing and connected by a shaft. A refrigerant intake for the compressor, also located within the casing, allows for the refrigerant gas to be fed into the compressor. A part of the intake gas (refrigerant) is re-circulated within the compressor shell in order to cool the motor and/or lubricant oil located in the bottom of the unit. The intake gas also picks up heat from the discharge tube. As a result, the refrigerant on the intake side gets heated. In turn, the compressor pressurizes the refrigerant, which increases both its temperature and pressure.

[0003] The hermetic casing includes a suction tube and a discharge tube. After the refrigerant gas has passed through an evaporator, the suction tube feeds such gas into the hermetic casing. After the refrigerant gas has been pressurized by the compressor, the discharge tube feeds the compressed refrigerant gas from the compressor, through the casing, and to a condenser located external of the casing.

[0004] One particular consideration in the design of a hermetic refrigerant compressor unit is the minimization of vibrations and noise. Another consideration is the dissipation of heat from the compressor and motor. As the refrigerant is compressed, it is discharged intermittently due to the reciprocating motion of a piston in the compressor. This intermittent discharge, along with the operation of the motor and the opening and closing of valve devices in the suction and/or intake of the compressor, creates pulsations of the refrigerant and other vibrations that can cause noise. Another concern is vibration of the discharge tube, which is located within the hermetically sealed compressor casing and extends through the case to transfer refrigerant from the compressor out to the condenser. Typically, the gas discharge tube does not extend in a straight line directly out through the compressor casing. Instead, to help minimize vibrations, the tube is relatively long and includes multiple bends and curves. In addition, one end of the discharge tube is connected to the discharge muffler of the compressor motor assembly, which vibrates and floats on springs connected to the casing. The other end of the discharge tube is stationary at the point where the tube is connected to the casing. It will be appreciated that due to the length of the conduit and the pulsating nature of the output of the positive displacement compressor, and additionally due to vibration induced by the rotation of the motor and compressor shaft, vibration of the discharge tube and resultant objectionable noise are typically produced. The increased length of the discharge tube also creates an undesirable pressure loss as the refrigerant travels through such tube to the condenser. It is desirable that this heat be removed from within the hermetic casing rather than having such heat contribute to a temperature increase of the motor or the compressor in the casing.

[0005] Accordingly, a device for reducing the generation of vibration and noise from a refrigeration compressor unit would be useful. Such a device that could also be used to reduce pressure losses on the discharge side of the compressor would also be beneficial. A device that could also help reduce the transfer of heat from pressurized refrigerant to the compressor and/or motor would also provide additional benefits.

BRIEF DESCRIPTION OF THE INVENTION

[0006] Aspects and advantages of the invention will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the invention.

[0007] In one exemplary embodiment, the present invention provides a discharge device for a refrigeration unit. The refrigeration unit has a compressor with a discharge for the output of pressurized refrigerant. The device includes a discharge tube in fluid communication with the discharge from the compressor. The discharge tube has an exterior wall. The discharge tube includes a first portion having a plurality of apertures positioned about the exterior wall of the discharge tube. The apertures are configured for the flow of refrigerant through the exterior wall of the discharge tube. A second portion is connected to the first portion and is configured to feed refrigerant away from the first portion. A dampening device is positioned around the first portion of the discharge tube and is configured for the capture of refrigerant flowing through the apertures in the first portion of the discharge tube.

[0008] In another exemplary embodiment, the present invention provides a hermetically sealed refrigeration unit. The unit includes a compressor for pressurizing refrigerant. The compressor has an outlet for the discharge of pressurized refrigerant. A motor is connected to the compressor by a shaft. A casing encloses the motor and the compressor. A suction tube feeds refrigerant into the casing. A discharge tube is provided in fluid communication with the outlet of the compressor. The discharge includes a perforated section of tubing configured for the passage of refrigerant in and out of the discharge tube, and a non-perforated section in fluid communication with the perforated section. The non-perforated section is configured for transferring refrigerant to the exterior of the casing. A stress-dissipating device surrounds the perforated section of the tubing. The stress-dissipating device is configured to capture refrigerant passing from the perforated section.

[0009] These and other features, aspects and advantages of the present invention will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] A full and enabling disclosure of the present invention, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:
FIG. 1 illustrates an exemplary embodiment of a refrigerator that can be equipped with a compact discharge device of the present invention.

FIG. 2 is a schematic of an exemplary refrigeration loop or cycle as can be equipped with the present invention.

FIG. 3 is a perspective view of an exemplary embodiment of a hermetically sealed refrigeration unit having a representative compact discharge device of the present invention. For purposes of clarity in the description, only a portion of the casing that seals the unit is shown.

FIG. 4 is an exploded, perspective view of an exemplary embodiment of a discharge tube, a muffler, and bellows of the present invention.

FIG. 5 is a perspective view of the exemplary embodiment of the refrigeration unit of FIG. 3 with an additional portion of the casing removed for purposes of clarity. The discharge tube, muffler, and bellows of FIG. 4 are also shown in partial cross-section as connected to the refrigeration unit.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a discharge device for a refrigeration compressor and, more specifically, to a device that includes a compact discharge tube and damper for the discharge tube connected to the refrigeration compressor of an appliance. Reference now will be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

FIG. 1 provides a front view of a representative refrigerator 10 as can be used with a compact discharge device of the present invention. For illustrative purposes, the present invention is described with a refrigerator 10 having a construction as shown and described further below. As used herein, a refrigerator includes appliances such as a freezer, refrigerator/freezer combination, compact, and any other style or model of a refrigerator. Accordingly, other configurations including multiple and different styled compartments could be used with refrigerator 10, it being understood that the configuration shown in FIG. 1 is by way of example only.

Refrigerator 10 includes a fresh food storage compartment 12 and a freezer storage compartment 14. Freezer compartment 14 and fresh food compartment 12 are arranged side-by-side within an outer case 16 and defined by inner liners 18 and 20 therein. A space between case 16 and liners 18 and 20, and between liners 18 and 20, is filled with foamed-in-place insulation. Outer case 16 normally is formed by folding a sheet of a suitable material, such as prepainted steel, into an inverted U-shape to form the top and side walls of case 16. A bottom wall of case 16 normally is formed separately and attached to the case side walls and to a bottom frame that provides support for refrigerator 10. Inner liners 18 and 20 are molded from a suitable plastic material to form freezer compartment 14 and fresh food compartment 12, respectively. Alternatively, liners 18, 20 may be formed by bending and welding a sheet of a suitable metal, such as steel. The illustrative embodiment includes two separate liners 18, 20 as it is a relatively large capacity unit and separate liners add strength and are easier to maintain within manufacturing tolerances. In smaller refrigerators, a single liner is formed and a mullion 24 spans between opposite sides of the liner to divide it into a freezer compartment and a fresh food compartment.

A breaker strip 22 extends between a case front flange and outer front edges of liners 18, 20. Breaker strip 22 is formed from a suitable resilient material, such as an extruded acrylo-hutadiene-styrene based material (commonly referred to as ABS). The insulation in the space between liners 18, 20 is covered by another strip of suitable resilient material, which also commonly is referred to as a mullion 24. In one embodiment, mullion 24 is formed of an extruded ABS material. Breaker strip 22 and mullion 24 form a front face, and extend completely around inner peripheral edges of case 16 and vertically between liners 18, 20. Mullion 24, insulation between compartments, and a spaced wall of liners separating compartments, sometimes are collectively referred to herein as a center mullion wall 26. In addition, refrigerator 10 includes shelves 28 and slide-out storage drawers 30, sometimes referred to as storage pans, which normally are provided in fresh food compartment 12 to support items being stored therein.

Refrigerator 10 can be controlled by a microprocessor (not shown) according to user preference via manipulation of a control interface 32 mounted in an upper region of fresh food storage compartment 12 and coupled to the microprocessor. A shelf 34 and wire baskets 36 are also provided in freezer compartment 14. In addition, an ice maker 38 may be provided in freezer compartment 14.

A freezer door 42 and a fresh food door 44 close access openings to freezer and fresh food compartments 14, 12, respectively. Each door 42, 44 is mounted to rotate about its outer vertical edge between an open position, as shown in FIG. 1, and a closed position (not shown) closing the associated storage compartment. Freezer door 42 includes a plurality of storage shelves 46, and fresh food door 44 includes a plurality of storage shelves 48.

Refrigerator 10 includes a machinery department that incorporates at least part of a refrigeration cycle 50 as shown in FIG. 2. The components of refrigeration cycle 50 include a refrigerant compressor unit 52, a condenser 54, valves 56 and 58, and an evaporator 60—all connected in series and charged with a refrigerant. Evaporator 60 is also a type of heat exchanger that transfers heat from air passing over the evaporator 60 to a refrigerant flowing through evaporator 60, thereby causing the refrigerant to vaporize. As such, cooled air is produced and configured to refrigerate compartments 12, 14 of refrigerator 10.

From evaporator 60, vaporized refrigerant flows to compressor unit 52, which increases the pressure of the refrigerant. This compression of the refrigerant raises its temperature, which is subsequently lowered by passing the gaseous refrigerant through condenser 54 where heat exchange with ambient air takes place so as to cool the refrigerant. Valves 56 and 58 further reduce the pressure of refrigerant leaving condenser 54 before being fed as a liquid to evaporator 60. The refrigeration cycle 50 depicted in FIG. 2 is provided by way of example only. It is within the scope of the present invention for other configurations of the refrigeration system 50 to be used as well.
FIGS. 3 and 5 provide a perspective view of an exemplary embodiment of a hermetically sealed refrigeration compressor unit 52 as may be utilized with the present invention. Unit 52 includes a casing 66 that encloses, i.e., hermetically seals, a compressor 74 and motor 68 within. For the sake of clarity in describing the invention, portions of casing 66 have been removed in the figures so that components contained within casing 66 are more visible.

Compressor 74 and motor 68 are directly connected by a shaft (not shown) and together are supported by stabilizers 70 attached to the base 72 of casing 66. Suction tube 62 feeds refrigerant into casing 66 where it contacts e.g., compressor 74 and motor 68. Because this refrigerant comes from evaporator 60, such refrigerant is relatively cool and, therefore, helps to cool compressor 74 and motor 68. Although not shown, casing 66 is partially filled with oil that helps cool and lubricate motor 68 and compressor 74.

From within casing 66, refrigerant is pulled directly into compressor 74 where it is pressurized as part of refrigeration cycle 50 (FIG. 2). More specifically, compressor 74 includes a piston 76 that is received within cylinder 77. Power provided by motor 68 operates to cause piston 76 to reciprocate within cylinder 77. As piston 76 is pulled out of cylinder 77, refrigerant is pulled into compressor 74 from within casing 66. When piston 76 is pushed into cylinder 77, refrigerant is compressed to a higher pressure and eventually forced to exit cylinder 77 and enter muffler 80. This compression cycle also generates heat that raises the temperature of the refrigerant and creates vibration and noise due to the reciprocating action of piston 76.

Muffler 80 includes a chamber 81 that is enclosed within insulation 83. Compressed refrigerant enters chamber 81 through an inlet 85 located along one end. Together, muffler 80 with chamber 81 assist with dampening vibrations and noise creating by the surges of refrigerant flowing from the reciprocating action of piston 76. More specifically, chamber 81 helps to absorb some of the energy that might otherwise create noise within casing 66. In addition to assisting with noise reduction, insulation 83 also helps maintain heat energy in the refrigerant as opposed to transferring the heat to components located within casing 66 such as compressor 74 and motor 68.

From muffler 80, refrigerant enters into a discharge tube 64, an exploded version of which is shown in FIG. 4. Discharge tube 64 is comprised of a first portion 78 and a second portion 96. First portion 78 is connected directly to muffler 80. In turn, second portion 96 connects first portion 78 with the exterior of casing 66.

So as to reduce the pressure loss associated with the flow of refrigerant through discharge tube 64, the overall length of tube 64 is minimized. More specifically, the length of tubing between muffler 80 and the exit 102 of tube 64 through casing 66 is kept as short as possible—particularly the length of the non-perforated, second portion 96. This reduction in length helps minimize the surface area available for the transmission of heat from tube 64. For example, the length of the discharge tube in conventional compressors can be about 600 mm while, for example, the present invention can be used to shorten the discharge tube to about 300 mm or less. Similarly, while discharge tubing 64 is shown with turns 92 and 94, preferably the total number of turns is minimized to decrease pressure loss from frictional effects.

First portion 78 includes a perforated section of tubing 82 (FIG. 2) that is enclosed within bellows 88 by insertion through opening 86. Specifically, the exterior wall of tubing 82 contains multiple apertures 84 that allow refrigerant to flow through. Bellows 88 include discs 90 that can be more specifically described as folds or bends in the walls of bellows 88. Together, tubing 82 and bellows 88 define an expansion chamber 98 for refrigerant flowing through apertures 84. As such, first portion 78 operates as a dampener to dissipate some of the energy that is provided in the pulsation of refrigerant coming from compressor 74. As pressurized refrigerant moves into first portion 78, it can flow through apertures 84, which in turn helps to dissipate vibration and noise associated with pulses from reciprocating compressor 74. In addition, the shape of bellows 88 also helps to attenuate vibrations of discharge tube 64 so as to further dissipate the transmission of noise. Although not shown, bellows 88 may be covered with insulation such as e.g., silicon, Teflon®, EPDM (ethylene propylene diene methylene), or others so as to provide further acoustical dampening while also reducing heat transfer from the refrigerant to other components within casing 66.

Similarly, second portion 96 may also be covered with insulation 100. For purposes of clarity, only a portion of insulation 100 is shown in FIG. 2. Such insulation may be constructed from e.g., silicon, Teflon®, EPDM (ethylene propylene diene methylene), or others. Insulation 100 helps lessen the transmission of noise from discharge tube 64 and also helps to retain heat energy contained with the refrigerant flowing through tube 64. Second portion 96 can also be provided with insulation 65 outside of casing 66 as shown in the FIGS. 3 through 5.

Discharge tube 64 can be constructed from a variety of materials. By way of example, tubing 64 can be constructed from copper, steel, and other materials as well. Preferably, bellows 88 is welded to the non-perforated first portion 78 of tubing 64. In turn, first portion 78 and second portion 96 may be constructed integrally or may be welded to each other. Additional configurations may also be used.

If desired, the heat energy within refrigerant that is leaving casing 66 can be harnessed to provide heat or to operate other devices in the appliance so as to increase overall efficiency. For example, before passing into condenser 54, the refrigerant could be routed through another heat exchanger connected between discharge tube 64 and condenser 54. The recovered energy can then be applied at other places within the appliance to provide heat and/or to power other features. For example, a thermoelectric device can be used to drive the fan of an evaporator or a condenser and/or the recovered energy could be used to power internal lighting of the refrigerant 10.

Due to the presence of insulation 100 on discharge tube 64, only a negligible amount of heat escapes from discharge tube 64 within casing 66. Eventually, unless other adjustments are made, this heat must be dissipated in condenser 54. Accordingly, additional features can be utilized to properly cool the refrigerant in discharge tube 64. For example, the size of condenser 54 can be increased to provide additional heat transfer area for the cooling of the refrigerant. Alternatively, an additional heat exchanger (i.e. a subcooling heat exchanger) could be provided between compressor unit 52 and condenser 54 to provide cooling of the refrigerant before it reaches condenser 54.

Alternatively, options for cooling that may be less costly or complex may also be employed. For example, cooling fins could be provided on the exterior of casing 66 to help
dissipate heat from inside casing 66. The discharge tube 64 can also be routed through the oil within casing 66 that is used to lubricate the motor 68 and compressor 74. This oil will assist in cooling refrigerant within discharge tube 66 and help transfer heat to casing 66 for discharge to the exterior. Additionally, various fins may be placed on the exterior of discharge tube 66 between casing 66 and condenser 54. For example, spine fins could be employed. Other configurations may be used as well including combinations of the previously described options for providing additional cooling of the refrigerant.

[0036] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they include structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A discharge device for a refrigeration unit, the refrigeration unit having a compressor with a discharge for the output of pressurized refrigerant, the device comprising: a discharge tube in fluid communication with the discharge from the compressor, the discharge tube having an exterior wall, said discharge tube comprising: a first portion having a plurality of apertures positioned about the exterior wall of said discharge tube, the apertures configured for the flow of refrigerant through the exterior wall of said discharge tube; a second portion connected to said first portion and configured to feed refrigerant away from said first portion; and, a dampening device is positioned around the first portion of said discharge tube and is configured for the capture of refrigerant flowing through the apertures in the first portion of said discharge tube.

2. A discharge device for a refrigeration unit as in claim 1, wherein said dampening device and the exterior wall of said discharge tube define an expansion chamber for the receipt of refrigerant.

3. A discharge device for a refrigeration unit as in claim 1, wherein said dampening device comprises a bellows attached to the exterior wall of said discharge tube.

4. A discharge device for a refrigeration unit as in claim 3, wherein said dampening device is welded to the exterior wall of said discharge tube.

5. A discharge device for a refrigeration unit as in claim 1, wherein said discharge tube is connected to a muffler that is attached to the compressor.

6. A discharge device for a refrigeration unit as in claim 5, further comprising insulation positioned about the exterior of said muffler.

7. A discharge device for a refrigeration unit as in claim 1, wherein said discharge tube extends through the wall of a casing surrounding the refrigeration unit.

8. A discharge device for a refrigeration unit as in claim 7, wherein a portion of the discharge tube is routed through an oil reservoir used to lubricate the refrigeration unit.

9. A discharge device for a refrigeration unit as in claim 1, further comprising insulation surrounding at least a part of said discharge tube.

10. A discharge device for a refrigeration unit as in claim 1, further comprising insulation enclosing the second portion of said discharge tube.

11. A hermetically sealed refrigeration unit, comprising: a compressor for pressurizing refrigerant, the compressor having an outlet for the discharge of pressurized refrigerant; a motor connected to said compressor by a shaft; a casing enclosing the motor and the compressor; a suction tube for feeding refrigerant into said casing; a discharge tube in fluid communication with the outlet of said compressor, said discharge comprising: a perforated section of tubing configured for the passage of refrigerant in and out of said discharge tube; a non-perforated section in fluid communication with said perforated section and configured for transferring refrigerant to the exterior of said casing; and, a stress-dissipating device surrounding said perforated section of tubing, said stress-dissipating device configured to capture refrigerant passing from said perforated section.

12. A hermetically sealed refrigeration unit as in claim 11, wherein said stress-dissipating device and said perforated section of tubing define a chamber for the receipt of refrigerant.

13. A hermetically sealed refrigeration unit as in claim 11, further comprising a muffler connected to the outlet of said compressor, and wherein said discharge tube is connected to said muffler.

14. A hermetically sealed refrigeration unit as in claim 13, wherein said first section of said discharge tube is connected to said muffler.

15. A hermetically sealed refrigeration unit as in claim 13, further comprising insulation positioned about the exterior of said muffler.

16. A hermetically sealed refrigeration unit as in claim 13, further comprising fins positioned on said casing to provide additional heat transfer from said casing.

17. A hermetically sealed refrigeration unit as in claim 11, further comprising: a condenser in fluid communication with said discharge tube; and a heat exchanger connected between said discharge tube and said condenser so as to allow for the dissipation, recovery, or both, of heat energy from the refrigerant before it is fed to said condenser.

18. A hermetically sealed refrigeration unit as in claim 11, further comprising: a condenser in fluid communication with said discharge tube; and wherein portions of said discharge tube are provided with cooling fins to help dissipate heat from refrigerant in said discharge tube.

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