May 24, 1932. G. H. PHELPS 1,859,840

REFRIGERATING MACHINE

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Fig. 1.

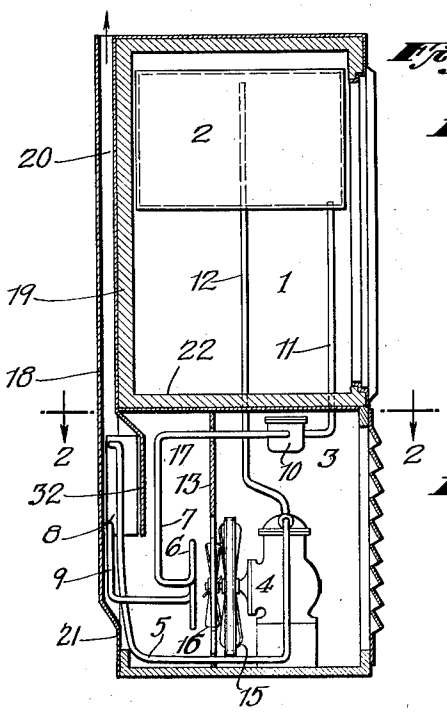


Fig. 2.

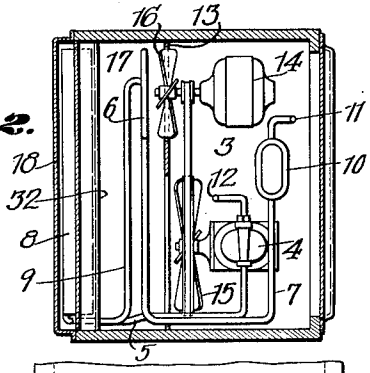


Fig. 3.

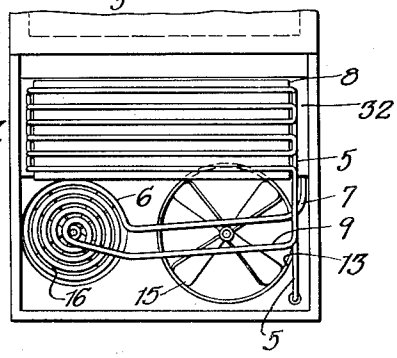


Fig. 4.

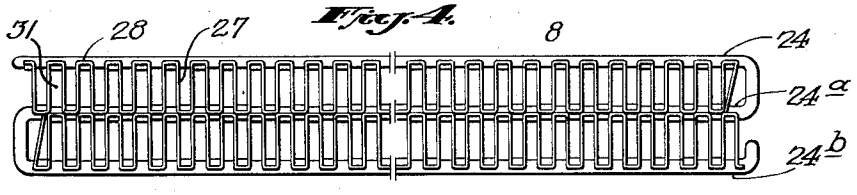


Fig. 5.

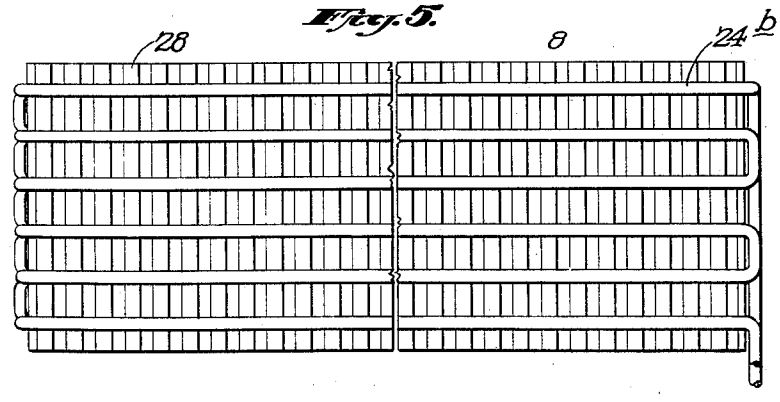
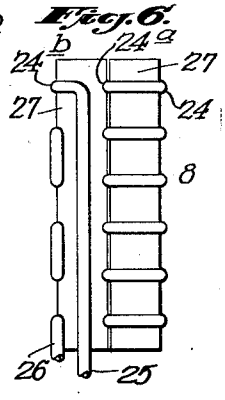


Fig. 6.



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REFRIGERATING MACHINE

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Fig. 8.

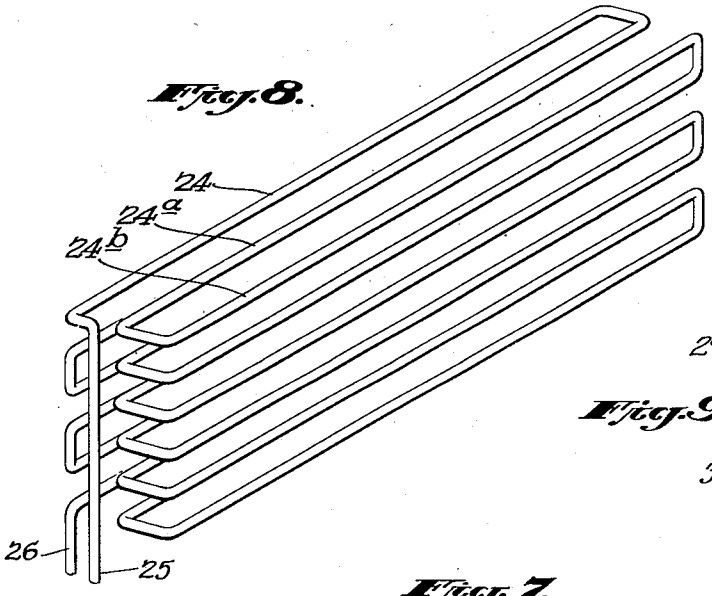


Fig. 9.

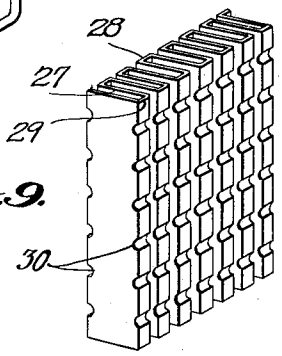


Fig. 7.

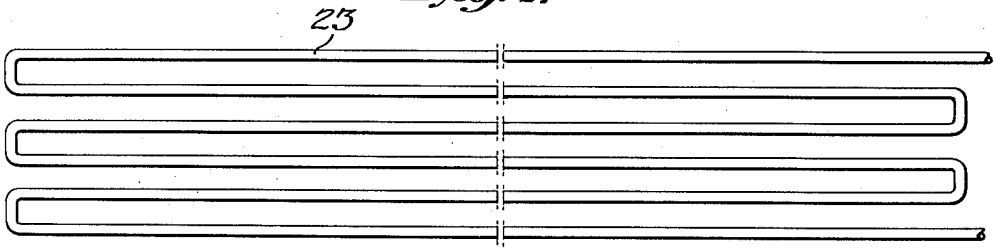


Fig. 11.

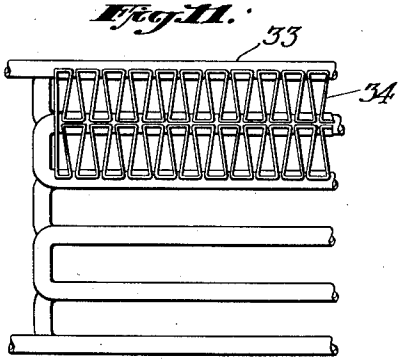
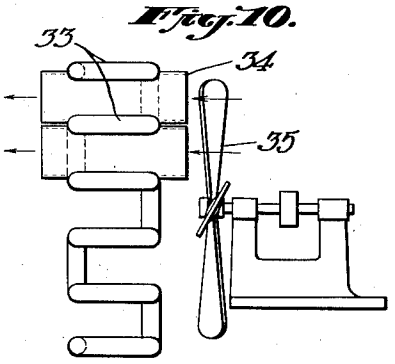


Fig. 10.



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UNITED STATES PATENT OFFICE

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REFRIGERATING MACHINE

Application filed December 14, 1927. Serial No. 239,875.

The invention provides a new arrangement of the condenser of refrigerant-cooler with relation to the other parts of the mechanism and the cabinet by which an economy of space is secured with a high efficiency of the cooling arrangement.

The accompanying drawings illustrate embodiments of the invention.

Fig. 1 is a more or less diagrammatic view showing the cabinet in vertical section with the principal parts of the refrigerating system in side elevation;

Fig. 2 is a sectional view on the line 2—2 of Fig. 1;

Fig. 3 is a rear elevation of the lower part of Fig. 1 with the back wall removed;

Figs. 4, 5 and 6 are respectively a plan and a front and an end elevation of the condenser or cooler for the refrigerant;

Fig. 7 is a developed elevation of the tubing of the condenser;

Fig. 8 is a perspective of the tubing as it is bent in the condenser;

Fig. 9 is a similar view of a corrugated plate forming part of the condenser;

Figs. 10 and 11 are diagrams in end and face elevation respectively illustrating an alternative arrangement.

The cabinet has an upper compartment 1 containing food shelves and a brine tank or cooling unit 2, and a separate machine compartment 3 at the bottom. The refrigerant is compressed by a compressor 4 whence it passes by way of a pipe 5 to the inlet end of a condenser indicated as a whole by the numeral 8. The outlet pipe 9 from the condenser leads through a flat spiral coil 6 and pipe 7 to a float valve 10 and pipe 11 to the cooling unit, where it is expanded and absorbs heat from the air in the cabinet. The expanded refrigerant passes back through pipe 12 to the compressor 4. Various other arrangements may be used and various controlling devices for the refrigerant circuit.

The refrigerant is heated in the compressor. The heat thus absorbed as well as latent heat has to be extracted and this is done by the condensing or refrigerant-cooling arrangements. A vertical diaphragm or partition 13 is arranged in the rear of the compressor 4 and motor 14 with holes in it which accommodate a pair of fans 15 and 16 of the propeller type mounted on the ends of the shafts of the compressor and motor. The space 17 back of the partition 13 may be termed the condenser compartment. The back wall of this compartment is a metal sheet or plate 18 which is extended upward a slight distance in the rear of the back wall 19 of the cabinet proper; forming a narrow air outlet flue 20 of substantially the width of the cabinet and the full height thereof. At its lower end the back plate 18 is offset to provide a portion 21 substantially in line with the rear wall of the cabinet and high enough to clear the usual base board at the bottom of the wall of the room. In this way the cabinet may be set against the wall and the usual space occurring at the back by reason of the projecting base board is utilized for an air flue.

This air flue 20 is arranged to form a common outlet from a number of separate flues which pass through the condenser. The latter, being located below the horizontal wall 22 at the bottom of the food compartments, can be made thicker than the common flue 20, the extra thickness projecting forward into the machine compartment; so that the aggregate area across its separate flues will correspond to the area across the common outlet flue 20 and thus take the fullest advantage of the latter to use the maximum quantity of air.

The structure of the condenser is illustrated in Figs. 4 to 8. A long continuous tube 23, Fig. 7, is bent to form a number of parallel lengths arranged in a vertical plane. It is then bent horizontally in the manner of Fig. 8 so that each length is converted into three shorter lengths 24, 24^a and 24^b Fig. 8. We thus have a continuous tube assembled in eighteen lengths arranged close to each other in three parallel vertical groups, with an inlet pipe 25 and an outlet pipe 26 at one end of the assembly. Initially the spaces between lengths 24^a and 24^b (and similarly for each horizontal series) are bent to leave a slightly flaring space between them. A radi-

ating structure is inserted in each of the spaces.

As shown separately in Fig. 9, this consists of a plate corrugated to form transverse walls or fins 27 connected at alternate ends by webs 28 and 29 in which are recesses 30 embracing the several lengths of pipe. After this radiating structure is applied, one in each of the spaces between the vertical groups of tubes, the latter are clamped closely against the corrugated sheets and the whole structure soldered by dipping, or otherwise united. The resulting structure, shown in Figs. 4, 5 and 6 forms a number of small vertical flues 31. The tubing and the radiating structure are preferably made of thin copper, brass or other metal of high conductivity. The heat is abstracted rapidly from the refrigerant.

A large surface of the radiating structure is exposed to the air and a comparatively rapid upward draft of the warm air is induced by the small flues which act in the manner of chimneys; the draft being strengthened by the height of the common outlet flue 20.

The spaces between the fins are closed at the rear by the back wall 18, Fig. 1, and at the front by a plate 32 which is continued upward to the common flue. The condenser is open at the bottom to admit air forced in by the fans. The flat spiral coil 6 is placed directly in front of one of the fans and cooperates with the condenser 8 by cooling the liquid refrigerant as it leaves the condenser and before it enters the valve 10.

Figs. 10 and 11 show an arrangement of the condenser in which the flues or passages are transverse instead of longitudinal. The pipe for the refrigerant is bent into a succession of horizontal coils 33, each consisting of two adjacent lengths. And the radiating structure is in a series of separate sections one between each two horizontal coils. Each section 34 is corrugated to form transverse fins connected at alternate ends by webs which are shaped (as in Fig. 9) to fit the tubes. The result is a series of small transverse flues between the fins, through which the air is blown as indicated by the arrows in Fig. 10.

The fan 35 is actuated by any part of the mechanism to blow the air through the flues. The shape of this condenser is such that it can be arranged in substantially the same position as the condenser of Fig. 1, that is with the flues horizontal, open at the front for the admission of air and discharging at the back into the common outlet flue 20. Or, where space permits, it may be arranged with its principal dimensions horizontal and its flues vertical.

The refrigerant enters the compressor as a cold low pressure gas. It leaves it as a hot high pressure gas. The function of the compressor is to raise the pressure on the refrigerant gas to such a point that it can be condensed to a liquid in the condenser. The condenser receives a high pressure gas and by absorbing heat from this gas liquefies it. A small part of this heat absorbed in the condenser is the heat of compression—the heat equivalent of the mechanical work done on the gas in the compressor. However, a great majority of the heat removed from the gas in the condenser is the latent heat of liquefaction (or vaporization) of the gas. This latter is not sensible heat, but rather the heat necessarily removed from the gas in changing it to the liquid state without altering its temperature. The constant temperature at which this relatively large amount of latent heat will be given up by the gas,—that is, the temperature at which the gas will liquefy, depends upon its pressure. Therefore the compressor must deliver the gas to the condenser at a pressure sufficiently high to allow liquefaction at a temperature which can be maintained by the available cooling medium,—in this case air at room temperature.

Now the refrigerant gas having been condensed to the liquid state in the condenser, it is obvious that it will be of advantage to return this liquid to the brine tank as cool as is possible. Otherwise heat is being carried unnecessarily into the refrigerator. Hence, the liquid refrigerant is conducted through the flat spiral coil 6 which is impinged upon by the incoming or coolest air. In this way, the liquid refrigerant is cooled below the temperature at which it formed and is returned to the brine tank as cool as is conveniently possible. This cooling of the liquid cannot take place in those parts of the condenser where the liquid is in contact with uncondensed gas, for any attempt to cool it there would only result in condensing more of the gas. Hence but little cooling of the liquid refrigerant takes place in the condenser, and the flat spiral coil is introduced to accomplish this result more thoroughly.

There is no absolute necessity for the use of the flat spiral coil. Its use merely results in a slightly improved efficiency which in various cases may or may not be of sufficient importance to warrant its use. This coil is not a vital part in any way and may be, and very frequently is, dispensed with.

But it is important to have an extended area of conductive metal for contact with the cooling air and this involves a large number of separate air flues formed by the sheet metal radiating structure. In this way the column of cooling air is divided into a number of small columns from which the maximum cooling effect is obtained in the limited space available for the condenser of these refrigerating apparatus. The total air space provided is not substantially different from

that in the common outlet flue 20, but the contact area for the air is very many times as great. The provision of the numerous flues and extended area in the condenser permits of a complete cooling effect therein, so that the common flue 20 does not have to carry any part of the refrigerant coil (as has been the case in other designs of apparatus) and can be made of minimum cross-section to secure a given draft.

Various other modifications of the condenser and of the details and arrangement of the other parts of the refrigerant circuit may be made by those skilled in the art without departing from the invention as defined in the following claims.

What I claim is:

1. A refrigerating machine having a refrigerant circuit including a condenser, said machine having a cabinet in the lower part of which is a compartment formed by a partition, said cabinet having a narrow vertical air exit flue back communicating at its lower end with the top of said compartment, the entire condenser being located below said flue and enclosed within said compartment, means for blowing air into said compartment and through said condenser to said exit flue, said compartment being closed except to admit air from said blower and to discharge it into said exit flue, said condenser having a number of small passages in which the passing air is confined laterally between metal walls which communicate its cooling effect to the refrigerant, said passages all discharging directly into the lower end of said exit flue.

2. A refrigerating machine having a refrigerant circuit including a condenser and a separate cooler, said machine having a cabinet in the lower part of which is a compartment formed by a partition, said cabinet having a narrow vertical air exit flue back communicating at its lower end with the top of said compartment, the entire condenser and the cooler being located below said flue and enclosed within said compartment, means for blowing air into said compartment and through said condenser and cooler to said exit flue, said compartment being closed except to admit air from said blower and to discharge it into said exit flue, said condenser having a number of small passages in which the passing air is confined laterally between metal walls which communicate its cooling effect to the refrigerant, said passages all discharging directly into the lower end of said exit flue.

3. A refrigerating machine having a refrigerant circuit including a condenser, said machine having a cabinet in the lower part of which is a compartment enclosing said condenser, said cabinet having also a narrow vertical air exit flue at the back, said condenser being located below said flue and having a number of small vertical flues formed by metal walls in which the passing air is confined between said walls which communicate its cooling effect to the refrigerant, said condenser flues discharging at their upper ends into said air exit flue, and means for blowing air into the lower ends of said condenser flues, so that the air is heated in the condenser and passed rapidly through it with the aid of an induced draft proportioned to the combined height of the condenser flues and the common exit flue.

4. A refrigerating machine having a refrigerant circuit including a condenser, said machine having a cabinet in the lower part of which is a compartment enclosing said condenser, said cabinet having also a narrow vertical air exit flue at the back, said condenser being located below said flue and having a number of small vertical flues in which the passing air is confined between metal walls which communicate its cooling effect to the refrigerant, said condenser flues discharging at their upper ends into said air exit flue, means for blowing air into said compartment and blocking it off from direct escape by the air exit flue so that it all enters the lower ends of the condenser flues and is heated therein and passed rapidly through it with the aid of an induced draft proportioned to the combined height of the condenser flues and the common exit flue.

5. A refrigerating machine having a refrigerant circuit including a condenser, said machine having a cabinet in the lower part of which is a compartment enclosing said condenser, said cabinet having also a narrow vertical air exit flue at the back, said condenser being located below said flue and having a number of small vertical flues in which the passing air is confined between metal walls which communicate its cooling effect to the refrigerant, said condenser flues discharging at their upper ends into said air exit flue, and means for blowing air into the lower ends of said condenser flues, so that the air is heated in the condenser and passed rapidly through it with the aid of an induced draft proportioned to the combined height of the condenser flues and the common exit flue, said condenser being of greater thickness (front to back) than said exit flue and being located partly in line with it and partly projecting forward into the compartment.

6. A refrigerating machine having a refrigerant circuit including a condenser, said machine having a cabinet in the lower part of which is a compartment enclosing said condenser, said cabinet having also a narrow vertical air exit flue at the back, said condenser being located below said flue and having a number of small vertical flues formed by metal walls in which the passing air is confined between said walls which communicate its cooling effect to the refrigerant,

said condenser flues discharging at their upper ends into said air exit flue, and means for blowing air into the lower ends of said condenser flues, so that the air is heated in the condenser and passed rapidly through it with the aid of an induced draft proportioned to the combined height of the condenser flues and the common exit flue, said exit flue being formed by a back wall which at its lower end is offset forwardly to accommodate a projection at the base of the wall of a room, said condenser being located above said offset.

In witness whereof I have hereunto signed my name.

GEORGE H. PHELPS.