This invention relates to refrigerating apparatus and more particularly to combined refrigerator-freezer units having separate compartments for the storage of fresh food and frozen food.

In the past, household refrigerators having a frozen food compartment in addition to the usual fresh food compartment have taken two principal forms. In most cases the frozen food compartment is located within the fresh food compartment and a single evaporator is provided which directly cools the frozen food compartment and indirectly cools the fresh food compartment either by convection or by the utilization of blowers for providing forced air circulation.

Alternately two separate compartments are provided which are usually cooled by separate coils. The condenser is located either at the rear of the refrigerator or in a compartment at the bottom of the refrigerator. The location and configuration of the condenser has a marked effect on the overall efficiency of the refrigerator apparatus.

All condensers now in use are of the fin and tube or wire and tube type. While such condensers operate with relatively good efficiency when properly maintained, they are susceptible to clogging due to the accumulation of dust, lint and other particles on the coils, wires or fins. Accordingly, to avoid serious loss of efficiency and compressor overload, prior condensers must be cleaned frequently. Since this is an annoying and troublesome task it is often deferred or overlooked with the result that the refrigerator operates at constantly reducing efficiency.

In the various prior forms of household refrigerators having multiple compartments, the problems of maintaining effective temperature control in the two compartments, achieving efficient operation and effectively disposing of moisture accumulating within the refrigerator have also continued to exist.

With these considerations in mind, it is the principal purpose and object of the present invention to provide improved refrigerators of the type in which the separate compartments for the storage of frozen and fresh foods are provided and which produce better refrigeration, more effective temperature control and greater operating efficiency than heretofore obtainable.

It is a further object to provide refrigerators of this type which are relatively simple mechanically, thus decreasing their initial cost and increasing their service life.

It is also an object of the present invention to provide such refrigerators embodying a novel disposition of the evaporator and condenser coils and the apparatus for controlling the flow of air in both interior compartments and over the exterior condenser coil.

It is an additional object to provide improved means for eliminating excess moisture from the interior of the compartments when the fan 54 in operation or evaporating such moisture externally of the compartments, the apparatus including a condenser of novel form.

It is also an object of the present invention to provide novel condensers for refrigerating apparatus which are self-cleaning in operation and which thus provide for high efficiency of operation over an extended period of time and eliminate the need for periodic cleaning of the condenser which has proved a source of annoyance in the past or has been neglected altogether resulting in the substantial impairment of the efficiency of prior units.

In attaining these and other objects, the present invention broadly provides a household refrigerator having an upper compartment for the storage of fresh foods, a lower compartment for the storage of frozen foods, a single evaporator coil disposed in the lower compartment and separate blowers controlling the flow of air through both compartments, means for circulating cooling air for both compartments over the single evaporator coil in a unique manner, and a novel condenser positioned at the bottom of the refrigerator directly beneath the freezer compartment.

Additional advantages and objects will become apparent as the description proceeds in connection with the accompanying drawings in which:

FIGURE 1 is a semi-diagrammatic front elevation of the refrigeration apparatus of the present invention with parts broken away to show interior details;

FIGURE 2 is a vertical section taken substantially along line 2--2 of FIGURE 1; and

FIGURE 3 is a perspective view of the condenser and associated blower assembly removed from the unit of FIGURES 1 and 2.

Referring now more particularly to the drawings, the refrigerator of the present invention comprises an insulated box indicated generally at 20, the interior of which is divided by an insulated horizontal wall 22 into an upper fresh food compartment 24 and a lower frozen food compartment 26. Separate upper and lower doors 28 and 30 are provided to permit independent access to the upper and lower compartments 24 and 26, respectively.

The bottom insulated wall 32 of the freezer compartment is located a substantial distance above floor level to provide an uninsulated bottom compartment to accommodate the compressor 34 and the condenser assembly 36 and associated apparatus described in detail below.

It is a feature of the present invention that the single evaporator is utilized in a unique manner to provide controlled cooling for both the fresh food and frozen food compartments. In accordance with the present invention, this evaporator indicated generally at 38 is vertically disposed along the rear wall of the frozen food compartment 26.

The usual conduits and valves connecting the compressor 34, the condenser 36 and the evaporator 38 in a closed series circuit have been omitted for clarity.

The entire front surface of the evaporator 38 is covered by a thin uninsulated sheet metal baffle 40, the bottom edge of which is spaced from the lower wall 32 of the frozen food compartment 26 to provide an opening 42 for the passage of cooling air. A vertical baffle 46 extends between the rear wall of the compartment 26 and the front baffle 40 to divide the area covered by the baffle 40 into two independent sections, 48 and 52. The section 48 includes substantially the entire evaporator coil 38 and provides a flow path for cooling air for the frozen food compartment 26. The air is caused to flow through this section 48 by a fan 54 mounted on the rear wall of the compartment 26 opposite an opening 56 in the upper portion of the cover plate 40. Thus when the fan 54 is in operation, air is drawn inwardly through the opening 42 at the bottom of the cover plate 40 upwardly over the portion of the evaporator coil to the left of the vertical baffle 46 and is re-introduced into the compartment 26 by the fan 54.

The area 48 at the left of baffle 46 is in communication at its upper end with an opening 58 formed in the rear wall of the compartment 26 and leading into the
bottom end of a conduit 60 which extends upwardly within the rear wall of the fresh food compartment and terminates at its upper end in the compartment 62 positionally midway of the sides of the top of the rear wall of the compartment 24. A blower 64 is mounted in the compartment 62 to draw air successively upwardly over the portion 48 of the evaporator through the conduit 60 and to deliver it through a grille 56 in the upper end of the fresh food compartment 24. Air is returned from the fresh food compartment 24 to the region of the evaporator through a relatively short conduit 68, the upper end of which has an opening 70 at the lower end of the rear wall of the fresh food compartment and the bottom end of which has an opening 72 in the rear wall of the frozen food compartment at the upper end of the region 52 at the right of the baffle 46 as viewed in FIGURE 1.

As stated above, the condenser assembly 36 which forms an important feature of the present invention is located in a separate compartment at the bottom of the refrigerator. The condenser per se is of one-piece construction, one end of the condenser being bent to form a box-like section having a flat bottom wall section 74, and end wall 76, a top wall 78 and an opposite end wall 80. The end of the bottom wall section 74 is provided with tabs 82 welded to the bottom of the end wall section 78 to impart additional rigidity to the structure. The remainder of the condenser plate is provided with a series of reverse U-bends as at 84 to form a plurality of parallel wall sections 86 of essentially the same height as the box section. The condenser assembly is initially made from two flat plates having mating half-tube sections embossed in them. The two plates are welded together with the half-tube sections in juxtaposition to form a single sealed continuous fluid conduit 90 through which the refrigerant passes. Alternatively the assembly may be made by soft-soldering a tube on a metal sheet. The process by which the original flat assembly is made is wholly conventional and will not be further described here. The novel condenser assembly of the present invention is completed by the installation of a back plate 92 which encloses the rear side of the box-like section of the condenser. The condenser fan 94 is carried by the plate 92 in alignment with an opening 96 in the plate, the fan being driven to force air forwardly through the box-like section of the condenser drawing air from the region at the rear of the entire condenser assembly. Thus when the fan 94 is in operation, air is drawn inwardly through the box-like section of the condenser fan 94 which extends completely across the front wall of the condenser-compressor compartment, the air passes over the wall portions 86 of the condenser into the rear of the compressor-condenser compartment over the compressor 34 and outwardly through the box section of the condenser and through the right-hand portion of the grill 98 where it re-enters the room.

Actual experience has shown that this novel condenser of the present invention effects a remarkable improvement in operating efficiency over the more conventional fins and tube type condensers. The wire and tube type condensers now in universal use in domestic refrigerators. Since closely spaced fins and tubes or wires are completely eliminated by the condenser of the present invention, there is no tendency for the condenser to become clogged with dust. It is thus inherently self-cleaning and maintains its original efficiency over an indefinite period. Also it is to be noted that the condenser construction provides substantially unrestricted flow of air, thus assuring its operation with a high degree of efficiency and preventing any build-up of heat within the condenser and thus avoids overloading the compressor.

The novel condenser assembly also effectively disposes of defrost water in a unique manner. In accordance with the present invention, a moisture collecting trough 100 extends along the bottom edge of the evaporator 38. This trough is inclined downwardly toward the right as viewed in FIGURE 1 and the moisture accumulating in the trough is delivered through a conduit 102, the outlet end of which is disposed just below the top wall 78 of the box section of the condenser in front of the fan 94. A substantial portion of the water issuing from the lower end of the conduit 102 is immediately evaporated by the air flow. The unevaporated portion collects in a pan 106 which rests on the bottom wall section 74 of the condenser. Since the portion of the moisture issuing from the pan 106 is in heat exchange relation with the condenser and since the pan is disposed directly in the flow of relatively warm air produced by the fan 94, any water accumulating in the pan 106 is quickly evaporated.

The operation of the several blowers and the compressor is effected through essentially conventional components which will not be described in detail. The blower 64 is essentially under the control of a door switch and a thermostat located within the fresh food compartment 24. In accordance with conventional practice, the door switch is arranged to discontinue operation of the fan when the door is open. The thermostat will normally be set to operate the blower 64 when the cabinet temperature reaches approximately 40° and to discontinue operation of the blower when the cabinet temperature is in the neighborhood of 36°.

The fan 54 is also under the control of a door switch and a thermostat located at a convenient position within the frozen food compartment 26. The thermostat also controlling the operation of the compressor 34 and the fan 94. Again the door switch is arranged to discontinue operation of the fan 54 when the door is open. The thermostat will normally be set to operate the fan 54 and the compressor when the temperature adjacent the evaporator is about 12°F and to discontinue the operation of the blower and compressor when the cabinet temperature reaches —9°F.

The blower 30 is arranged to operate whenever the compressor is running except when the door 39 is opened or during the defrost cycle. Provision is also made for the so-called hot gas defrost cycle in accordance with conventional practice. For this purpose, a defrost timer clock may be provided which periodically reverses the fluid circuit connections between the compressor and the evaporator directing the hot refrigerant directly to the evaporator. The defrost cycle control also includes a thermostat to restore the normal connections when the evaporator reaches the temperature of approximately 38° F.

In operation four basic conditions are encountered. For example, if cooling is required in the freezer section only, the compressor 34, the condenser fan 94 and the fan 54 will be in operation and the fan 64 will be out of operation. When the temperature has been lowered sufficiently to satisfy the requirements of the evaporator, the operation of the compressor 34, the condenser fan 94 and the fan 34 will be discontinued. At any time when cooling is required only in the fresh food compartment, the fan 64 will operate while the remainder of the apparatus is out of operation.

When cooling is required in both compartments, the compressor, the condenser fan, and both fans 54 and 64 will be placed in operation.

During the defrost cycle, the compressor and the condenser fan will be placed in operation but the operation of the fans 54 and 64 will be discontinued.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come in within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A combined refrigerator-freezer assembly compris-
ing an insulated housing, an insulated horizontal wall dividing said housing into an upper fresh food compartment and a lower frozen food compartment, an evaporator coil in said frozen food compartment extending vertically closely adjacent a vertical wall thereof, a main baffle within said frozen food compartment forming with said wall of said compartment a relatively narrow channel around said evaporator, an additional baffle vertically extending between said main baffle and said wall and dividing said channel into two vertically extending portions, a fan in said frozen food compartment for causing air to flow in a re-circulating pattern in said frozen food compartment and including one of said channel portions, conduit means connecting the top of said fresh food compartment with one of said channel portions, additional conduit means connecting the bottom of said fresh food compartment with the other of said channel portions, a fan mounted in said fresh food compartment for causing air to flow through said one channel portion into said fresh food compartment, and a condenser-compressor assembly operatively connected to said evaporator and positioned externally of said insulated housing.

2. The combination according to claim 1 wherein said condenser is a plate having a refrigerant conduit formed therein, said plate being bent to provide a box-like section at one end and the remainder of said plate being provided with a series of U-bends to form a sinuous heat dissipating area.

3. A condenser assembly for refrigeration apparatus comprising a plate having a refrigerant conduit formed therein, said plate being bent to form a box-like section at one end and the remainder of said plate being bent to provide a sinuous heat dissipating surface, a plate closing one side of said box-like section, said plate having an opening, and a fan for causing air to move through said opening and said box-like section.

4. For use with a refrigerator having a condensate drain tube leading to the exterior thereof, a condenser assembly comprising a plate having a refrigerant conduit formed therein, said plate being bent to provide a box-like section at one end, the remainder of said plate being provided with a series of U-bends to form a sinuous heat dissipating area, the bottom of said box-like section providing a surface for supporting a drip pan, the top of said box-like section having an opening to receive the end of said drain tube, a plate covering one side of said box-like section, said plate having an opening, and a fan positioned to force air through said opening and said box-like section across the path of water draining from said condensate tube to said pan.

5. The combination according to claim 1 wherein said condenser is a plate having a refrigerant conduit formed therein, said plate being bent to provide a series of U-bends to form sinuous heat dissipating area.

6. A combined refrigerator freezer assembly comprising an insulated housing, an insulated horizontal wall dividing said housing into an upper fresh food compartment and a lower frozen food compartment, a vertically extending evaporator coil in said frozen food compartment adjacent a rear vertical wall thereof, a main baffle within said frozen food compartment forming with said rear wall of said compartment a relatively narrow vertical channel enclosing said evaporator, and having an air inlet and an air outlet in direct communication with said frozen food compartment, an additional vertical baffle extending between said main baffle and said rear wall and dividing said channel into two vertically extending portions, conduit means connecting the top of said fresh food compartment with the upper end of one of said channel portions, additional conduit means connecting the bottom of said fresh food compartment directly with the top of the other of said channel portions, fan means for causing air to flow over said evaporator for delivering air to said fresh food compartment and said frozen food compartment, and a condenser-compressor assembly operatively connected to said evaporator in position externally of said insulated housing.

7. The combination according to claim 6 wherein said fan means comprises a first fan positioned opposite an opening in said main baffle for causing air to flow in a recirculating pattern in said frozen food compartment, and a fan mounted in said fresh food compartment for causing air to flow through said one conduit means into said fresh food compartment and for returning said air through said additional conduit means directly to said one evaporator compartment.

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