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REFRIGERANT COOLED OIL COOLER SYSTEM

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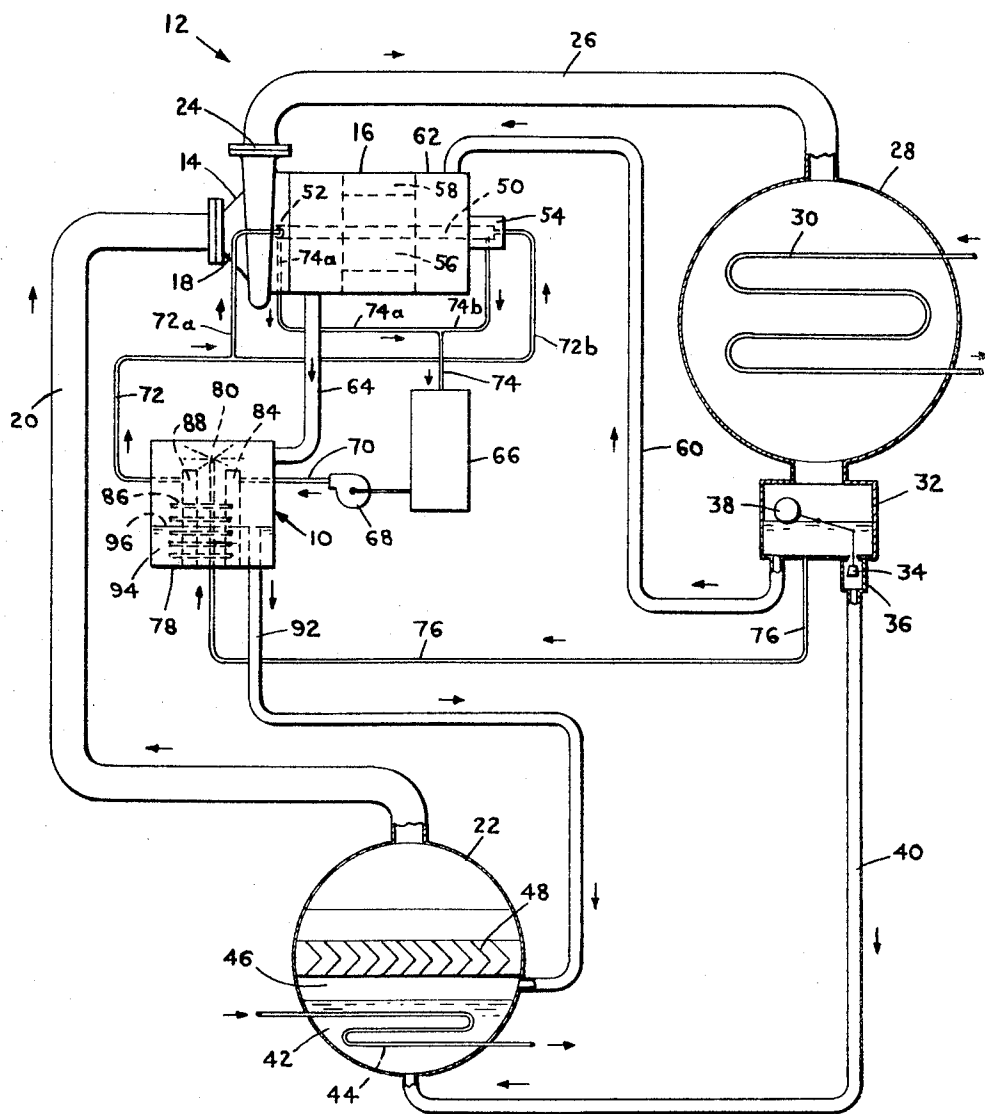


FIG. 1

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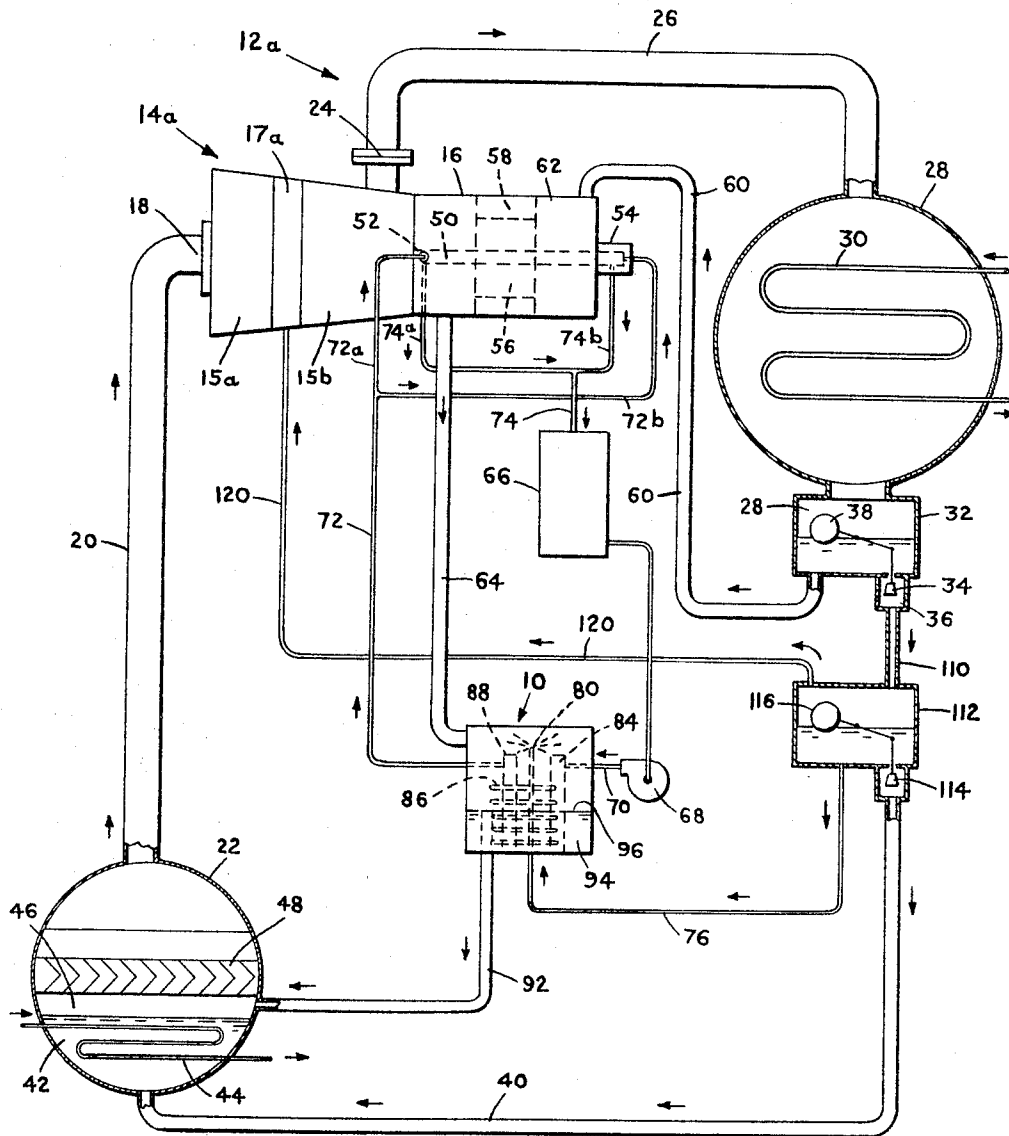


FIG. 2

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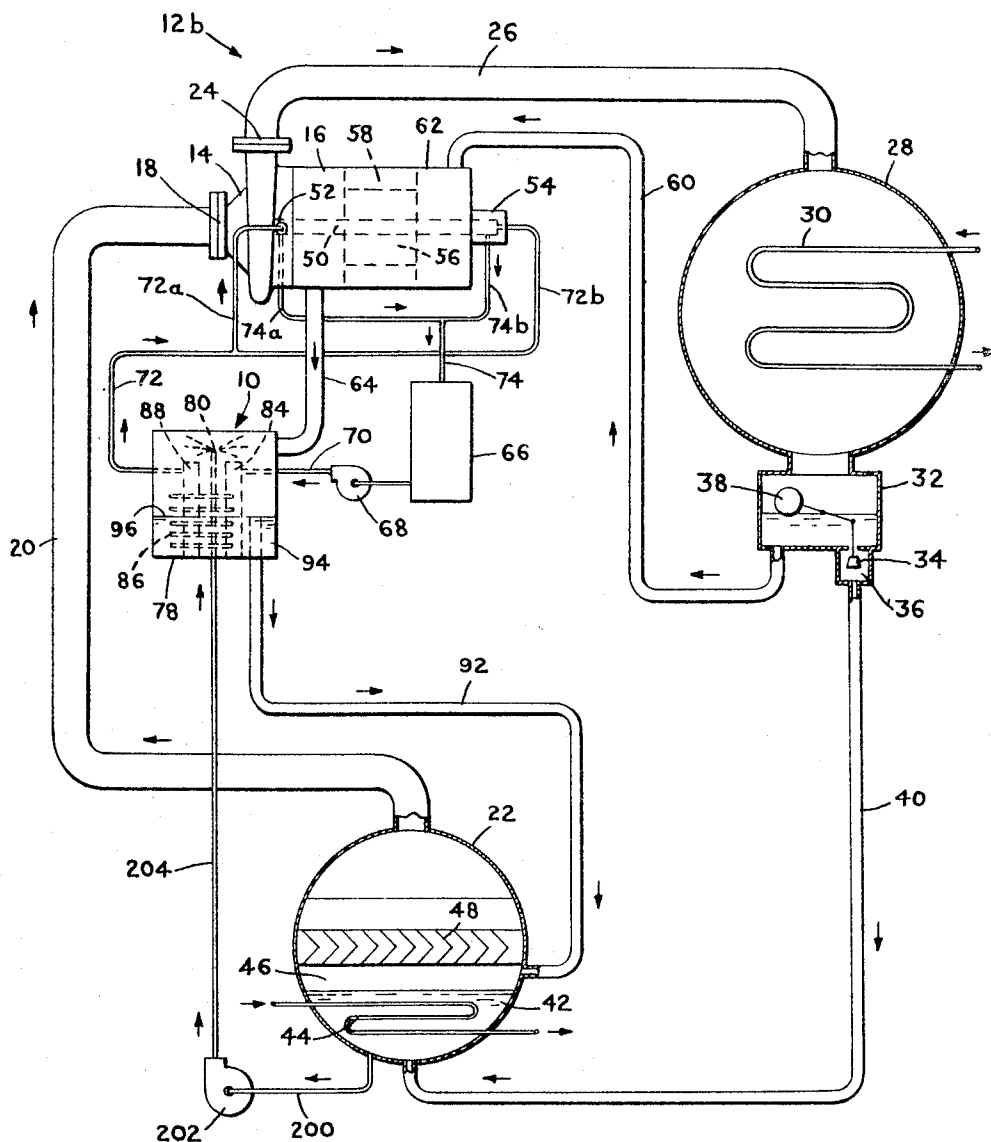


FIG. 3

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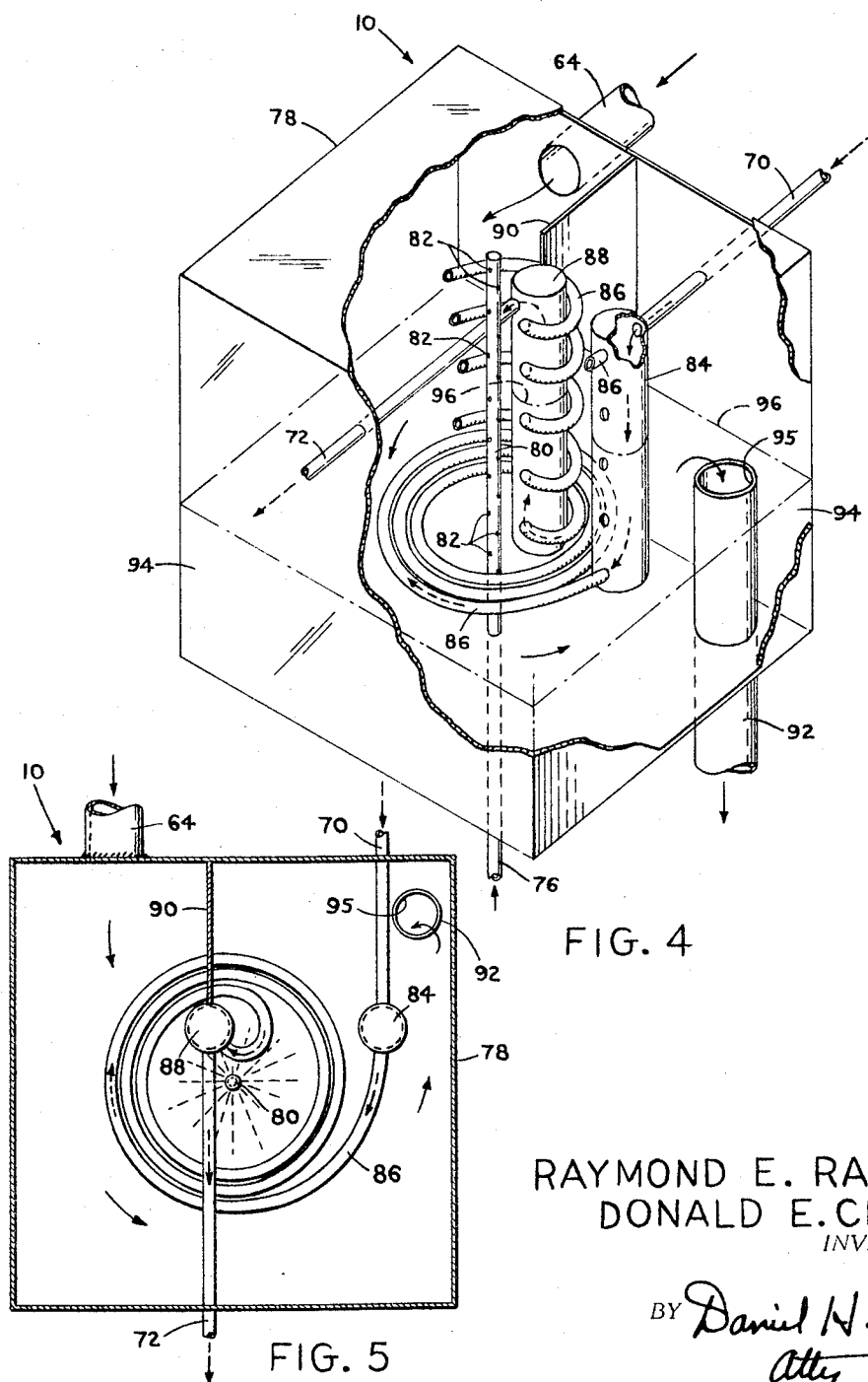
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REFRIGERANT COOLED OIL COOLER SYSTEM
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 Filed Sept. 8, 1965, Ser. No. 485,682
 12 Claims. (Cl. 62-469)

This invention relates to a refrigeration system. More particularly, the invention relates to a refrigeration system having a refrigerant cooled oil cooler system.

Oil that is used to lubricate the bearings of the prime mover of the compressor increases in temperature through use and is required to be cooled. Heretofore, one way of cooling this oil has been by passing it in indirect heat exchange relation to water connected by auxiliary lines from a suitable source. However, this has proved to be not only costly but it creates a maintenance problem due to surface fouling and sealing associated with water use, and leakage which may occur between the oil and water and results in water entering the oil and contamination of the lubrication system.

Accordingly, it is an object of the present invention to provide a novel oil cooler which utilizes refrigerant from the refrigeration system; which is simple, reliable and economical; which optimizes surface and flow patterns for maximum heat transfer at minimum cost and pressure drop in either oil or refrigerants; which utilizes a plurality of spiral coils in parallel flow between inlet and outlet headers of the oil cooler; which has a portion of the spiral coils immersed in a pool of liquid refrigerants; and which maintains a predetermined temperature condition for the refrigerant in the oil cooler corresponding to the saturation pressure for the refrigerant in question.

Other objects and advantages will be apparent from the following description of several embodiments of the invention and the novel features will be particularly pointed out hereinafter in the claims; reference being had to the accompanying drawings forming a part of this specification wherein like referenced characters designate corresponding parts in the several views. Furthermore, the phraseology or terminology employed herein is for purpose of description and not of limitation.

In the drawings:

FIGURE 1 is a diagrammatic illustration of a refrigeration system embodying the present invention.

FIGURE 2 is a diagrammatic illustration of another refrigeration system embodying the present invention.

FIGURE 3 is yet another refrigeration system in which the present invention is embodied.

FIGURE 4 is a perspective view, partially broken away of the novel oil cooler of the present invention.

FIGURE 5 is a top view, partially in section, of the novel oil cooler of the present invention.

In the embodiment of the invention shown in FIGURES 1, 4 and 5 the novel refrigerant cooled oil cooler, designated generally as 10, as incorporated in refrigeration system 12.

Refrigeration system 12, as illustrated in FIGURE 1, includes a compressor 14 powered by a suitable motive means, such as electric motor 16. The suction inlet 18 of compressor 14 is connected by line 20 to the discharge of evaporator 22 for receiving and compressing vaporous refrigerant therein and passing the hot, relatively high pressure compressed gas from its discharge 24 through line 26 to condenser 28. The vaporous refrigerant is condensed by contact with cooling coil 30 and will pass to a receiver or hot well 32 as a saturated or slightly subcooled liquid refrigerant at substantially condenser pressure.

A float valve 34 disposed in chamber 36 regulates the level of contained liquid in hot well 32 responsive to the

2

level of float 38 disposed in hot well 32. The float valve 34 will meter a stream of refrigerant and expand it to a low pressure to pass it through line 40 to the liquid space 42 of evaporator 22. A coil 44 is immersed in liquid space 42 and has a fluid passing therethrough from which heat is extracted by the temperature difference between the fluid and the refrigerant in the liquid space 42. The heat passing to the refrigerant in the liquid space 42 causes a portion of the refrigerant to vaporize and pass to the gas space 46 and then upwardly through demisters 48 wherein any entrained droplets will be collected to prevent their entering the pressure. The low pressure refrigerant gas above the demister 48 will be drawn by the compressor suction into line 20 and subsequently pass through suction inlet 18 into compressor 14 to once again increase its pressure and temperature to complete the cycle.

Motor 16 may be hermetically connected to compressor 14 and have a common shaft 50 housed in a front bearing 52 and a rear bearing 54. Rotor 56 is mounted on shaft 50 and has a stator 58 disposed thereabout in the usual manner. An impeller (not shown) is also suitably mounted on the end of the shaft extending into compressor 14.

The components of motor 16 are suitably cooled by passing high pressure, saturated liquid refrigerant from any suitable point in the system as for example from hot well 32. Line 60 will pass the liquid refrigerant from hot well 32 to motor casing 62 wherein the liquid refrigerant will at least partially flash in cooling the components of motor 16 and the discharge therefrom in line 64.

Bearings 52 and 54 of motor 16 are lubricated with oil from oil reservoir 66. The oil from reservoir 66 is forced by pump 68 and passes through line 70 into oil cooler 10 in which the oil is suitably cooled. The cooled oil passes from oil cooler 10 into lubrication line 72 having branches 72a and 72b which pass the oil to lubricate bearings 52 and 54, respectively. The spent and heated oil will be suitably collected and returned via branch lines 74a and 74b to main line 74 and then back to reservoir 66.

Oil cooler 10 receives a supply of refrigerant gas and excess liquid refrigerant from motor 16 in line 64, and it also receives a supply of high pressure liquid refrigerant from the refrigeration system 12. FIGURES 1, 4 and 5 show this supply of high pressure liquid refrigerant supplied from hot well 32 through line 76 which extends into the housing 78 of oil cooler 10 to form a high pressure liquid refrigerant header or spray header 80. Header 80 has a plurality of circumferentially spaced nozzle openings 82 formed therein from which liquid refrigerants will be sprayed radially outwardly therefrom to pass in indirect heat exchange relationship with the oil to be cooled as more fully described hereinafter.

Referring to FIGURES 4 and 5, an enlargement of oil cooler 10 is shown. Oil inlet line 70 extends into housing 78 and connects into an inlet header 84 to which is connected a plurality of horizontally disposed spiral coils 86 in vertically spaced relationship to each other. The end of spiral coil 86 remote from inlet header 84 is connected to an outlet header 88 in corresponding vertically spaced relationship. Spiral coils provide for parallel flow of the oil between inlet header 84 and outlet header 88 and thus provide a maximum surface in a minimum space with minimum pressure drop. The oil will enter oil cooler through line 70 and pass to inlet header 84 from which it will pass in parallel flow through the spiral coils 86 in a radially inwardly prescribed path to outlet header 88 from which it will be discharged in lubrication line 72 as described hereinbefore.

The side of header 88 remote from the connection of the spiral coils 86 has a baffle 90 extending therefrom to

connect to the rear wall of housing 78. Baffle 90 extends the full height of housing 78 so as to form a transverse partition which prevents short circuiting of the refrigerant flow from line 64 to the refrigerant overflow line 92. Overflow line 92 is disposed remote from line 64 on the opposite side of baffle 90 and extends a predetermined vertical distance into housing 78. An opening 95 is formed in the top of overflow line 92 which the refrigerant, gas and liquid, will pass.

The refrigerant gas is forced to swirl about spiral coils 86 prior to being drawn into overflow line 92 so as to effect maximum heat transfer therebetween. Any excess liquid refrigerant in line 64 will pass to liquid refrigerant collecting portion 94 in housing 78, the height of which is established by the vertical extension of overflow pipe 92 so that the liquid level 96 will remain substantially at that level, being shown as approximately $\frac{1}{3}$ of the height of housing 78 and in which approximately $\frac{1}{3}$ of the spiral coils are immersed.

Spray header 80 is disposed inside the spiral coils 86 adjacent outlet header 88. Spray header 80 will spray its liquid refrigerant radially outwardly to effect the greatest contact therewith, thus obtaining the maximum heat transfer therebetween. The liquid refrigerant sprayed therefrom will collect in the liquid refrigerant collecting portion 94 and maintain a liquid level 96 with any excess amount being discharged through overflow line 92 from which it will enter gas space 46 of evaporator 22 so that the gaseous refrigerant will pass upwardly through demister 48 and the liquid refrigerant will pass downwardly to liquid space 42.

For purposes of example, the refrigerant in question is assumed to have properties which will permit the liquid refrigerant in the liquid refrigerant collecting portion 94 to boil at between 40° F. to 50° F., while the top of the coil is being cooled by the relatively cooled refrigerant gas at between 45° F. and 55° F. These temperatures will correspond to the saturation pressure existing in the oil cooler, with the gas having a slight amount of superheat i.e. approximately 5° F.

In the embodiment of the invention illustrated in FIGURE 2, the refrigeration system is designated generally as 12a.

Refrigeration system 12a is substantially identical to the refrigeration system 12 described hereinbefore, except that it incorporates a multi-stage compressor and an economizer in the system.

Compressor 14a has a first stage 15a which draws vaporous refrigerant from the suction inlet 18 and discharges it into an intermediate volute 17a from which the gaseous refrigerant is vertically compressed in the second stage 15b prior to discharge at 24 into line 26 from which it passes to the condenser 28. Condenser 28 includes coil 30 for extracting sufficient heat from the gaseous refrigerant to enable it to change phase into the liquid state prior to passing to hot well 32. Hot well 32 has a portion of the liquid refrigerant pass through line 60 to cool motor 16, as described hereinbefore. Float valve 34 controls the main discharge from hot well 32 and permits the liquid refrigerant to pass in line 110 into an economizer 112 which also has a float valve 114 the flow from which is controlled by float 116. The liquid refrigerant passing float valve 114 enters line 40 for passage to the liquid space 42 of evaporator 22.

A portion of the liquid refrigerant from economizer 112 will pass through line 76 to header 80 from which it will be spray discharged in oil cooler 10 to substantially cool the oil passing therethrough.

The liquid refrigerant passing from the condenser 28 to the hot well 32, to the economizer 112, to the evaporator 22, will pass from an initial higher pressure to a successively lower pressure as the liquid refrigerant is expanded through float valve 34 and 114. Any vapor formed in economizer 112 due to a flashing action as the liquid passes to a zone of lower pressure will pass through line

120 into volute 17a wherein it will combine with the discharge from first stage 15a and be compressed therewith in second stage 15b of compressor 14a.

The lubrication system including oil cooler 10, oil reservoir 66 and oil pump 68 is substantially identical to that described hereinbefore and will not be repeated. Oil cooler 10 is shown in detail in FIGURES 4 and 5 which also have been described hereinbefore. Since the structure and operation of oil cooler 10 in this embodiment of the invention is substantially the same as that set forth in connection with the embodiment of the invention shown and described under FIGURE 1 and will be clearly understood by referring to the description given thereunder.

In the embodiment of the invention illustrated in FIGURE 3 yet another form of a refrigeration system is shown, designated generally as 12b.

Refrigeration system 12b is substantially identical to refrigeration system 12 of FIGURE 1, except that instead of supplying high pressure liquid refrigerant to spray header 80 from hot well 32 low pressure liquid refrigerant from liquid space 42 of evaporator 22 is passed through line 200 into booster pump 202 and discharged in line 204 as high pressure liquid refrigerant. Line 204 extends into housing 78 of oil cooler 10 and has spray header 80 formed at its end therein.

The remaining structure and operation of refrigeration system 12b is substantially the same as refrigeration system 12 and like reference characters designate the various components.

Briefly describing refrigeration system 12b, gaseous refrigerant will be drawn into compressor 14 and the compressed gaseous refrigerant will be passed therefrom in line 26 into condenser 28 wherein the same will be condensed. The liquid refrigerant will be collected in hot well 32 from which a controlled amount will be discharged past float valve 34 and expanded thereby. The expanded liquid refrigerant will pass in line 40 into liquid refrigerant space 42 of evaporator 22 wherein the liquid refrigerant will extract heat from coil 44 and be evaporated therein to substantially pass in line 20 into compressor 14 to repeat the cycle.

A portion of the liquid refrigerant from hot well 32 will pass in line 60 to enter motor casing 62 to cool motor 16 prior to being discharged therefrom in line 64 to enter oil cooler 10 for purposes of cooling the oil passing therethrough.

Bearings 52 and 54 are lubricated by lubrication system which includes oil reservoir 66, oil pump 68, oil cooler 10 and suitable connecting lines 70, 72, 72a, 72b and 74. The structure and operation of oil cooler 10 is exactly the same as that shown and described herebefore under FIGURES 4 and 5.

It will be understood that various changes in the details, materials, arrangement of parts and operating conditions which have been herein described and illustrated in order to explain the nature of the invention may be made by those skilled in the art by the principles and scope of the invention as expressed in the claims.

What is claimed is:

1. A refrigeration system in which refrigerant is circulated between a high pressure side and a low pressure side comprising:

- (a) a compressor driven by a motive means,
- (b) a condenser means to receive the high pressure refrigerant and condense the same,
- (c) an expansion device to expand the condensed refrigerant into a low pressure liquid,
- (d) an evaporator to receive the low pressure liquid to evaporate the same, the gas being drawn into the compressor,
- (e) an oil lubrication means to supply oil to and receive the returned oil from the motive means,
- (f) an oil cooler disposed in the oil lubrication means,
- (g) a coil means disposed in the oil cooler in communication with the oil lubrication means,

5

- (h) a delivery line connected between the oil cooler and said system to deliver high pressure refrigerant to the oil cooler,
- (i) spray means connected to the delivery line and disposed in the oil cooler, and to receive high pressure refrigerant from the delivery line for spray discharge therefrom in heat exchange relation with the coil means to cool the oil therein,
- (j) a return line connected between the oil cooler and the low pressure side of said system to return refrigerant to said system,
- (k) the coil means having the oil therein pass in an arcuate path of decreasing radius, and
- (l) the spray means disposed inwardly of the coil means to spray the refrigerant radially outwardly thereof to effect counter-flow heat exchange therewith.

2. A refrigeration system in which refrigerant is circulated between a high pressure side and a low pressure side comprising:

- (a) a compressor driven by a motive means,
- (b) a condenser means to receive the high pressure refrigerant and condense the same,
- (c) an expansion device to expand the condensed refrigerant into a low pressure liquid,
- (d) an evaporator to receive the low pressure liquid to evaporate the same, the gas being drawn into the compressor,
- (e) an oil lubrication means to supply oil to and receive the returned oil from the motive means,
- (f) an oil cooler disposed in the oil lubrication means,
- (g) a coil means disposed in the oil cooler in communication with the oil lubrication means,
- (h) a delivery line connected between the oil cooler and said system to deliver high pressure refrigerant to the oil cooler,
- (i) spray means connected to the delivery line and disposed in the oil cooler, and to receive high pressure refrigerant from the delivery line for spray discharge therefrom in heat exchange relation with the coil means to cool the oil therein,
- (j) a return line connected between the oil cooler and the low pressure side of said system to return refrigerant to said system,
- (k) a first line means connected between the condenser means and the motive means to deliver liquid refrigerant to cool the motive means, and
- (l) a second line means connected between the motive means and the oil cooler whereby the refrigerant will be discharged from the motive means into the oil cooler.

3. The combination claimed in claim 2 wherein:

- (a) the second means connected to the oil cooler in spaced relationship to the coil means whereby the refrigerant therefrom will pass in heat exchange relation with the coil means to cool the oil therein.

4. The combination claimed in claim 3 wherein:

- (a) the second means disposed externally of the coil means.

5. The combination claimed in claim 4 wherein:

- (a) the coil means having the oil therein pass in a single directional arcuate path of decreasing radius, and
- (b) baffle means disposed in the oil cooler to force the refrigerant from the second means to flow across the coil means in an oppositely directed path as that of the oil flowing in the coil means to effect maximum heat exchange therewith.

6. A refrigeration system in which refrigerant is circulated between a high pressure side and a low pressure side comprising:

- (a) a compressor driven by a motive means,
- (b) a condenser means to receive the high pressure refrigerant and condense the same,

6

- (c) an expansion device to expand the condensed refrigerant into a low pressure liquid,
- (d) an evaporator to receive the low pressure liquid to evaporate the same, the gas being drawn into the compressor,
- (e) an oil lubrication means to supply oil to and receive the returned oil from the motive means,
- (f) an oil cooler disposed in the oil lubrication means,
- (g) a coil means disposed in the oil cooler in communication with the oil lubrication means,
- (h) a delivery line connected between the oil cooler and said system to deliver high pressure refrigerant to the oil cooler,
- (i) spray means connected to the delivery line and disposed in the oil cooler, and to receive high pressure refrigerant from the delivery line for spray discharge therefrom in heat exchange relation with the coil means to cool the oil therein,
- (j) a return line connected between the oil cooler and the low pressure side of said system to return refrigerant to said system,
- (k) the condenser means including a condenser, a hotwell means and an economizer means,
- (l) the economizer means at an intermediate pressure and to receive liquid refrigerant from the hotwell means, and
- (m) the delivery line connected between the oil cooler and the economizer to deliver liquid refrigerant to the oil cooler.

7. A refrigeration system in which refrigerant is circulated between a high pressure side and a low pressure side comprising:

- (a) a compressor driven by a motive means,
- (b) a condenser means to receive the high pressure refrigerant and condense the same,
- (c) an expansion device to expand the condensed refrigerant into a low pressure liquid,
- (d) an evaporator to receive the low pressure liquid to evaporate the same, the gas being drawn into the compressor,
- (e) an oil lubrication means to supply oil to and receive the returned oil from the motive means,
- (f) an oil cooler disposed in the oil lubrication means,
- (g) a coil means disposed in the oil cooler in communication with the oil lubrication means,
- (h) a delivery line connected between the oil cooler and said system to deliver high pressure refrigerant to the oil cooler,
- (i) spray means connected to the delivery line and disposed in the oil cooler, and to receive high pressure refrigerant from the delivery line for spray discharge therefrom in heat exchange relation with the coil means to cool the oil therein,
- (j) a return line connected between the oil cooler and the low pressure side of said system to return refrigerant to said system,
- (k) the condenser means including a condenser and a hotwell means, and
- (l) the delivery line including:
 - (1) a line means connected between the evaporator and the oil cooler,
 - (2) a pumping means disposed in the line means to energize the liquid refrigerant therein.

8. A refrigeration system in which refrigerant is circulated between a high pressure side and a low pressure side comprising:

- (a) a compressor driven by a motive means,
- (b) a condenser means to receive the high pressure refrigerant and condense the same,
- (c) an expansion device to expand the condensed refrigerant into a low pressure liquid,
- (d) an evaporator to receive the low pressure liquid to evaporate the same, the gas being drawn into the compressor,

- (e) an oil lubrication means to supply oil to and receive the returned oil from the motive means,
- (f) an oil cooler disposed in the oil lubrication means,
- (g) a coil means disposed in the oil cooler in communication with the oil lubrication means,
- (h) a delivery line connected between the oil cooler and said system to deliver high pressure refrigerant to the oil cooler,
- (i) spray means disposed to the delivery line and disposed in the oil cooler, and to receive high pressure refrigerant from the delivery line for spray discharge therefrom in heat exchange relation with the coil means to cool the oil therein,
- (j) a return line connected between the oil cooler and the low pressure side of said system to return refrigerant to said system,
- (k) the return line extending into the oil cooler and having an opening therein in spaced relationship to the bottom of the oil cooler to permit a pool of liquid refrigerant to collect in the oil cooler prior to discharge therefrom, and
- (l) the coil means having at least a portion thereof extending into the pool or liquid refrigerant.
9. A refrigeration system in which refrigerant is circulated between a high pressure side and a low pressure side comprising:
- (a) a compressor driven by a motive means,
- (b) a condenser means to receive the high pressure refrigerant and condense the same,
- (c) an expansion device to expand the condensed refrigerant into a low pressure liquid,
- (d) an evaporator to receive the low pressure liquid to evaporate the same, the gas being drawn into the compressor,
- (e) an oil lubrication means to supply oil to and receive the returned oil from the motive means,
- (f) an oil cooler disposed in the oil lubrication means,
- (g) a coil means disposed in the oil cooler in communication with the oil lubrication means,
- (h) a delivery line connected between the oil cooler and said system to deliver high pressure refrigerant to the oil cooler,
- (i) spray means connected to the delivery line and disposed in the oil cooler, and to receive high pressure refrigerant from the delivery line for spray discharge therefrom in heat exchange relation with the coil means to cool the oil therein,
- (j) a return line connected between the oil cooler and the low pressure side of said system to return refrigerant to said system, and
- (k) the spray means disposed within the coil means to discharge the liquid refrigerant therefrom in heat exchange relation with the oil passing through the coil means.
10. A refrigeration system in which refrigerant is circulated between a high pressure side and a low pressure side comprising:
- (a) a compressor driven by a motive means,
- (b) a condenser means to receive the high pressure refrigerant and condense the same,
- (c) an expansion device to expand the condensed refrigerant into a low pressure liquid,
- (d) an evaporator to receive the low pressure liquid to evaporate the same, the gas being drawn into the compressor,
- (e) an oil lubrication means to supply oil to and receive the returned oil from the motive means,
- (f) an oil cooler disposed in the oil lubrication means,
- (g) a coil means disposed in the oil cooler in communication with the oil lubrication means,
- (h) a delivery line connected between the oil cooler

- and said system to deliver high pressure refrigerant to the oil cooler,
- (i) spray means connected to the delivery line and disposed in the oil cooler, and to receive high pressure refrigerant from the delivery line for spray discharge therefrom in heat exchange relation with the coil means to cool the oil therein,
- (j) a return line connected between the oil cooler and the low pressure side of said system to return refrigerant to said system,
- (k) the spray means disposed adjacent to the coil means to discharge the liquid refrigerant therefrom in heat exchange relation with the oil passing through the coil means.
11. A refrigeration system in which refrigerant is circulated between a high pressure side and a low pressure side comprising:
- (a) a compressor driven by a motive means,
- (b) a condenser means to receive the high pressure refrigerant and condense the same,
- (c) an expansion device to expand the condensed refrigerant into a low pressure liquid,
- (d) an evaporator to receive the low pressure liquid to evaporate the same, the gas being drawn into the compressor,
- (e) an oil lubrication means to supply oil to and receive the returned oil from the motive means,
- (f) an oil cooler disposed in the oil lubrication means,
- (g) a coil means disposed in the oil cooler in communication with the oil lubrication means,
- (h) a delivery line connected between the oil cooler and said system to deliver high pressure refrigerant to the oil cooler,
- (i) distribution means connected to the delivery line and disposed in the oil cooler, and to receive high pressure refrigerant from the delivery line for discharge therefrom in heat exchange relation with the coil means to cool the oil therein,
- (j) a return line connected between the oil cooler and the low pressure side of said system to return refrigerant to said system, and
- (k) a pump means operatively connected in the oil lubrication means to supply a forced feed of oil to the oil cooler and motive means.
12. The combination claimed in claim 11 wherein:
- (a) an inlet header connected on one end of the coil means,
- (b) an outlet header connected on the other end of the coil means,
- (c) the coil means including a plurality of individual coils extending between the inlet header and the outlet header.

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