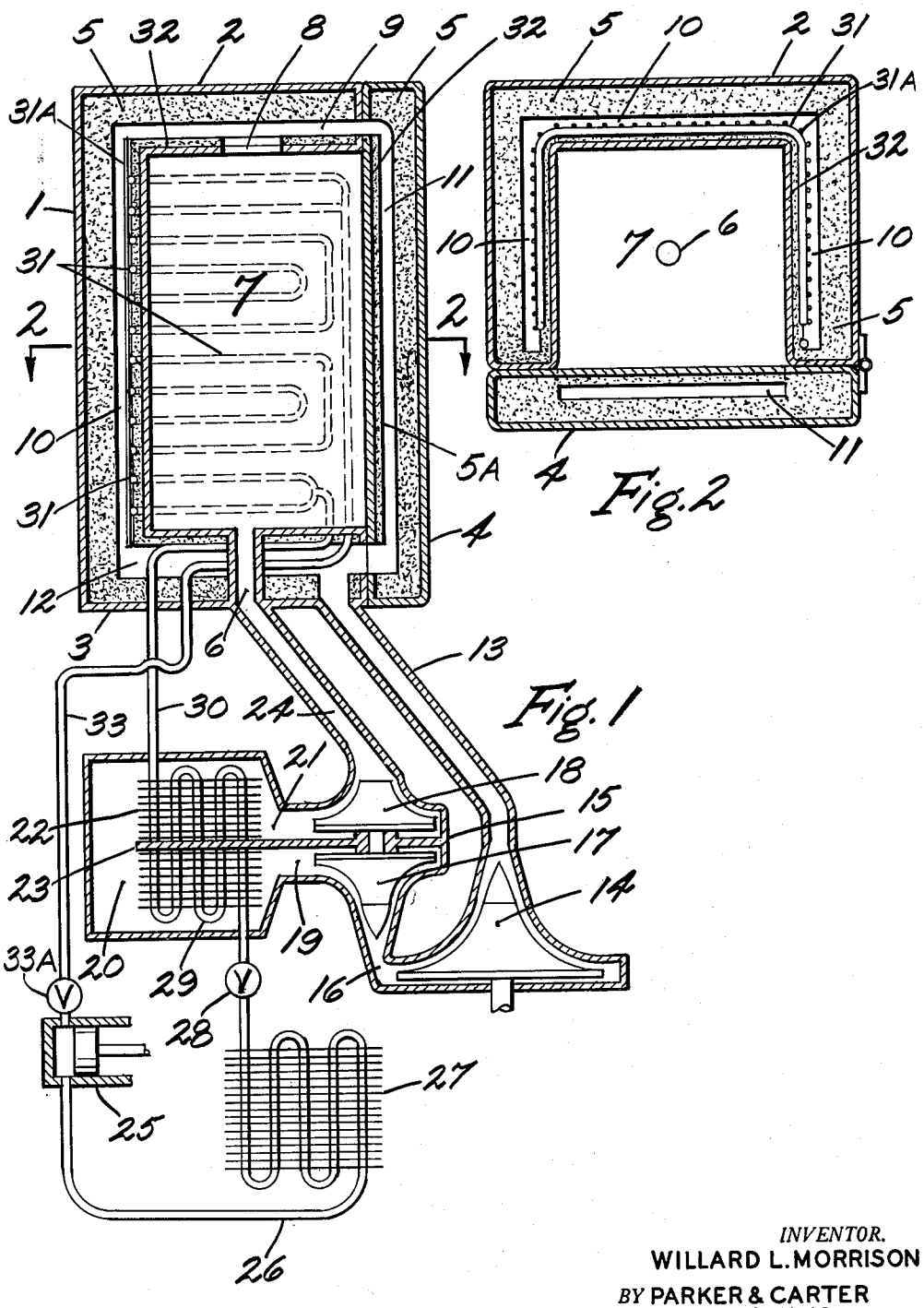
Nov. 8, 1960 W. L. MORRISON 2,959,025

HOUSEHOLD REFRIGERATOR

Filed July 16, 1957 2 Sheets-Sheet 1



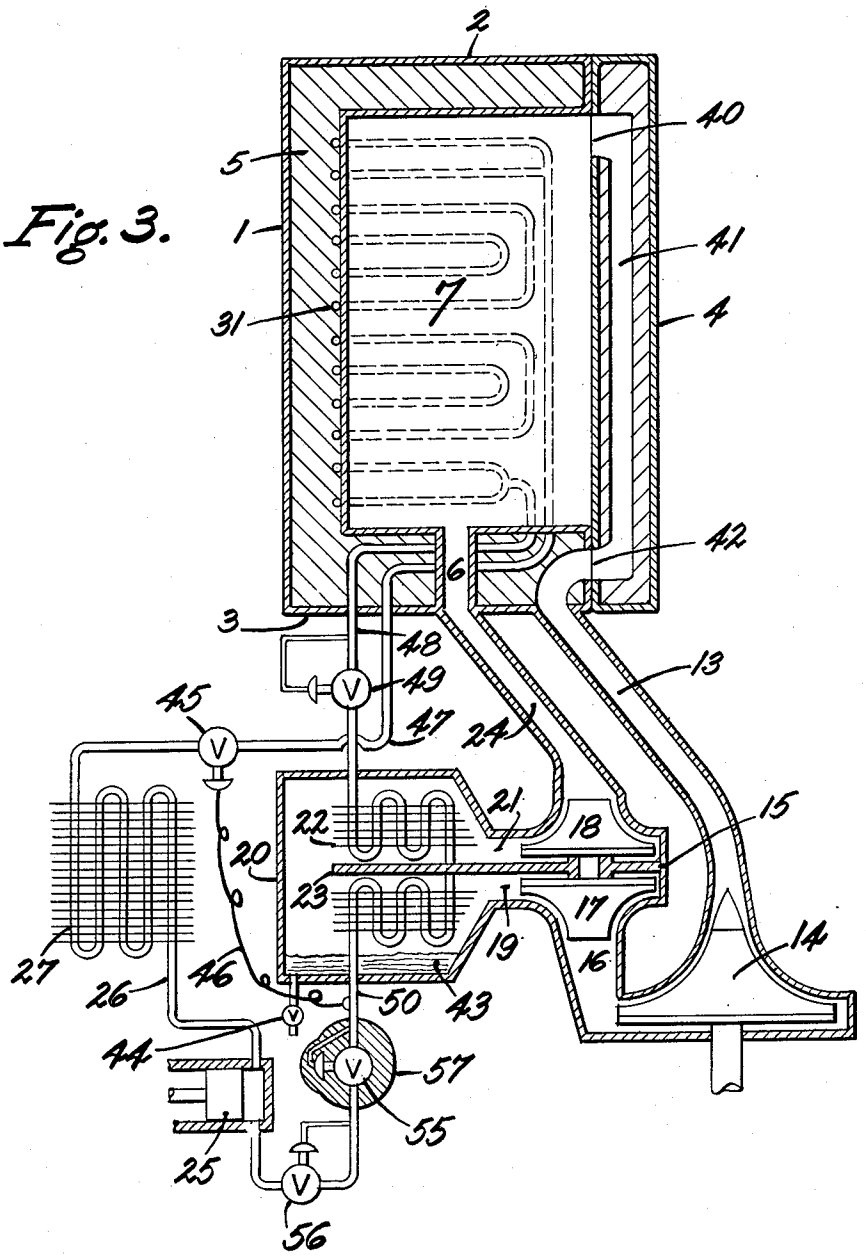
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Fig. 3.



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United States Patent Office 2,959,025 Patented Nov. 8, 1960

2,959,025

HOUSEHOLD REFRIGERATOR

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Filed July 16, 1957, Ser. No. 672,265

11 Claims. (Cl. 62—62)

My invention relates to improvements in refrigerators and is especially adapted though not limited to the household refrigerator which must be relatively light, portable and small enough to enter the rooms of a house or apartment through the ordinary door apertures.

This application is a continuation in part of my copending application Serial No. 372,032 filed August 3, 1953, now abandoned.

In the usual household refrigerator, cold heat exchange surfaces of comparatively small area and very low temperatures are usual. As a result of the very great temperature gradient between the cold surfaces and the refrigerator contents, vapor migration from the foodstuffs causes rapid desiccation and deterioration and necessitates frequent defrosting.

The contents of the refrigerator will be cooled by saturated or supersaturated air. This air will be continuously forced into the refrigeration chamber in a generally saturated or supersaturated condition, will be withdrawn from the chamber, cooled and without substantial loss of moisture be returned thereto. When the air is withdrawn, it will be compressed. The heat of compression will be removed. It will then be caused to expand and do work with resultant further substantial lowering of temperature and will then be returned to the storage chamber having nowhere in its travels been exposed to or in contact with any surface, the temperature of which is below the air temperature except at the point where heat of compression is removed but at that point, the heat exchange surfaces will still be below the dew point so the entire cycle may continue without loss of moisture.

While the walls of the refrigerating chamber will be maintained at a temperature above the temperature of the air in the chamber and therefore above the dew point, those walls in order to prevent substantial heat loss and waste of cooling will be maintained at a temperature lower than the temperature that would be maintained if insulation alone were relied upon. The walls of the chamber may be cooled by causing the air from the refrigeration chamber on its return path to contact the outside walls of the chamber itself or they may be cooled by heat exchange with a conventional compressor condenser expander refrigeration system or by both.

A convenient solution is to provide a conventional expansion refrigeration system. The air after compression will be cooled by heat exchange with the cold side of the system. This will raise the temperature of the coolant somewhat and that coolant may then by heat exchange cool the walls of the storage chamber to a point above the dew point but low enough so that heat loss will be a minimum.

The wall defining the refrigeration cooling chamber should approach the temperature of air in the system. It must be above the dew point to inhibit condensation or frosting but the closer it is to that temperature, the less will be the heat loss from the air and the more effective will be the cooling.

My invention is illustrated more or less diagrammatically in the accompanying drawings, wherein

Figure 1 is a diagrammatic section and flow sheet through a refrigerator and air and freon circulating systems associated therewith;

Figure 2 is a section along the line 2—2 of Figure 1;

Figure 3 is a section similar to Figure 1 of a modified form.

Like parts are indicated by like characters throughout the specification and drawings.

The refrigerator housing includes side, top and bottom walls and a door **1**, **2**, **3** and **4**, all insulated at **5**. Cold air enters the refrigerating chamber through the entrance port **6** in the bottom **3** and leaves the chamber through the exit ports **8** flowing around the outside of the chamber **7** along passages **9**, **10**, **11** and **12** in side, top and bottom walls to discharge through duct **13**. There may be a thin insulating layer **5***a* around the chamber between it and the passages **9**, **10**, and **11**.

Blower **14** driven by motor not shown draws air through duct **13** and discharges it under pressure through duct **16** to the turbo blower compressor **15**, which contains free running compressor expander wheels **17**, **18** working in unison. Compressor wheel **17** discharges air through duct **19** and heat exchange chamber **20** where it passes around the dividing wall **23** coming in contact with cooling coils **22** and after cooling is discharged through the duct **21** to expander wheel **18** where it expands, does work with further cooling and is discharged through duct **24** and entrance duct **6**.

Associated with the air circulating system is a closed refrigeration system which includes compressor **25**, duct **26**, condenser coil **27**, expansion valve **28**, heat exchange coil **22** where the compressed air is cooled, duct **30**, refrigeration chamber heat exchange coils **31** which cool the walls of the chamber, return duct **33** and valve **33***a* to control return to the compressor.

Thus the air drawn from the refrigeration chamber after it is compressed has the heat of compression removed from it by the heat exchange coil **22**, then expands and does work before it is returned to the refrigeration chamber. The coldest surface contacted by this air being at the heat exchange coil **22** under circumstances such that no surface contacted by the air is below the dew point. Meanwhile the refrigerant from the compressor having taken heat from the air and so being somewhat warm, takes more heat from the wall of the refrigeration chamber but having been warmed by the air in the heat exchange chamber **20**, the Freon in these coils is at a temperature which does not cool the refrigeration chamber walls below the dew point, the operation of the Freon system being controlled in the usual way by the valve **33***a*.

In the modified form shown in Figure 3, the air leaves the chamber **7** through the port **40** in the door **4** to pass down through duct **41**, passes through the port **42** to the duct **13**. Thus when the door is opened the air circulation is interrupted but when the door is closed, the circulation is as in Figure 1. In this case water **43** is supplied to the bottom of the heat exchange chamber **20** controlled by the valve **44** so that when desired, moisture may be added to the air.

The compressed refrigerant when it leaves the condenser **27** passes through an expansion valve **45**, the operation of which is controlled responsive to the low pressure side of the system through a capillary tube **46**. A duct **47** leads to the refrigeration chamber coils **31**. A duct **48** controlled by valve **49** leads to the heat exchange coil **22**. A duct **50** controlled by pressure regulating valves **55** and **56** controls the flow of refrigerant back to the compressor.

In this case, the operation of the valves **45** and **49**,

50, 55 and 56 maintains pressure differential in various parts of the system so that the temperature of the refrigerating chamber 7 is controlled at a point below the dew point. The temperature of the heat exchange coils exposed to the air is controlled at the proper point to extract heat of compression but not below the dew point and the pressure relief valves 55 and 56 are as indicated at 57 insulated so that they are independent of ambient temperature. Thus the air in contact with the foodstuffs does the cooling and since that air if not saturated or supersaturated is at least very high in moisture content and since the walls and surfaces to which that air is exposed are always above the dew point, vapor migration from the foodstuffs to and through the air is inhibited and so the foodstuffs are maintained at desired temperature with a minimum of desiccation.

I claim:

1. In a refrigerator, an insulated cold chamber, means for circulating through and maintaining in the chamber an atmosphere of cold moisture laden air, independent compressing and cooling means for controlling and maintaining the temperature of the chamber walls at a point adjacent to but above the dew point of the atmosphere in the chamber, where the means for circulating through and maintaining in the chamber an atmosphere of cold moisture laden air includes means for compressing, cooling and expanding said moisture laden air with the removal of moisture only during the cooling step when the amount of moisture present is beyond saturation whereby cold air supersaturated with moisture in vapor form, as distinguished from free water, is circulated through the chamber.

2. In a refrigerator, an insulated cold chamber, means for circulating through and maintaining in the chamber an atmosphere of cold moisture laden air, independent compressing and cooling means for, controlling and maintaining the temperature of the chamber walls at a point adjacent to but above the dew point of the atmosphere in the chamber, said controlling means including means for circulating about the outside of the chamber walls a blanket of cold air, the temperature of which is far below ambient air temperature, where the means for circulating through and maintaining in the chamber an atmosphere of cold moisture laden air includes means for compressing, cooling and expanding said moisture laden air with the removal of moisture only during the cooling step when the amount of moisture present is beyond saturation whereby cold air supersaturated with moisture in vapor form, as distinguished from free water, is circulated through the chamber.

3. In a refrigerator, an insulated cold chamber, means for circulating through and maintaining in the chamber an atmosphere of cold moisture laden air, independent compressing and cooling means for, controlling and maintaining the temperature of the chamber walls at a point adjacent to but above the dew point of the atmosphere in the chamber, said controlling means including means for circulating about the outside of the chamber walls a blanket of cold air, the temperature of which is far below ambient air temperature, such air blanket including cold air drawn from the chamber, where the means for circulating through and maintaining in the chamber an atmosphere of cold moisture laden air includes means for compressing, cooling and expanding said moisture laden air with the removal of moisture only during the cooling step when the amount of moisture present is beyond saturation whereby cold air supersaturated with moisture in vapor form, as distinguished from free water, is circulated through the chamber.

4. In a refrigerator, an insulated cold chamber, means for circulating through and maintaining in the chamber an atmosphere of cold moisture laden air, independent compressing and cooling means for, controlling and maintaining the temperature of the chamber walls at a point adjacent to but above the dew point of the atmosphere in the chamber, said controlling means including coils wrapped in heat exchange relation about the outside of the chamber walls and means for circulating a liquid refrigerant through them, where the means for circulating through and maintaining in the chamber an atmosphere of cold moisture laden air includes means for compressing, cooling and expanding said moisture laden air with the removal of moisture only during the cooling step when the amount of moisture present is beyond saturation whereby cold air supersaturated with moisture in vapor form, as distinguished from free water, is circulated through the chamber.

5. In a refrigerator, an insulated cold storage chamber, a cold air circulating chamber surrounding the storage chamber, an air circulating system for the chambers including a supply duct communicating directly with the storage chamber, a discharge duct communicating with the circulation chamber, a connection between the chambers, means for withdrawing air through the discharge duct, compressing it, cooling it to remove heat of compression, expanding and cooling it without loss of moisture and returning it to the storage chamber through the supply duct.

6. In a refrigerator, an insulated cold storage chamber, a cold air circulating chamber surrounding the storage chamber, an air circulating system for the chambers including a supply duct communicating directly with the storage chamber, a discharge duct communicating with the circulation chamber, a connection between the chambers, means for withdrawing air through the discharge duct, compressing it, cooling it to remove heat of compression, expanding and cooling it without loss of moisture and returning it to the storage chamber through the supply duct, the means for removing heat of compression including a separate closed circuit compressor, condenser, expander, evaporator unit having an evaporator in heat exchange relationship with the air between the points of compression and expansion.

7. In a refrigerator, an insulated cold storage chamber, a cold air circulating chamber surrounding the storage chamber, an air circulating system for the chambers including a supply duct communicating directly with the storage chamber, a discharge duct communicating with the circulation chamber, a connection between the chambers, means for withdrawing air through the discharge duct, compressing it, cooling it to remove heat of compression, expanding and cooling it without loss of moisture and returning it to the storage chamber through the supply duct, the means for removing heat of compression including a separate closed circuit compressor, condenser, expander, evaporator unit having an evaporator in heat exchange relationship with the air between the points of compression and expansion, the unit including evaporator coils in heat exchange relationship with the storage chamber walls.

8. In a refrigerator, an insulated cold storage chamber, a cold air circulating chamber surrounding the storage chamber, an air circulating system for the chambers including a supply duct communicating directly with the storage chamber, a discharge duct communicating with the circulation chamber, a connection between the chambers, means for withdrawing air through the discharge duct, compressing it, cooling it to remove heat of compression, expanding and cooling it without loss of moisture and returning it to the storage chamber through the supply duct, the means for removing heat of compression including a separate closed circuit compressor, condenser, expander, evaporator unit having an evaporator in heat exchange relationship with the air between the points of compression and expansion, independent means for controlling the unit to maintain the temperature of the surfaces exposed to the air below the dew point.

9. In a refrigerator, an insulated cold storage chamber,

a cold air circulating chamber surrounding the storage chamber, an air circulating system for the chambers including a supply duct communicating directly with the storage chamber, a discharge duct communicating with the circulation chamber, a connection between the chambers, means for withdrawing air through the discharge duct, compressing it, cooling it to remove heat of compression, expanding and cooling it without loss of moisture and returning it to the storage chamber through the supply duct, the means for removing heat of compression including a separate closed circuit compressor, condenser, expander, evaporator unit having an evaporator in heat exchange relationship with the air between the points of compression and expansion, the unit including evaporator coils in heat exchange relationship with the storage chamber walls, and means for maintaining the temperature of the storage chamber walls below the dew point.

10. The method of preserving foodstuffs which consists in holding them in a refrigerating chamber, maintaining and circulating through such chamber an atmosphere of cold, moist air which serves as the sole refrigerating medium, maintaining the walls of the chamber with which such atmosphere comes in contact at a point above the dew point of such atmosphere, continuously withdrawing air from the chamber and outside the chamber, compressing, expanding and cooling it and returning it without loss of moisture in cooled condition from the chamber to maintain the circulation of the atmosphere.

11. The method of preserving foodstuffs which consists in holding them in a refrigerating chamber, maintaining and circulating through such chamber an atmosphere of cold, moist air which serves as the sole refrigerating medium, maintaining the walls of the chamber with which such atmosphere comes in contact at a point above the dew point of such atmosphere, the wall temperature closely approximating the temperature of the atmosphere in the chamber, continuously withdrawing air from the chamber and outside the chamber, compressing, expanding and cooling it and returning it without loss of moisture in cooled condition from the chamber to maintain the circulation of the atmosphere.

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