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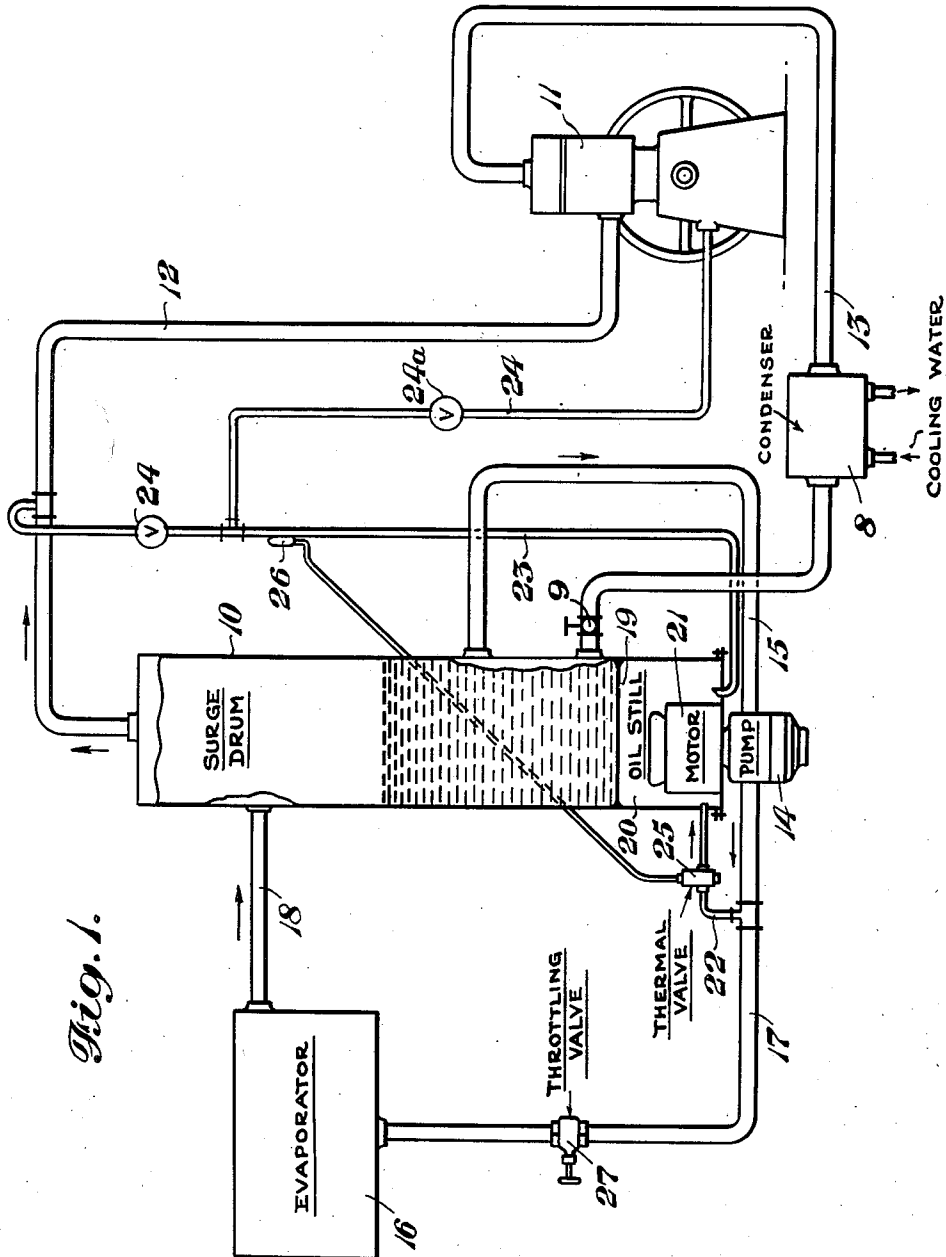
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OIL REMOVAL SYSTEM FOR REFRIGERATION APPARATUS

Filed Jan. 16, 1951

3 Sheets-Sheet 1



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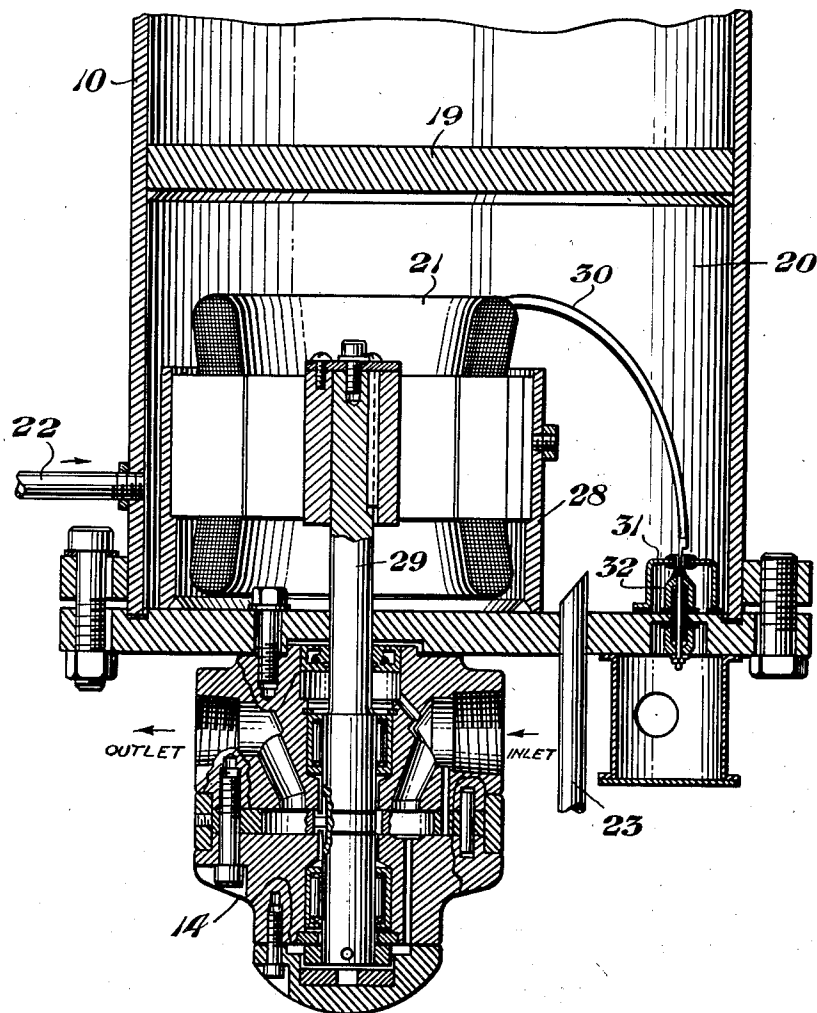
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Fig. 2.



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3 Sheets-Sheet 3

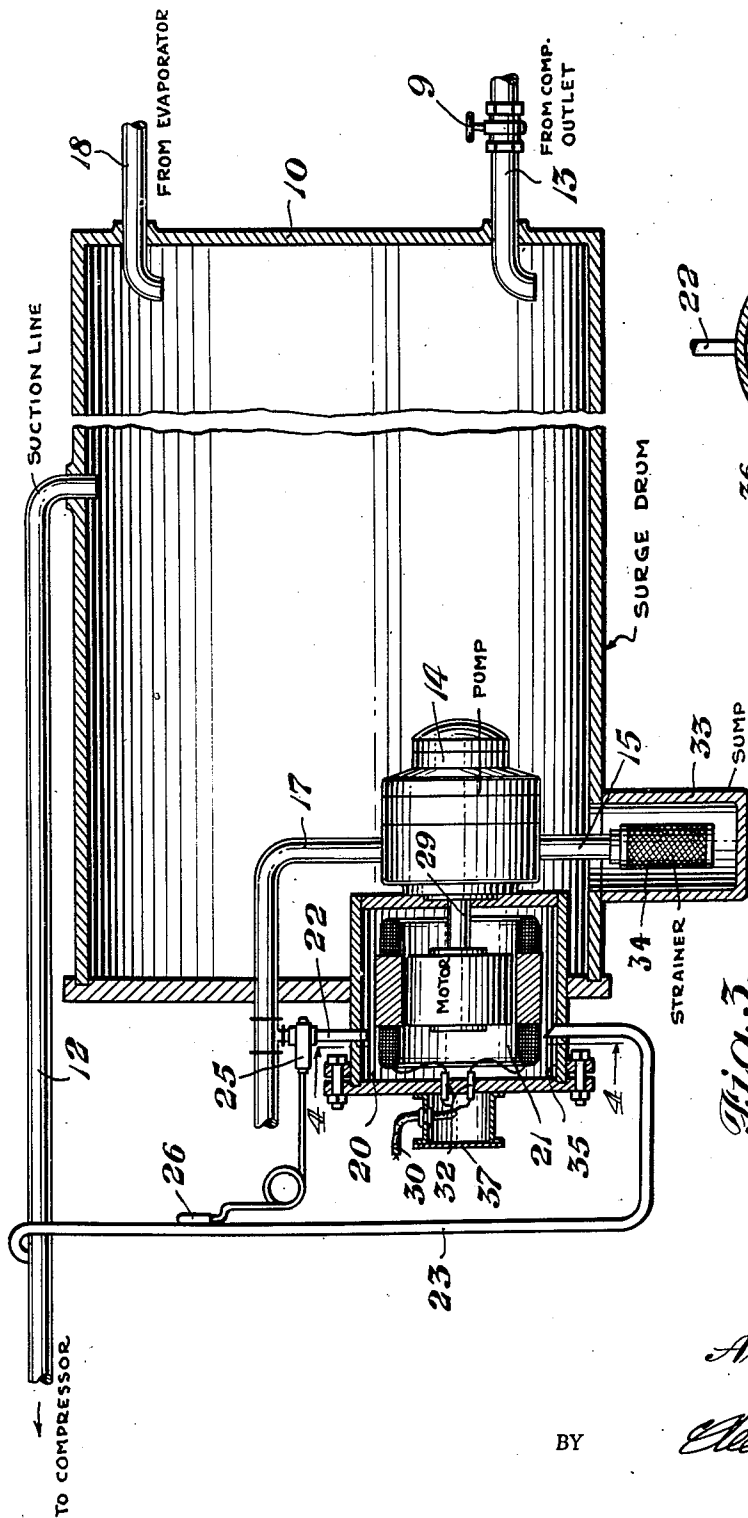


Fig. 3.

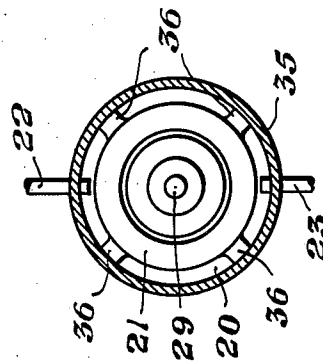


Fig. 4.

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OIL REMOVAL SYSTEM FOR REFRIGERATION APPARATUS

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This invention relates to refrigeration apparatus and more particularly to oil removal systems in apparatus designed to provide extremely low temperatures for low temperature test rooms and the like.

It has been determined that refrigeration systems best adapted to extreme low temperature applications are those which employ a surge drum as a storage receptacle for liquid refrigerant supplied by a compressor and in which the liquid refrigerant in the drum is circulated, preferably by means of a small pump, to an evaporator of any conventional type.

The problem of oil removal is, unfortunately, as much of a problem in apparatus of this type as in any conventional refrigeration system. There are numerous schemes in the prior art for effecting a separation of the oil from the refrigerant and returning it to the compressor. When using refrigerants from the Freon group, the difficulties of the problem are increased due to the extreme miscibility of lubricating oils in these refrigerants in all proportions. A simple trap is ineffective, and consequently recourse has been had to a fractionating still. Since such a still requires heat, it was natural that those skilled in the art would look to some part of a refrigerating apparatus to supply this heat to avoid the necessity of additional apparatus and power. Examples of the prior art may be found in the U. S. patents to Beline, 2,223,882 and Pownall, 2,223,900 of 1940.

This invention has as its object, the provision of a compact oil still for use in a refrigerating system of the type which includes a surge drum and circulating pump.

A further object is to provide heat for such a still without materially reducing the overall efficiency of the refrigerating system, and without the addition of any separate source of heat to the refrigerating system.

Other objects will be apparent from the following description in conjunction with the accompanying drawings, in which

Figure 1 shows in somewhat diagrammatic form one embodiment of a refrigeration system including the apparatus of this invention,

Figure 2 is a sectional view of a preferred embodiment of an oil still in accordance with this invention,

Figure 3 shows another embodiment of the oil still and surge drum apparatus,

Figure 4 is a sectional view taken on line 4—4 of Figure 3.

In general, the objects of this invention are

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achieved by providing, in the base of the surge drum, a separate compartment or chamber which serves as an oil still. The motor which drives the circulating pump is housed within the chamber and the waste heat from this motor is sufficient to operate the still.

Referring now to Figure 1, the surge drum 10 is linked to the compressor 11 by a suction line 12 and a liquid line 13. Refrigerant in liquid form is thus supplied to the lower portion of the drum and gaseous refrigerant is withdrawn from the upper portion of the drum through the lines 12 and 13, respectively. The latter may be closed conduits of a size best suited for the amount of refrigerant to be handled.

Interposed in liquid line 13, between the compressor 11 and the surge drum 10 are a condenser 8 and an expansion valve 9. Condenser 8 may be of any conventional type and hence is shown only diagrammatically. The expansion valve 9 may be a manual type valve as shown, or it may be a float controlled valve of the type well known to the art.

The pump 14 is connected to the drum by an inlet line 15 and to the evaporator 16 by line 17. The evaporator may be of any conventional type and hence is not shown other than diagrammatically. Refrigerant passing through the evaporator largely changes from a liquid to gaseous phase and the gas is returned to the drum 10 through the line 18. This completes the basic refrigerant circuit and the oil still apparatus of this invention will be described with reference thereto.

As is well known in the art, there is a marked tendency for lubricating oil from the compressor to become mixed with the refrigerant. In the evaporator, the oil tends to still or settle out and accumulate as the refrigerant evaporates. A steady accumulation of oil in the evaporator detracts to a considerable degree from the efficiency of the whole system and hence some means is necessary to limit this accumulation.

Referring again to Figure 1, the surge drum has an imperforate partition 19 near the bottom thereof thus defining a separate closed chamber 20. Mounted within the chamber, is the motor 21 which drives the pump 14. A line 22, is connected between the chamber and some intermediate point on the line 17. Line 22 is much smaller than line 17 and hence is capable of handling only a small volume of refrigerant. Another line 23 connects the lower end of the chamber 20 with the suction line 12. Alternatively, this connection could be made between the chamber 20 and the crankcase of the compres-

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sor as shown at 24 by opening valve 24a and closing valve 24b, because both the crankcase and the suction line are at substantially the same pressure. A thermal expansion valve 25 of the conventional type may be placed in line 22 to control the admission of refrigerant to the oil still chamber. Conveniently this valve may be made responsive to temperatures in line 23 by means of the usual bulb 26, and in practice is set to hold at approximately a ten degree temperature differential between lines 22 and 23. A fixed orifice has also been used successfully in place of the thermal expansion valve 25.

A simple throttling valve 27 is placed in line 17 between the evaporator and the point of jointure between lines 17 and 22. This valve is for the purpose of maintaining a pressure differential effective to feed oil-containing refrigerant to the thermal valve.

An equally workable substitute for the thermal expansion valve 25 would be a capillary line which would take the place of line 22. Also, in lieu of connecting line 22 to line 17 as shown, this connection can also be made to line 18, although this change would further necessitate locating valve 27 at a point in line 18 intermediate the surge drum and the point of connection of line 22.

In operation, therefore, a small amount of the liquid refrigerant which would otherwise be fed to the evaporator by the pump 14, is by-passed through line 22 to the oil still chamber 20. The waste heat from the motor windings is sufficient to cause evaporation of the liquid refrigerant which allows entrained lubricant to settle-out in the bottom of the chamber 20. Since the still chamber is connected to the suction side of the system through lines 23 or 24, the lubricant is carried back to the compressor, in relatively small liquid portions in compact form ("slugs") by the gaseous refrigerant. Whether the lubricant return is to the suction line inlet or to the crankcase is immaterial, because the piston rings in compressors of the conventional type tend to direct lubricant down the cylinder walls and into the crankcase. Where the lubricant and refrigerant gas are returned to the crankcase, the refrigerant will work past the rings into the compression space on the down stroke of the pistons.

Referring now to Figure 2 which shows the oil still chamber in detail, and in which corresponding parts are given the same reference numerals as in Figure 1, only the lower part of the drum 10 is shown. The partition 19 is welded or otherwise suitably affixed to the drum walls to form a liquid and gas tight joint. The motor 21 is surrounded by a metallic shield 28 which may be welded to the bottom of the surge drum as shown, to provide a liquid tight joint.

Line 22 which carries the refrigerant from the high pressure side of the pump to the oil still is led through the side of the surge drum into the oil still chamber at a point which is below the level of the top of the shield 28. By this arrangement liquid refrigerant and lubricant are prevented from pouring in and over the motor itself and are confined to the space external to the shield member 28.

Line 23 which connects the oil still chamber to the suction side of the refrigeration system is shown as entering the still chamber through the bottom portion and extending only a short distance up from the base of the chamber. The proximity of the opening or end portion of this line to the base of the still chamber is the im-

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portant consideration. Obviously the same result could be achieved if the line 23 were led into the chamber at some intermediate point and extended downwardly to a point adjacent the bottom. Since the oil which is distilled out of the refrigerant collects in the base of the chamber, it is desirable to have at least a portion of the open end of the line 23 so positioned that it extends below the surface of the oil. As gas pressure builds up in the upper part of the chamber due to evaporation of liquid refrigerant, the oil is forced out through the line 23 and returned in "slugs" to the compressor.

The shaft 29 of the motor 21 passes through the base of the oil still chamber through a liquid and gas tight seal.

The same holds true for the conductors 30, and a metallic shield member 31 is also provided around the insulated bushing 32, to shield it from the liquids in the still chamber.

The pump 14 may be of any suitable type but is shown here as a gear type positive displacement pump.

Since the waste heat from the motor windings is utilized to operate the oil still, the windings are kept cool. In addition, the metallic connection between the pump and the refrigerated surge drum serves to cool the pump. One advantage of this is that it minimizes the tendency for refrigerant to evaporate in the pump which would otherwise result in loss of pump prime or pump efficiency.

Referring now to Figure 3 which shows an alternative arrangement of the oil still apparatus, and in which corresponding parts are given the same reference numerals as in the other drawings, the pump 14 is mounted within the surge drum 10, the latter being supported in a horizontal position. The pump 14 is positioned to be submerged in the liquid refrigerant in the drum, and therefore in direct heat conducting relation thereto. This insures chilling of the pump to an extent that will prevent evaporation of liquid refrigerant in the pump with consequent tendency to cause it to lose its efficiency and prime. A sump 33 is provided in the lower portion of the drum 10, and the pump inlet line 15 is connected to a strainer 34 which is positioned in the sump. The oil still chamber 20 which in this case may be formed by a cylindrical member such as shown at 35 is mounted at least partially within the drum. The shaft 29 which is common to the pump 14 and the motor 21 must, as in the embodiment shown in Figures 1 and 2, extend through one wall of the oil still chamber 20. The remaining conduit connections to the drum and to the oil still chamber are the same as before, and while the return line 23 is shown connected to the suction line 12, Figure 3, this could also be returned to the crankcase of the compressor as indicated in the dotted line showing at 24 in Figure 1.

Figure 4 is a section on line 4-4 of Figure 3 and shows, in some detail, the mounting of the motor 21 within the oil still chamber 20. A plurality of ribs 36 may be interposed between the motor 21 and the wall 35, and these may be held in place by bolts which extend through the wall 35, the ribs 36 and are anchored in the frame of the motor 21. Depending on the length of the ribs 36 it may be necessary to cut out a portion of these ribs to allow lubricant-bearing refrigerant to drain down to the lower portion of the oil still chamber where it may exit through line 23 as described with reference to Figure 1.

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Although any suitable arrangement of the electric conductors 30 to bring them out through the wall of the oil still chamber in conformance with good engineering practice would be satisfactory, they are shown here as entering through a junction box 37 which is suitably affixed to an outer wall of the chamber 20.

The suggested substitutes for the thermal valve 25 discussed with reference to Figure 1 would, of course, be equally workable in the apparatus shown in Figure 3 and such substitutions are within the scope of the instant invention.

From the foregoing it will be apparent to those skilled in the art that the apparatus herein disclosed constitutes a new and useful oil still in use in connection with a specific type of refrigeration system applicable generally to the extreme low temperature field. The novel features are set forth with particularity in the appended claims:

I claim:

1. In refrigeration apparatus of the type in which a compressor feeds liquid refrigerant to a surge drum and a circulating pump supplies liquid refrigerant from the drum to an evaporator, an oil fill system comprising: a closed oil still chamber housing the prime mover for the said circulating pump; a first conduit connecting said chamber to a point in the refrigerant circuit intermediate the pump outlet and the point of return of refrigerant to the surge drum from the evaporator; a second conduit connected with said chamber and with the low pressure side of said compressor for returning separated oil and refrigerant to said compressor; and means for maintaining a pressure differential for feeding refrigerant through said first conduit; whereby a portion of the refrigerant circulating between the surge drum and evaporator is by-passed to the closed chamber where the oil in the refrigerant is separated therefrom by the distilling action of the waste heat of the prime mover and returned in relatively small liquid portions, in compact form, to the compressor through said second conduit.

2. In refrigeration apparatus of the type in which a compressor feeds liquid refrigerant to a surge drum and a circulating pump supplies liquid refrigerant from the drum to the evaporator, an oil still system comprising: a closed oil still chamber housing the prime mover for the said circulating pump; a first conduit connecting said chamber to a point in the refrigerant circuit intermediate the pump outlet and the point of return of refrigerant to the surge drum from the evaporator; a second conduit connected with said chamber and with the low pressure side of said compressor for returning separated oil and refrigerant to said compressor; throttling means in said first conduit for controlling the passage of refrigerant therethrough; and means for maintaining a pressure differential for feeding refrigerant through said first conduit; whereby a portion of the refrigerant circulating between the surge drum and evaporator is by-passed to the closed chamber where the oil in the refrigerant is separated therefrom by the distilling action of the waste heat of the prime mover and returned in relatively small liquid portions, in compact form, to the compressor through said second conduit.

3. In refrigeration apparatus of the type in which a compressor feeds liquid refrigerant to a surge drum and a circulating pump supplies liquid refrigerant from the drum to an evapora-

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tor, an oil still system comprising: a closed oil still chamber located within the surge drum and housing the prime mover for the circulating pump; a first conduit connecting said chamber to a point in the refrigerant circuit between the pump outlet and the evaporator inlet; a second conduit connected with said chamber and with the low pressure side of said compressor for returning separated oil and refrigerant to said compressor; a thermal valve in said first conduit responsive to temperatures in said second conduit; and a throttling valve located between said first conduit and the evaporator for maintaining a pressure differential for feeding refrigerant through said thermal valve; whereby a portion of the refrigerant circulating between the surge drum and evaporator is by-passed to the closed chamber where the oil in the refrigerant is separated therefrom by the distilling action of the waste heat of the prime mover and returned in relatively small liquid portions, in compact form, to the compressor through said second conduit.

4. Apparatus as defined by claim 1 in which the second conduit is connected between the closed chamber and the suction line of the compressor.

5. Apparatus as defined by claim 1 in which the second conduit is connected between the closed chamber and the crankcase of the compressor.

6. Refrigeration apparatus including an oil still and comprising in combination: a compressor; a surge drum; means including closed conduits connecting said surge drum and said compressor for furnishing liquid refrigerant to the lower portion of said drum and withdrawing gaseous refrigerant from the upper portion of said drum; a closed oil still chamber in the base of said drum; a motor mounted in said chamber; a pump mounted externally of said chamber and having a driving connection with said motor; an evaporator; closed conduit means connecting said pump, evaporator and surge drum to provide a path for circulation of refrigerant from said drum through said evaporator; means including a thermally controlled valve for by-passing a small quantity of oil-bearing liquid refrigerant to said closed chamber from the conduit linking said pump and evaporator in order to evaporate said refrigerant by subjecting it to the waste heat of said motor thus separating lubricant entrained therein; and means including a closed conduit for returning the separated lubricant to the compressor.

7. Refrigeration apparatus including an oil still and comprising in combination: a compressor; a surge drum; means including closed conduits connecting said surge drum and said compressor for furnishing liquid refrigerant to the lower portion of said drum and withdrawing gaseous refrigerant from the upper portion of said drum; a closed chamber in the base of said drum; a motor mounted in said chamber; a pump mounted externally of said chamber and having a driving connection with said motor; an evaporator; closed conduit means connecting said pump, evaporator and surge drum to provide a path for circulation of refrigerant from said drum through said evaporator; a first closed line connecting with the closed chamber and the conduit linking said pump and evaporator for by-passing a small quantity of oil-bearing refrigerant to said closed chamber; a second closed line connecting with said chamber and with the low pressure side of said compressor for returning separated oil and refrigerant to said compressor; thermal valve

means in said first line responsive to temperatures in said second line for controlling the admission of refrigerant to said closed chamber; and means for maintaining a pressure differential for feeding refrigerant through said thermal valve; whereby a portion of the refrigerant circulating between the surge drum and evaporator is by-passed to the closed chamber where the oil in the refrigerant is separated therefrom by the distilling action of the waste heat of the motor and returned in relatively small liquid portions, in compact form, to the compressor through said second closed line.

8. A surge drum and refrigerant circulating pump structure, for use in a refrigeration system of the type in which a compressor feeds liquid refrigerant to the drum and the pump circulates refrigerant from the drum to an evaporator, said structure comprising: a surge drum; means on said surge drum affording inlet and outlet connections for the high and low pressure sides respectively of said compressor; a closed chamber mounted in heat conducting relation to said drum; a motor mounted within said chamber; a pump mounted externally of said chamber and in heat conducting relation thereto; and a drive shaft connecting said pump and said motor, said shaft extending through a wall of said chamber.

9. In refrigeration apparatus of the type in which a compressor feeds liquid refrigerant to a surge drum and a circulating pump supplies liquid refrigerant from the drum to an evaporator, an oil still system comprising: a closed oil still chamber positioned at least partially within said surge drum; a circulating pump positioned within said surge drum and immersed in the liquid refrigerant therein; a motor positioned within said chamber and having a driving connection with said pump; a first conduit connecting said chamber to a point in the refrigerant circuit intermediate the pump outlet and the point of return of refrigerant to the surge drum from the evaporator; a second conduit connected with said chamber and with the low pressure side of said compressor for returning separated oil and refrigerant to said compressor; and means for maintaining a pressure differential for feeding refrigerant through said first conduit; whereby a portion of the refrigerant circulating between the surge drum and the evaporator is by-passed to the closed chamber where the oil in the refrigerant is separated therefrom by the distilling action of the waste heat of the prime mover and returned in relatively small liquid portions, in compact form, to the compressor through said second conduit.

10. A surge drum and refrigerant circulating pump structure, for use in a refrigeration system of the type in which a compressor feeds liquid refrigerant to the drum and the pump circulates refrigerant from the drum to an evaporator, said structure comprising: a surge drum; means on said surge drum affording inlet and outlet connections for the high and low pressure sides respectively of said compressor; a closed chamber positioned in heat conducting relation to said drum; a motor mounted within said chamber; a pump mounted within said surge drum and submerged in the liquid refrigerant therein; and driving means forming a positive connection between said pump and said motor.

11. Refrigeration apparatus including an oil still and comprising in combination: a compres-

sor; a surge drum; means including closed conduits connecting said surge drum and said compressor for furnishing liquid refrigerant to the lower portion of said drum and withdrawing gaseous refrigerant from the upper portion of said drum; a closed oil still chamber positioned at least partially within said drum; a circulating pump positioned within said surge drum and submerged in the liquid refrigerant therein; a motor positioned within said closed chamber and having a driving connection with said pump; an evaporator; closed conduit means connecting said pump, evaporator and surge drum, to provide a path for circulation of refrigerant from said drum through said evaporator; means including a thermally controlled valve for by-passing a small quantity of oil bearing refrigerant to said closed chamber from the conduit linking said pump and evaporator in order to evaporate said refrigerant by subjecting it to the waste heat of said motor thus separating lubricant entrained therein; and means including a closed conduit for returning the separated lubricant to the compressor.

12. Refrigeration apparatus including an oil still and comprising in combination: a compressor; a surge drum; means including closed conduits connecting said surge drum and said compressor for furnishing liquid refrigerant to the lower portion of said drum and withdrawing gaseous refrigerant from the upper portion of said drum; a closed oil still chamber positioned at least partially within said drum; a circulating pump positioned within said surge drum and submerged in the liquid refrigerant therein; a motor positioned within said closed chamber and having a driving connection with said pump; an evaporator; closed conduit means connecting said pump, evaporator and surge drum, to provide a path for circulation of refrigerant from said drum through said evaporator; a first closed line connecting with the closed chamber and the conduit linking said pump and evaporator for by-passing a small quantity of oil bearing refrigerant to said closed chamber; a second closed line connecting with said chamber and with the low pressure side of said compressor for returning separated oil and refrigerant to said compressor; thermal valve means in said first line responsive to temperatures in said second line for controlling the admission of refrigerant to said closed chamber; and means for maintaining a pressure differential for feeding refrigerant through said thermal valve; whereby a portion of the refrigerant circulating between the surge drum and evaporator is by-passed to the closed chamber where the oil in the refrigerant is separated therefrom by the distilling action of the waste heat of the motor and returned in relatively small liquid portions, in compact form, to the compressor through said second closed line.

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