Dec. 3, 1935. J. L. GIBSON ET AL 2,022,764

REFRIGERATING APPARATUS

Original Filed Oct. 13, 1931 2 Sheets-Sheet 1

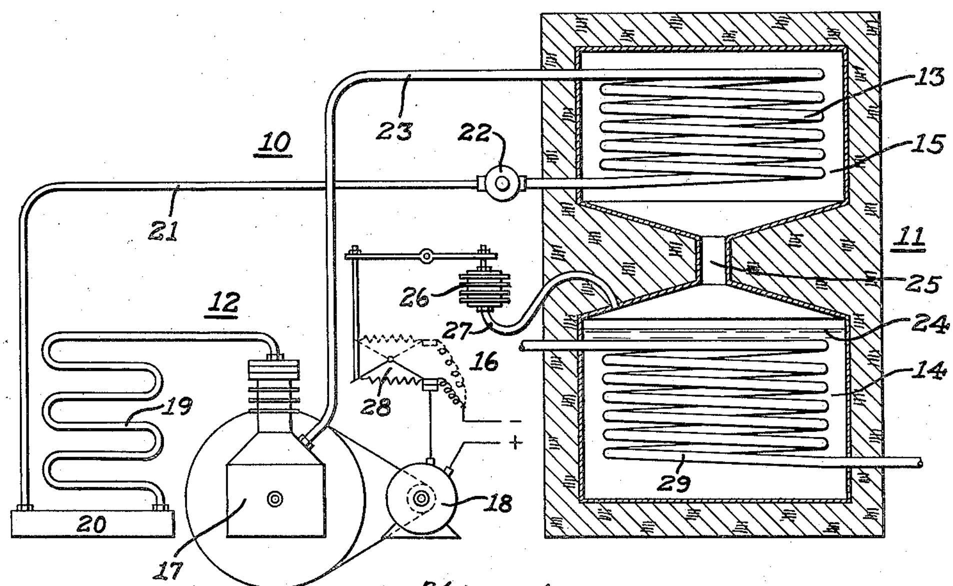

Fig. 1

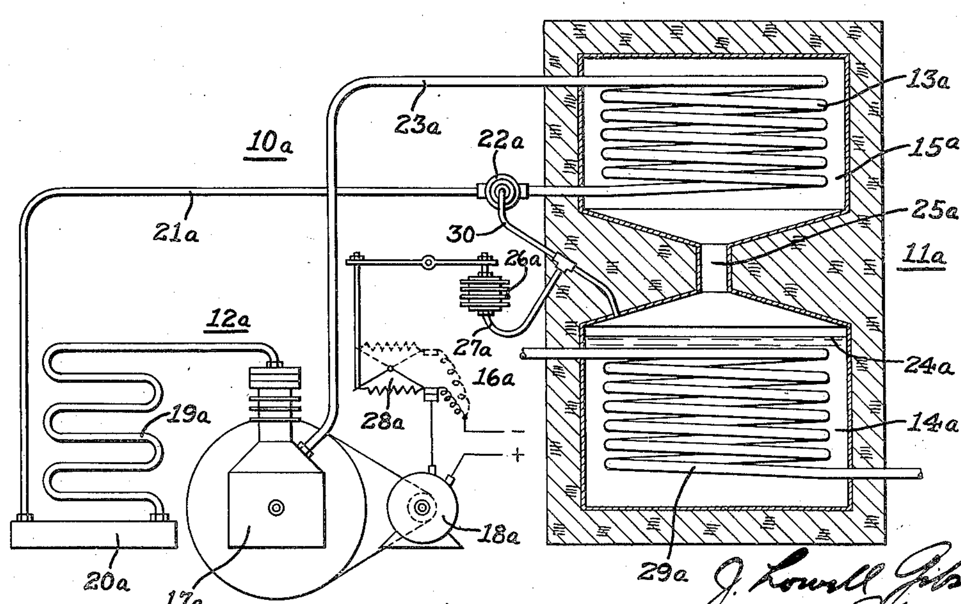

Fig. 2

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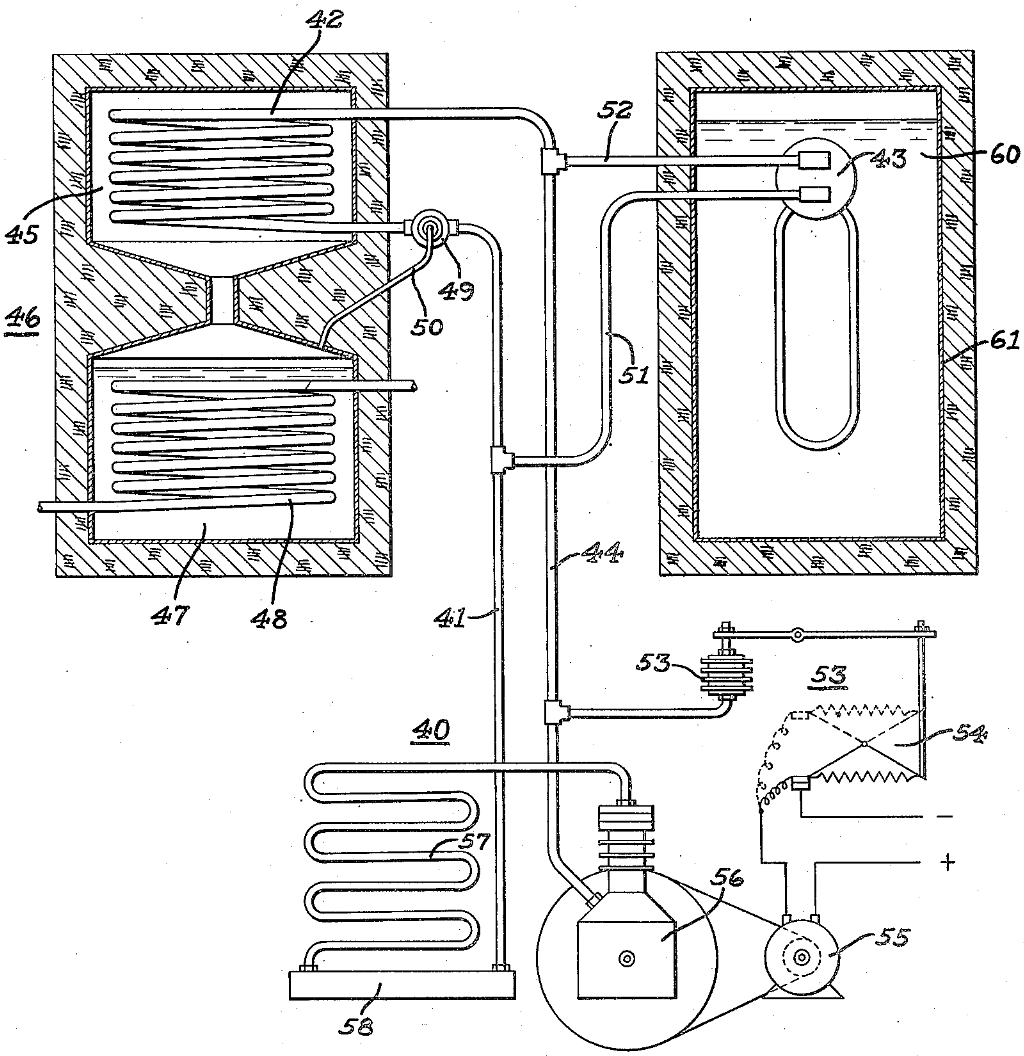

Fig. 3

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REFRIGERATING APPARATUS

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13 Claims. (Cl. 62—4)

This invention relates to refrigerating apparatus. More particularly it relates to that type of apparatus wherein an object to be cooled is in heat exchange relation with a secondary refrigerating circuit, this circuit, in turn, being cooled by a primary refrigerating circuit. In this type of apparatus the danger of mixing the refrigerant of the primary circuit with any substance of the object to be cooled is minimized, since, in case of accidental bursting of any part of the apparatus, the mixture of refrigerant from the secondary system with the substance of the object to be cooled does not set up a chemical reaction which is likely to injure the apparatus. This is so because the refrigerant for the secondary refrigerating circuit can be chosen from a class which is chemically inert to the substances in the object to be cooled, while the refrigerant of the primary refrigerating circuit may be, if so desired, of the more potentially chemical active type.

Heretofore, particularly when cooling liquids, it has been customary to place a conduit in the liquid refrigerant of the evaporator of a refrigerating system. When the refrigerating system creates an abnormally low temperature in the liquid refrigerant, there is danger that the liquid to be cooled may be accidentally frozen, with the consequent likelihood of bursting the conduit. This mixes together the liquid to be cooled and the refrigerant, and results in damage to the refrigerating system and also to the system with which the liquid conduit is connected. It is one of the objects of this invention to provide a system in which this danger is reduced and in which, nevertheless, a quick and efficient heat transfer is obtained.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a diagrammatic view of an apparatus embodying my invention;

Fig. 2 is a diagrammatic view similar to Fig. 1 but showing a slightly modified form of the invention; and

Fig. 3 is a diagrammatic view showing the invention applied to a multiple installation.

A refrigerating apparatus embodying features of this invention comprises, in general, a primary refrigerating circuit, generally designated 10, and a secondary refrigerating circuit, generally designated 11. The primary refrigerating circuit may include a refrigerant liquefying unit 12 and an evaporator 13. The secondary refrigerating circuit may include an evaporator 14 and a condenser 15, the condenser 15 being in heat exchange relation with the evaporator 13. An automatic control 16 governing the operation of the refrigerant liquefying unit 10 is provided, this control 16 being responsive to refrigerant conditions in the secondary refrigerating circuit 11.

More specifically, the refrigerant liquefying unit 12 may be of the motor-compressor-condenser type and includes a compressor 17, driven by a motor 18, and discharging refrigerant into a condenser 19. The refrigerant liquefied in the condenser 19 is stored in a receiver 20 and is conveyed by the pipe 21 past the automatic expansion valve 22 to the evaporator 13, from whence it returns by the pipe 23 to the compressor 17. The secondary refrigerating circuit may include a chamber having refrigerant liquid 24 to the level indicated, forming the evaporator 14, and this chamber is in communication by the passage 25 with the condenser 15 which surrounds the evaporator 13. The automatic control 16 includes a bellows 26 in communication with the evaporator 14 by means of the pipe 27, the bellows 26 operating a snap switch 28 which starts and stops the motor 18.

Liquid to be cooled by the apparatus passes from any suitable source of supply through a conduit 29 submerged in the liquid refrigerant 24 of the evaporator 14 and from thence to a faucet or the like. When the liquid is drawn through the conduit 29 it warms the refrigerant 24 which in turn evaporates and condenses on the surface of the evaporator 13 in the condenser 15. The refrigerant in the evaporator 13 is evaporated and is withdrawn by the compressor 17 which in turn compresses and liquefies the same through the medium of the condenser 19 and recirculates in the evaporator 13. The refrigerant liquefying unit 12, being controlled by control 16, operates intermittently in response to the pressure and temperature conditions in the evaporator 14 and maintains the liquid refrigerant 24 at a substantially constant temperature. The valve 22 is of the type which automatically feeds refrigerant to the evaporator 13 when the evaporator pressure reaches a predetermined low level and is so calibrated that the temperature of the evaporator 13 is maintained sufficiently low to provide the desired temperatures in the liquid 24.

The liquid refrigerant 24 preferably is of a composition which does not tend to form corrosive substances when mixed with the liquid to be cooled. Thus where water is the liquid to be cooled, it is convenient to use a halo-fluoro derivative of methane, such as CCl_2F_2, in the evaporator 14, while any of the well-known refrigerants which may or may not be potentially corrosive, and may be chosen more to conform with the requirements of the primary refrigerating circuit than for their chemical relation to the liquid to be cooled. Thus the primary circuit may contain SO_2. If for any reason the water in the conduit 29 should be frozen sufficiently to burst the conduit, there would be no danger of damage either to the refrigerating apparatus or to the water system because of mixture of the water with the refrigerant 24, since a mixture of water and CCl_2F_2 is not highly corrosive.

In the modification shown in Fig. 2, all of the parts which correspond to those shown in Fig. 1 have been numbered with the same number and with the suffix "*a*" attached. The valve 22*a*, however, has been slightly modified by connecting its bellows to the secondary system through the medium of a conduit 30, to make the valve responsive to refrigerant conditions in the secondary system. The construction of the valve 22*a* is of such a character that when the temperature of the liquid 24*a* falls, the valve 22*a* is throttled because of the vapor pressure-temperature characteristics of the refrigerant liquid 24*a* and is completely closed when the temperature of the liquid 24*a* falls below a certain temperature limit. Conversely, when the temperature of the liquid 24*a* rises, the valve 22*a* opens. The result of such a construction is that when a large demand is placed on the refrigerating apparatus by a sustained flow of water through the conduit 29*a*, then the valve 22*a* is opened wide and the primary refrigerating circuit operates with a high back pressure. This increases its capacity and provides the necessary refrigeration for the increased demand. The bellows 26*a* of the control 16*a* is connected by the conduit 27*a* with the secondary refrigerant system 11*a*. The bellows 26*a* is so calibrated that it does not stop operation of the unit 12*a* until the temperature of the evaporator 14*a* has been reduced below a predetermined temperature limit and starts the unit when the temperature is above a predetermined limit.

In the modification shown in Fig. 3 the invention is shown as applied to a multiple installation wherein the refrigerant liquefying unit of the primary refrigerating circuit is connected to a plurality of evaporators. In this case the refrigerant liquefying unit 40 is connected by the liquid refrigerant line 41 with the evaporators 42 and 43. The evaporated refrigerant returns through the line 44 to the liquefying unit 40. One of the evaporators, in this case 42, is in heat exchange relation with the condenser 45 of a secondary refrigerating circuit 46. The condenser 45 is connected with an evaporator 47 of the secondary refrigerating circuit similar to the evaporator 14 heretofore described, this evaporator being similarly provided with a conduit 48 for liquid to be cooled. The expansion valve 49 is connected by the conduit 50 with the refrigerant space of the secondary system 46, and the valve 49 is of the same type as the valve 22*a* heretofore described, and is responsive to refrigeration demands in the evaporator 47 so that it is throttled with a fall in temperature in the evaporator 47 and is opened with the rise in temperature in evaporator 47. The evaporator 43 is of the well-known float controlled inlet valve type now generally used and is fed with liquid refrigerant through the pipe 51 which leads to the float controlled inlet valve and the evaporated refrigerant returns through the pipe 52 which is connected to the line 44. The evaporator 43 may cool a brine solution 60 in an ice cream cabinet 61 in which it is intended to maintain lower temperatures than those maintained in the evaporator 47. The automatic control 53 for the refrigerant liquefying unit 40 is made responsive to refrigeration demands of one of the evaporators of the primary refrigerating system and also to the demands of the evaporator 47. This is accomplished by providing a bellows 53 which operates a snap switch 54 which in turn starts and stops a motor 55 driving a compressor 56 which in turn discharges refrigerant to the condenser 57 and the receiver 58 in the same manner in which the refrigerant liquefying unit 12 does. The bellows 53 is so calibrated that it does not stop the operation of the unit 40 until the pressure in conduit 44 is below the pressure at which the evaporator 42 needs to operate to provide refrigeration for the conduit 48. The bellows 53 is so calibrated also that it starts the liquefying unit 40 when the pressure in the line 44 rises above the pressure necessary to provide the predetermined upper limit of the temperature in the evaporator 42. The stopping of the unit 40 is so calibrated that it will reduce the pressure in the pipe 44 sufficiently to provide the desired low temperature in the evaporator 43. Thus the unit 40 is controlled in response to refrigerant conditions not only within the evaporator 43 but also within the evaporator 47.

The operation of the apparatus herein disclosed is such that the refrigerant liquefying unit of the primary refrigerating circuit starts to operate almost immediately when there is a refrigeration demand upon the evaporator of the secondary system. This is important since it is desirable to release the full power of the liquefying unit as soon as the demand occurs, in order that when there is a sustained withdrawal of water, the liquefying unit is in full operation during the entire time that water is being drawn. This prevents the refrigerant in the secondary system from being warmed up unduly before the liquefying unit starts operation and results in an increased capacity for refrigeration in the apparatus as a whole.

In the preferred form of this invention, the secondary refrigerating circuit is charged with a refrigerant which is entirely volatile within the temperature-pressure range of operation of the secondary refrigerating circuit. However, it may be desirable under certain conditions of operation to charge the secondary refrigerating circuit with a certain amount of gas which is non-condensable and substantially insoluble, or only slightly soluble, in the volatile refrigerant. This creates a temperature differential between the evaporators of the primary and secondary circuits respectively.

Many advantages of this invention are obtained even when the refrigerant in the primary refrigerating circuit is chemically inert when mixed with the liquid to be cooled.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. Refrigerating apparatus comprising: a primary refrigerant circuit including a refrigerant liquefying unit and an evaporator; a secondary refrigerant circuit including a condenser and evaporator, said condenser being in heat exchange

relation to said first named evaporator; a conduit for liquid to be cooled in heat exchange relation to said second named evaporator, and a control governing the operation of said refrigerant liquefying unit responsive to refrigerant pressure within said secondary circuit.

2. Refrigerating apparatus comprising: a primary refrigerant circuit including a refrigerant liquefying unit and an evaporator; a secondary refrigerant circuit including a condenser and evaporator, said condenser being in heat exchange relation to said first named evaporator; a conduit for liquid to be cooled in heat exchange relation to said second named evaporator, and a control governing the operation of said refrigerant liquefying unit responsive to refrigerant conditions within said secondary circuit.

3. Refrigerating apparatus comprising: a primary refrigerating circuit having a motor-compressor-condenser unit and a plurality of evaporators; a secondary refrigerating circuit having a condenser and an evaporator, said condenser being in heat exchange relation with one of said first named evaporators; and an automatic switch governing the operation of said motor-compressor-condenser unit, said switch being responsive to refrigerant pressure of one of said first named evaporators and to refrigeration demands of the evaporator of said secondary system.

4. Refrigerating apparatus comprising: a primary refrigerating circuit having a refrigerant liquefying unit and a plurality of evaporators; a secondary refrigerating circuit having a condenser and an evaporator, said condenser being in heat exchange relation with one of said first named evaporators; and an automatic control governing the operation of said refrigerant liquefying unit, said control being responsive to refrigerant pressure of one of said first named evaporators and to refrigeration demands of the evaporator of said secondary system.

5. Refrigerating apparatus comprising: a primary refrigerating circuit having a motor-compressor-condenser unit and a plurality of evaporators; a secondary refrigerating circuit having a condenser and an evaporator, said condenser being in heat exchange relation with one of said first named evaporators; and an automatic switch governing the operation of said motor-compressor-condenser unit, said switch being responsive to refrigeration demands of one of said first named evaporators and of the evaporator of said secondary system.

6. Refrigerating apparatus comprising: a primary refrigerating circuit having a refrigerant liquefying unit and a plurality of evaporators; a secondary refrigerating circuit having a condenser and an evaporator, said condenser being in heat exchange relation with one of said first named evaporators; and an automatic control governing the operation of said refrigerant liquefying unit, said control being responsive to refrigeration demands of one of said first named evaporators and of the evaporator of said secondary system.

7. Refrigerating apparatus comprising: a primary refrigerating circuit provided with a motor-compressor-condenser unit and an evaporator; a secondary refrigerating circuit including a condenser and an evaporator, said last named condenser being in heat exchange relation with said first named evaporator; an automatic switch governing the operation of said unit, said switch being responsive to pressure within said secondary system.

8. Refrigerating apparatus comprising: a primary refrigerating circuit provided with a refrigerant liquefying unit, and an evaporator; a secondary refrigerating circuit including a condenser and an evaporator, said condenser being in heat exchange relation with said first named evaporator; and an automatic control governing the operation of said refrigerant liquefying unit, said control being responsive to pressure within said secondary system.

9. Refrigerating apparatus comprising: a primary refrigerating circuit provided with a refrigerant liquefying unit, an evaporator and an expansion valve substantially responsive to pressures in said evaporator; a secondary refrigerating circuit including a condenser and an evaporator, said condenser being in heat exchange relation with said first named evaporator; and an automatic control governing the operation of said refrigerant liquefying unit, said control being responsive to refrigeration demands within said secondary system.

10. Refrigerating apparatus comprising a primary refrigerating circuit including a refrigerant liquefying unit and an evaporator, a secondary refrigerant circuit including a condenser and evaporator, said condenser being in heat exchange relation to said first named evaporator, a conduit for liquid to be cooled in heat exchange relation to said second named evaporator, and a control governing the flow of refrigerant in said first named evaporator in accordance with refrigeration conditions in said second named evaporator.

11. Refrigerating apparatus comprising a primary refrigerating circuit including a refrigerant liquefying unit and an evaporator, a secondary refrigerant circuit including a condenser and evaporator, said condenser being in heat exchange relation to said first named evaporator, a conduit for liquid to be cooled in heat exchange relation to said second named evaporator, and a control governing the flow of liquid refrigerant into said first named evaporator in accordance with refrigeration conditions in said second named evaporator.

12. Refrigerating apparatus comprising a primary refrigerating circuit including a refrigerant liquefying unit and an evaporator, a secondary refrigerant circuit including a condenser and evaporator, said condenser being in heat exchange relation to said first named evaporator, means to be cooled in heat exchange relation to said second named evaporator, and a control governing the flow of liquid refrigerant into said first named evaporator in accordance with refrigerant pressure in said second named evaporator.

13. Refrigerating apparatus comprising a primary refrigerating circuit including a refrigerant liquefying unit and an evaporator, a secondary refrigerant circuit including a condenser and evaporator, said condenser being in heat exchange relation to said first named evaporator, means to be cooled in heat exchange relation to said second named evaporator, and a control governing the flow of liquid refrigerant into said first named evaporator in accordance with refrigerant temperature conditions in said second named evaporator.

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