

April 10, 1934.

H. F. SMITH

1,954,148

REFRIGERATING APPARATUS

Filed Jan. 31, 1930

3 Sheets-Sheet 1

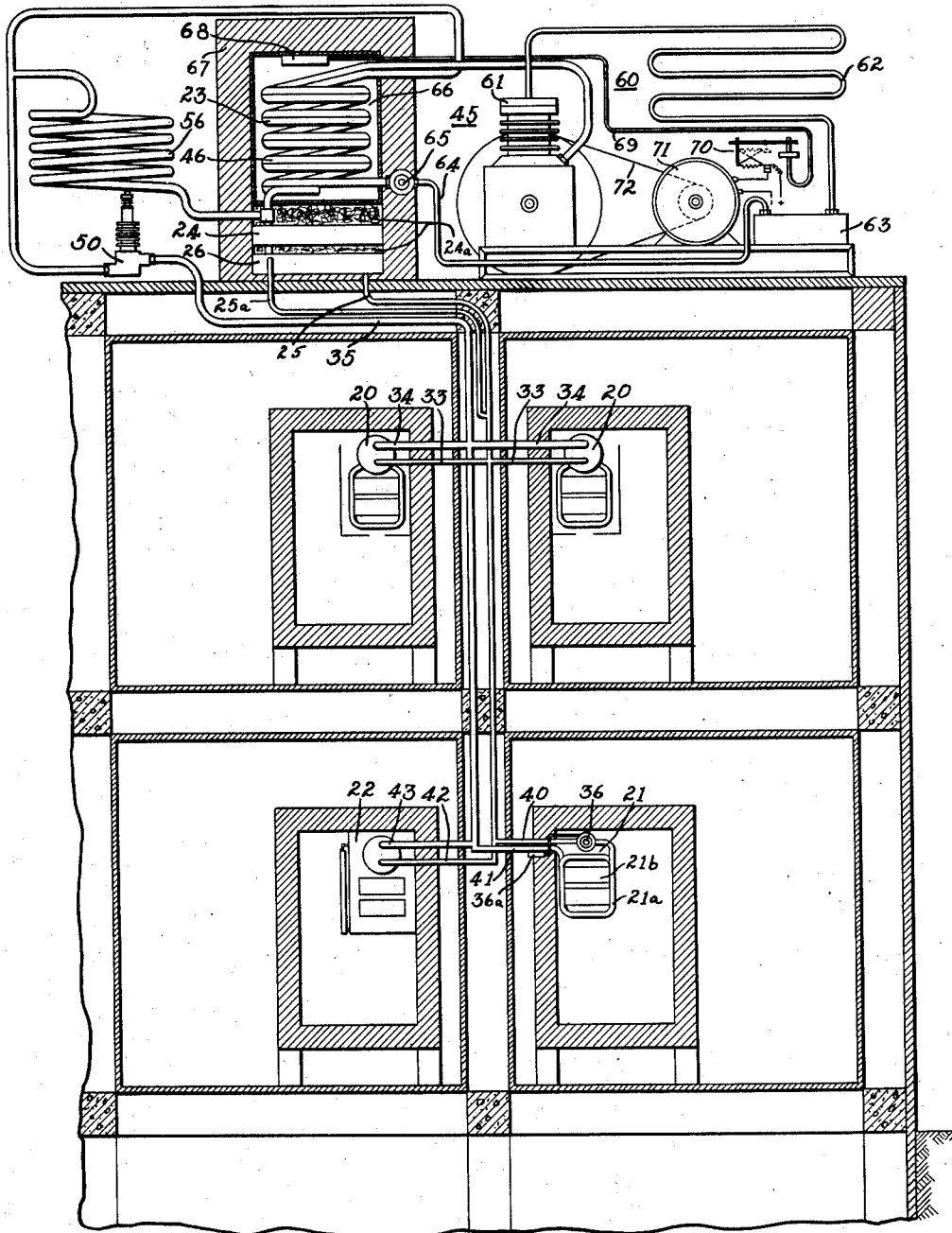


Fig. 1

Harry F. Smith, INVENTOR
BY Spencer, Hardman & John, ATTORNEYS

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3 Sheets-Sheet 2

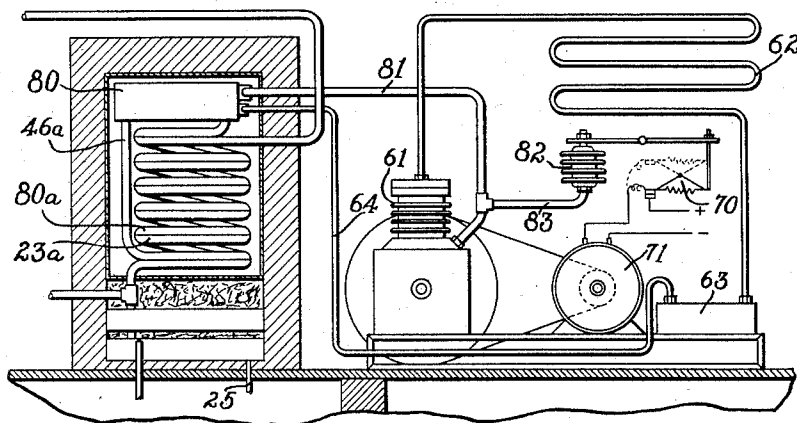


Fig. 4

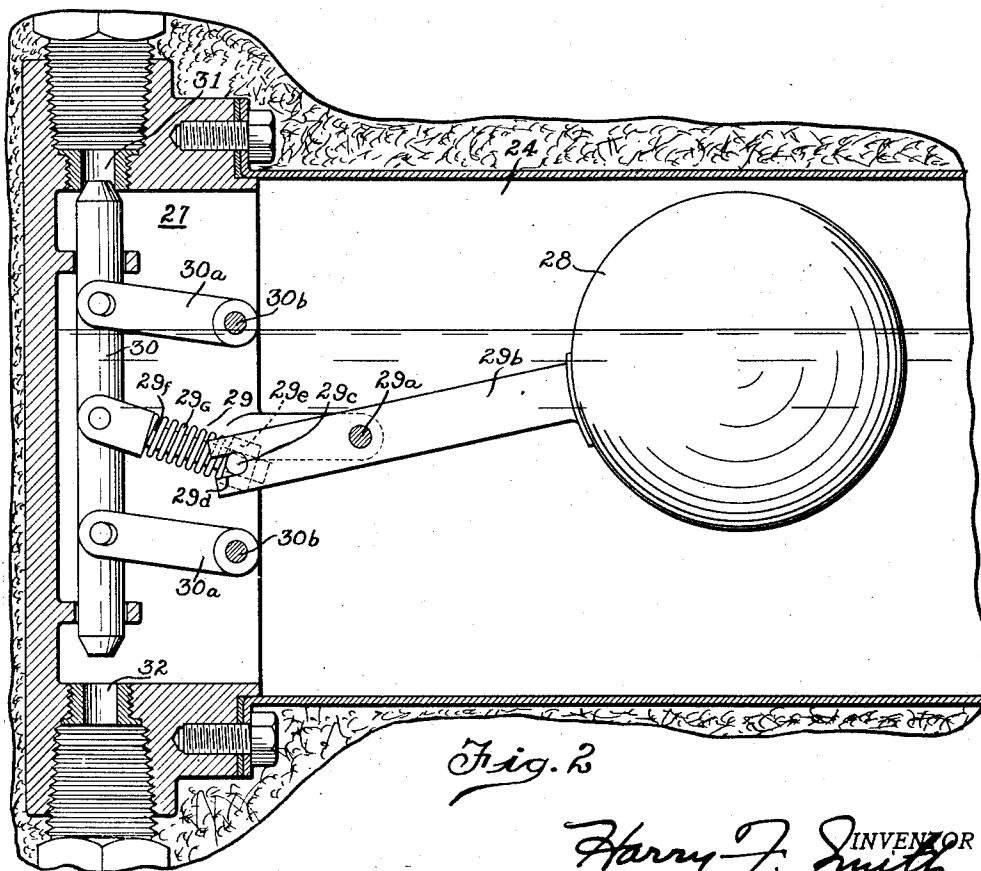


Fig. 2

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3 Sheets-Sheet 3

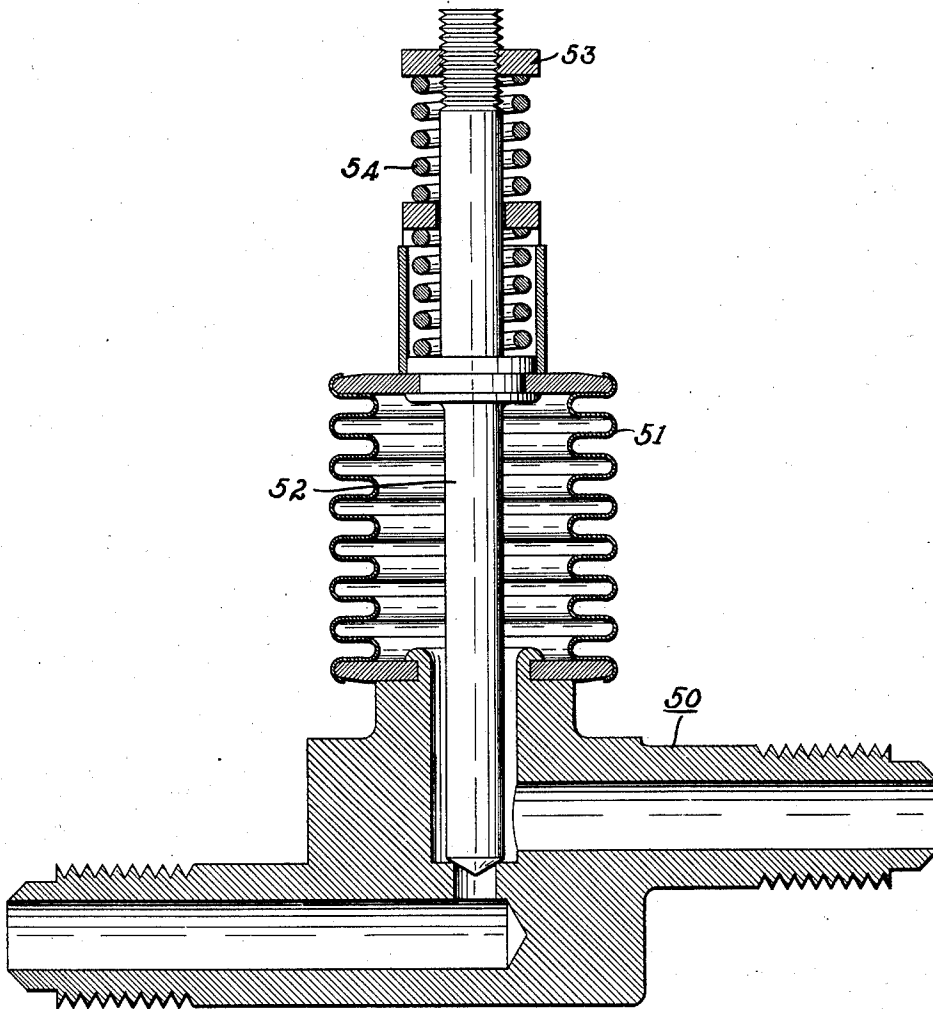


Fig. 3

Harry F. Smith INVENTOR
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UNITED STATES PATENT OFFICE

1,954,148

REFRIGERATING APPARATUS

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aire Corporation, Dayton, Ohio, a corporation
of Delaware

Application January 31, 1930, Serial No. 425,008

21 Claims. (Cl. 62—115)

This invention relates to refrigerating apparatus and has for one of its objects to provide a heat exchange volatile refrigerant system which is adapted to circulate the refrigerant without the usual compressing mechanism and which in so operating does not require any of the refrigerant lines to be thermally insulated in order to maintain the circulating liquid refrigerant at low temperatures.

Another object of this invention is to provide a refrigerating system which takes advantage of low atmospheric temperatures to obtain refrigeration therefrom and which automatically and mechanically provides refrigeration when atmospheric temperatures rise.

Further objects and advantages of the present invention are 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 vertical cross-sectional view, somewhat diagrammatic, of a refrigerating apparatus, embodying features of this invention;

Figs. 2 and 3 are vertical cross-sectional views of portions of the system shown in Fig. 1; and

Fig. 4 is a vertical cross-sectional view, somewhat diagrammatic, of a modification of a portion of Fig. 1.

Heretofore volatile refrigerant circulating systems have been provided without the use of a compressor or the like, in which a volatile refrigerant is condensed and travels to an evaporator where it absorbs heat, evaporates the refrigerant and returns the evaporated refrigerant to the condenser to be recondensed. However, in these prior systems, it has been deemed necessary either to have the evaporator very close to the condenser to avoid the use of long refrigerant lines or it has been deemed necessary to insulate the liquid refrigerant line if the line has to be any appreciable length. In accordance with my invention, however, it is possible to provide such a system with liquid refrigerant lines of any desired length and in which the liquid refrigerant is permitted to have its vapor pressure raised to correspond to the temperature of the medium through which the liquid refrigerant line travels. According to my invention it is not necessary to retain the entire system under low vapor pressure corresponding to the vapor pressures of the refrigerant in the condenser; but on the other hand my system includes a relatively high vapor pressure side, in which the liquid refrigerant is transported from the condenser to the evapo-

rator at a relatively warm temperature, and the system also includes a relatively low vapor pressure side which includes the evaporator and the condenser as well as the evaporated refrigerant line (if one is used). By this arrangement the necessity for insulating the liquid refrigerant line is partly or wholly avoided to the extent desired.

To this end, a refrigerating system embodying features of this invention includes a high vapor pressure side and a low vapor pressure side of a closed refrigerant circuit. Refrigerant may flow in a closed path through said closed circuit and may be caused to circulate in condensed and evaporated form without the use of the usual pumping mechanism. For this purpose, the low vapor pressure side may include one or more evaporators 20, 21 or 22 and a condenser 23. The high vapor pressure side may include means for transporting the condensed refrigerant to the evaporator or evaporators.

Means for transferring liquid refrigerant from the low vapor pressure side to the high vapor pressure side without the use of pumping mechanism of the usual type is provided. This means may make use of gravitational forces for this purpose. For instance, a trap 24 may be provided for transferring liquid refrigerant condensed by the condenser 23 under relatively low vapor pressure to the high vapor pressure side of the system. This trap may be insulated by insulation 24a. The liquid refrigerant may be transferred to a portion of the high vapor pressure liquid refrigerant line 25 and preferably it may be transferred to a liquid refrigerant receiver 26 forming a part of the high vapor pressure liquid refrigerant line 25. The temperatures of the refrigerant in receiver 26 and in the line 25 are equalized by return line 25a. The trap 24 may be provided with valve means 27 for connecting the trap selectively either with the condenser 23 or with the high vapor pressure side of the system. The valve means 27 may be float controlled. Thus the float 28 may be connected by means of the snap acting mechanism 29 with the valve rod 30. The vertical movement of the float 28 is thus adapted to seat the rod 30 alternately on the valve seats 31 and 32 which are connected respectively with the condenser 23 and the receiver 26. The snap acting mechanism 29 may include a rigidly held pivot rod 29a carrying the arm 29b of the float 28. A connecting pin 29c is keyed in the slot 29d and is secured to the yoke 29e sliding on the pin 29f. The yoke 29e compresses spring 29g and provides the snap action in the rod 30 which is pivotally supported on links 30a which, in turn, are pivoted on rigid rods 30b.

The evaporators 20, 21 and 22 may be provided with means for reducing the vapor pressure on the liquid refrigerant as it enters the evaporator. Thus the evaporators 20 may be of the type disclosed in the patent to R. G. Osborn, No. 1,556,708, patented October 13, 1925 so that the float controlled valve (not shown) in each evaporator 20 may be connected by means of either branch 33 with the liquid refrigerant line 25. The evaporated refrigerant in the evaporators 20 may be conveyed by means of the branches 34 to the evaporated refrigerant line 35 leading back to the condenser 23. The evaporator 21 may be of expansion valve type. The liquid refrigerant passing through the branch 40 may have its pressure reduced by valve 36, may then pass through the coils 21a wound around the ice tray sleeves 21b and may then pass through the branch 41 to the line 35. The evaporator 21 may be maintained in a flooded condition by providing a thermostatic bulb 36a responsive to the temperature of the refrigerant leaving the evaporator and maintaining the zone of refrigeration within the evaporator 21. The evaporator 22 may be of the type disclosed in the application of Harry F. Smith, Serial No. 367,158, filed May 30, 1929. The evaporator 22 is provided with a float controlled valve somewhat similar to the float controlled valves shown in the patent to Osborn, heretofore referred to. The evaporator 22 may be connected by means of the branch 42 with the liquid refrigerant line 25 and by means of the branch 43 with the evaporated refrigerant line 35.

The condenser 23 may be cooled by any suitable means and preferably it may be cooled by a mechanically operated refrigerating system of the compressor or absorption type generally designated as 45, the compressor type being hereinafter more fully described. The evaporator 46 of the system 45 is adapted to cool the condenser 23 of the first described refrigerating system.

The first described refrigerating system is adapted to operate as follows. Refrigerant is condensed in the condenser 23 and drains to the trap 24 until such a time as the float 28 snaps the valve rod 30 to close the valve seat 31 and to open the valve seat 32. When this occurs the liquid refrigerant in the trap 24 flows into the receiver 26 until such a time as the float 28 snaps the valve rod 30 down to close the valve seat 32 and open the valve seat 31. This operation is repeated as long as sufficient refrigerant is condensed in the condenser 23. The liquid refrigerant in the receiver 26 flows through the line 25 and through any or all of the branches 33, 41 or 42 to any or all of the evaporators 20, 21 or 22. In flowing through the line 25, the liquid refrigerant is generally warmed, for instance to the temperature of the walls of the building, so that the vapor pressure in the line 25 and its receiver 26 is substantially higher than the vapor pressure prevailing in the evaporator. This relatively high vapor pressure liquid refrigerant has its vapor pressure reduced by means of pressure reducing valves when it enters any one or all of the evaporators 20, 21 or 22. Here the liquid refrigerant is evaporated and is returned through any one or all of the branches 34, 40 or 43, from thence through the evaporated refrigerant line 35 back to the condenser 23. Since the condenser 23 is maintained at a relatively low temperature by means of the evaporator 46, it maintains a relatively low vapor pressure within the evaporators 20, 21 or 22. Since the valve means 27 alternately connects the condenser 23 and the high

vapor pressure liquid refrigerant line 25 it is to be seen that the liquid refrigerant condensed under low vapor pressure in the condenser 23 is transferred to the high vapor pressure liquid refrigerant side of the system without the use of the usual pumping mechanism with the aid of gravitational forces. This provides a system for transporting refrigeration from the condenser 23 to the evaporators 20, 21 or 22 with relatively small thermal losses.

An automatic pressure valve 50 may be placed between evaporators 20, 21 or 22 and the condenser 23 if it is desired to maintain the evaporators 20, 21 or 22 at a constant temperature. The valve 50 is adapted to maintain a predetermined pressure in the evaporators 20, 21 or 22 by means of the metallic bellows 51 which is adapted to actuate the valve stem 52 in response to the pressure in said evaporators. Suitable adjusting means 53 may be provided for adjusting the tension on the spring 54 to thus vary the pressure to which the valve 50 is responsive.

When the foregoing type of system, or any other type of refrigerating system is used which is provided with a heat absorber, or evaporator, and a heat dissipator or condenser in thermal exchange, or refrigerant circulating relationship, I may also make use of low atmospheric temperatures, when they occur, either to replace or to augment the primary refrigerating system 45, so as to remove the necessity of operating the primary system 45, with its consequent electric or fuel consumption, during such periods of low atmospheric temperatures. To this end I provide an atmospheric heat exchange device, or condenser, in thermal contact with one of the refrigerating systems and preferably place a condenser in refrigerant circulating relationship with the heat absorber or evaporator, so that said atmospheric condenser removes heat from the evaporator when atmospheric temperatures fall below a certain value and so construct the apparatus, that the atmospheric condenser cannot introduce heat into the evaporator when atmospheric temperatures rise above such value. The structure may be arranged to accomplish this purpose automatically. Thus an atmospherically cooled device or condenser 56 may be placed in parallel relation with condenser 23, sufficiently elevated from the trap 24 so that no liquid refrigerant flows either from the trap 24 or the condenser 23 into the condenser 56. Whenever the atmospheric temperature equals or falls below the temperature of the condenser 23, (which is maintained automatically at a predetermined value by system 45) part or all of the refrigerant is condensed by condenser 56; but when the atmospheric temperature rises above the temperature of condenser 33, the condenser 56 is automatically isolated from the system by the gaseous refrigerant in the condenser 56.

The primary refrigerating system 45 may be used to cool the condenser 23 with or without the aid of the condenser 56. The refrigerating system 45 may include a refrigerant liquefying unit of the compressor or absorption type generally designated at 60 and the evaporator 46 heretofore described. Thus the refrigerant liquefying unit 60 may include a compressor 61 delivering compressed refrigerant to a condenser 62 from whence the refrigerant flows to the liquid refrigerant receiver 63. The refrigerant from thence flows to the evaporator 46 through the pipe 64 and through the pressure reducing valve 65. The condenser 23 and the evaporator 46 may

be placed in a tank 66 provided with suitable insulation 67. Thus the evaporator 46 cools the condenser 23 by a direct thermal contact and also by the hold-over capacity of brine or a freezable liquid in the tank 66.

The refrigerating system 45 may be automatically controlled to maintain a suitable temperature in the evaporator 46. Thus, as a specific embodiment, a thermostatic bulb 68, on the tank 66, may be connected by the line 69 with the snap switch 70 which starts and stops the electric motor 71 drivingly connected to the compressor 61, for instance, by means of the belt 72.

If the condenser 56 is used, the snap switch 70 may be so adjusted that it prevents the motor 71 from running whenever the condenser 56 is operating below the heretofore described atmospheric temperature, but the setting is such that the system 45 operates when the condenser 56 is disconnected. If the condenser 56 is not used, the refrigerating system 45 performs the entire condensing operations by maintaining the condenser 23 at the proper temperature.

Preferably the tank 66 is filled with a freezable solution so that ice is formed around the coils of the evaporator 46 and the condenser 23, which ice serves as a hold-over during the period of idleness of the motor 71.

In the modification shown in Fig. 4 the evaporator 46a is provided with a slightly different refrigerant pressure reducing means. Thus it may be provided with a header 80 provided with a float controlled valve (not shown) of the type disclosed in the patent to Osborn heretofore referred to. In this modification the compressor 61 delivers refrigerant to the condenser 62 and from thence to the liquid refrigerant receiver 63. The liquid refrigerant from thence flows through the pipe 64 to the header 80 where the pressure is reduced, and the evaporated refrigerant returns through the pipe 81 to the compressor 61. The header 80 may be provided with one or more depending ducts 80a in direct contact with the condenser 23a similar to the condenser 23 of Fig. 1. In this modification the motor 71 may be controlled by a bellows 82 connected by the branch 83 with the line 81. The bellows 82 operates a snap switch 70 for starting and stopping the motor 71. In this modification, the other parts correspond to those shown in Fig. 1 and operate in substantially the same manner. The condenser 23a is connected to one or more evaporators and a trap substantially as shown in Fig. 1.

The refrigerating system including the evaporators 20, 21 and 22 and the condenser 23 may be provided with any volatile refrigerant, such as SO_2 , CH_3Cl , CF_2Cl_2 , and need not have any lubricant added thereto. The refrigerating system 45 shown in Fig. 1 or the compressor system 60 shown in Fig. 6 may be provided with any suitable refrigerant and accompanying lubricant, such as SO_2 , CH_3Cl or CF_2Cl_2 with any suitable oil.

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. A refrigerating system including means for maintaining a high vapor pressure side and a low vapor pressure side, said low vapor pressure side including an evaporator and a condenser, and means for transferring liquid refrigerant from said low vapor pressure side to said high vapor pressure side.

2. A refrigerating system including means for maintaining a high vapor pressure side and a low vapor pressure side, said low vapor pressure side including an evaporator and a condenser, and means for transferring liquid refrigerant from said low vapor pressure side to said high vapor pressure side by gravity.

3. A refrigerating system including a high pressure side and a low pressure side, said low pressure side including an evaporator and a condenser, and a trap provided with valve means for connecting said trap selectively either with said condenser or with said high pressure side.

4. A refrigerating system including a high pressure side and a low pressure side, said low pressure side including an evaporator and a condenser, and a trap provided with float controlled valve means for connecting said trap selectively either with said condenser or with said high pressure side.

5. A refrigerating system comprising a condenser, an evaporator below said condenser, liquid and evaporated refrigerant lines between said condenser and evaporator, a pressure reducing valve for said evaporator and a trap in said liquid refrigerant line for moving liquid refrigerant under relatively low vapor pressure from said condenser to a high vapor pressure part of the liquid refrigerant line.

6. A refrigerating system including means for maintaining a high vapor pressure side and a low vapor pressure side, said low vapor pressure side including an evaporator and a condenser, means for transferring liquid refrigerant from said low vapor pressure side to said high vapor pressure side, and another refrigerating system for cooling said condenser.

7. A refrigerating system including means for maintaining a high vapor pressure side and a low vapor pressure side, said low vapor pressure side including an evaporator and a condenser, means for transferring liquid refrigerant from said low vapor pressure side to said high vapor pressure side by gravity, and another refrigerating system for cooling said condenser.

8. A refrigerating system including a high pressure side and a low pressure side, said low pressure side including an evaporator and a condenser, a trap provided with valve means for connecting said trap selectively either with said condenser or with said high pressure side, and another refrigerating system for cooling said condenser.

9. A refrigerating system including a high pressure side and a low pressure side, said low pressure side including an evaporator and a condenser, a trap provided with float controlled valve means for connecting said trap selectively either with said condenser or with said high pressure side, and another refrigerating system for cooling said condenser.

10. A refrigerating system comprising a condenser, an evaporator below said condenser, liquid and evaporated refrigerant lines between said condenser and evaporator, a pressure reducing valve for said evaporator and a trap in said liquid refrigerant line for moving liquid refrigerant under relatively low vapor pressure from said condenser to a high vapor pressure part of the liquid refrigerant line, and another refrigerating system for cooling said condenser.

11. A refrigerating system including means for maintaining a high vapor pressure side and a low vapor pressure side, said low vapor pressure side including an evaporator and a condenser, means for transferring liquid refrigerant from said low

vapor pressure side to said high vapor pressure side, a second refrigerating system for cooling said condenser, and an atmospherically cooled condenser provided with means for connection with
 5 said first named refrigerating system when the temperature of the atmosphere reaches a predetermined limit.

12. A refrigerating system including means for maintaining a high vapor pressure side and a low
 10 vapor pressure side, said low vapor pressure side including an evaporator and a condenser, means for transferring liquid refrigerant from said low vapor pressure side to said high vapor pressure
 15 side by gravity, a second refrigerating system for cooling said condenser, and an atmospherically cooled condenser provided with means of connection with said first named refrigerating system when the temperature of the atmosphere reaches a predetermined limit.

20 13. A refrigerating system including means for maintaining a high vapor pressure side and a low vapor pressure side, said low vapor pressure side including an evaporator and a condenser, a trap provided with valve means for connecting said
 25 trap selectively either with said condenser or with said high pressure side, a second refrigerating system for cooling said condenser, and an atmospherically cooled condenser provided with means of connection with said first named refrigerating system when the temperature of the atmosphere reaches a predetermined limit.

30 14. A refrigerating system including means for maintaining a high vapor pressure side and a low vapor pressure side, said low vapor pressure side including an evaporator and a condenser, a trap provided with float controlled valve means for connecting said trap selectively either with said
 35 condenser or with said high vapor pressure side, a second refrigerating system for cooling said condenser, and an atmospherically cooled condenser provided with means of connection with said first named refrigerating system when the temperature of the atmosphere reaches a predetermined limit.

40 15. A refrigerating system comprising a condenser, an evaporator below said condenser, liquid and evaporated refrigerant lines between said condenser and evaporator, a pressure reducing valve for said evaporator and a trap in said liquid
 45 refrigerant line for moving liquid refrigerant under relatively low vapor pressure from said condenser to a high vapor pressure part of the liquid refrigerant line, a second refrigerating system for cooling said condenser, and an atmospherically cooled condenser provided with means
 50 of connection with said first named refrigerating system when the temperature of the atmosphere reaches a predetermined limit.

55 16. A refrigerating system including means for maintaining a high vapor pressure side and a low vapor pressure side, said low vapor pressure side including an evaporator and a condenser, means for transferring liquid refrigerant from said low vapor pressure side to said high vapor pressure
 60 side, a second refrigerating system for cooling said condenser, an atmospherically cooled condenser provided with automatic means of connection with said first named refrigerating system when the temperature of the atmosphere is at least as low as the temperature of said first
 65 named condenser, and means for automatically stopping the operation of said second named refrigerating system while said atmospherically cooled condenser is in operative connection with
 70 said first named refrigerating system.

17. A refrigerating system including means for maintaining a high vapor pressure side and a low vapor pressure side, said low vapor pressure side including an evaporator and a condenser, means
 80 for transferring liquid refrigerant from said low vapor pressure side to said high vapor pressure side, a second refrigerating system for cooling said condenser, said second refrigerating system including an evaporator and means for automatically maintaining said last named evaporator at a substantially constant temperature.

18. A refrigerating system including means for maintaining a high vapor pressure side and a low vapor pressure side, said low vapor pressure side including an evaporator and a condenser, means for transferring liquid refrigerant from
 90 said low vapor pressure side to said high vapor pressure side, a second refrigerating system for cooling said condenser, said second refrigerating system including an evaporator, a refrigerant liquefying unit for circulating and liquefying refrigerant passing through said last named evaporator, and means for automatically controlling
 95 said second refrigerating system to maintain said last named evaporator at a substantially constant temperature.

19. A refrigerating apparatus comprising a secondary refrigerating system including a heat absorber and a heat dissipator in thermal exchange relationship, a primary refrigerating system in thermal exchange with said heat dissipator, an atmospheric heat exchange device in thermal contact with one of said systems, and means
 100 for causing said atmospheric heat exchange device to remove heat relatively freely from said last named system when atmospheric temperatures are below a predetermined temperature and for retarding said atmospheric heat exchange device from introducing heat into said last named system when the atmospheric temperature is
 105 above said predetermined temperature.

20. A refrigerating apparatus comprising a secondary refrigerating system including an evaporator and a condenser in refrigerant circulating relationship, a primary refrigerating system in thermal exchange with said condenser, an atmospheric heat exchange device in thermal contact with one of said systems, and means for causing said atmospheric heat exchange device to remove heat relatively freely from said last
 110 named system when atmospheric temperatures are below a predetermined temperature and for retarding said atmospheric heat exchange device from introducing heat into said last named system when the atmospheric temperature is above said predetermined temperature.

21. A refrigerating apparatus comprising a secondary refrigerating system including an evaporator and a condenser in refrigerant circulating relationship, a primary refrigerating system in thermal exchange with said condenser, an atmospheric condenser in refrigerant circulating relationship with said evaporator, and means causing said atmospheric condenser to remove heat from said evaporator when the atmospheric temperature falls below a predetermined temperature and to retard said atmospheric condenser from introducing heat into said evaporator when the atmospheric temperature rises
 140 above said predetermined temperature.

HARRY F. SMITH.