June 12, 1956 D. B. DUNCAN ET AL 2,749,717

FLEXIBLE DEFROSTER-HEATER INSTALLATION FOR REFRIGERATOR

Filed Oct. 15, 1952 3 Sheets-Sheet 1

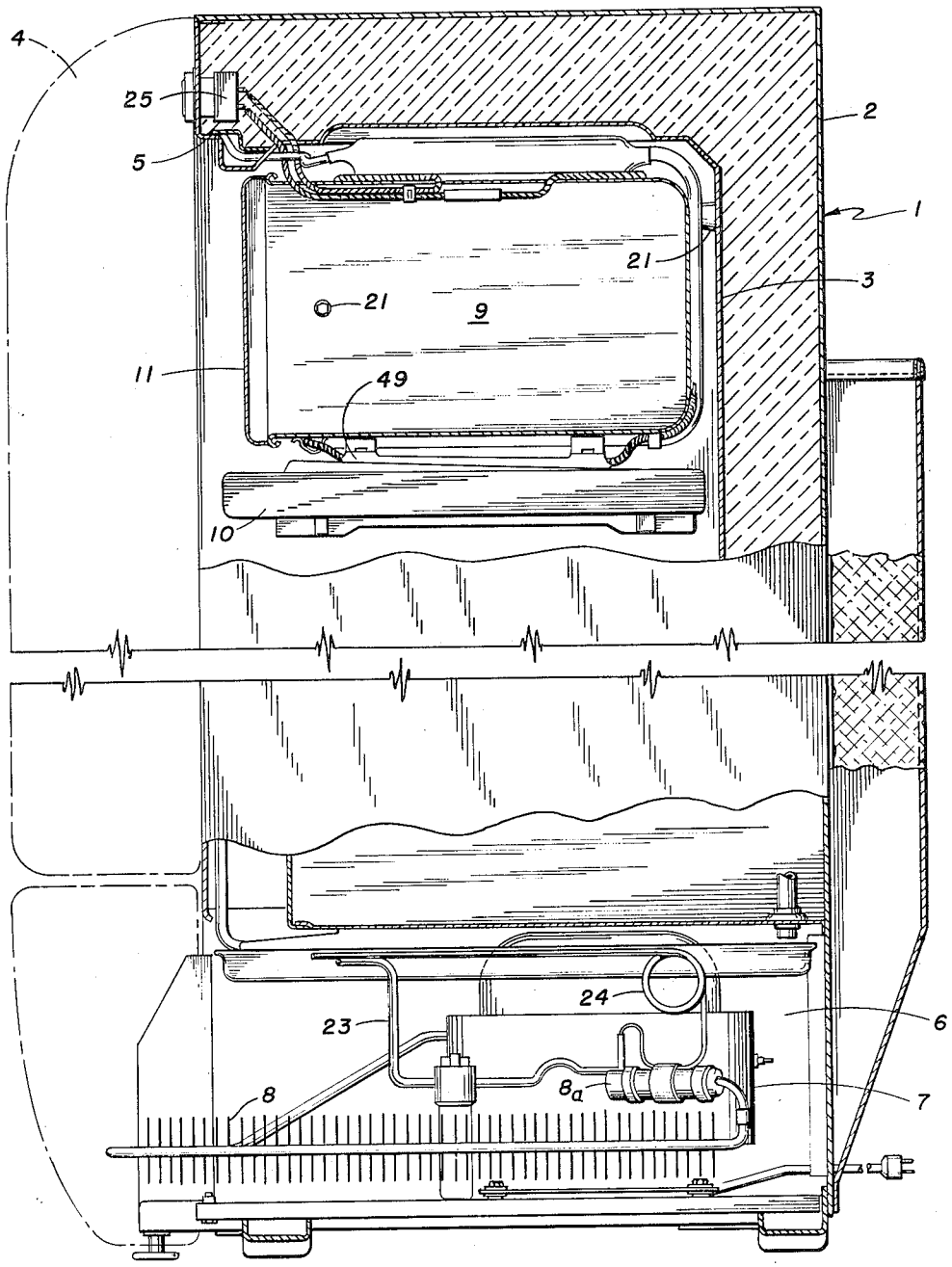


Fig 1

INVENTOR.
DAN B. DUNCAN
WILLIAM R. MITTENDORF
BY Alden D. Redfield
Warren Kurz
ATTORNEYS.

June 12, 1956 D. B. DUNCAN ET AL 2,749,717

FLEXIBLE DEFROSTER-HEATER INSTALLATION FOR REFRIGERATOR

Filed Oct. 15, 1952 3 Sheets-Sheet 2

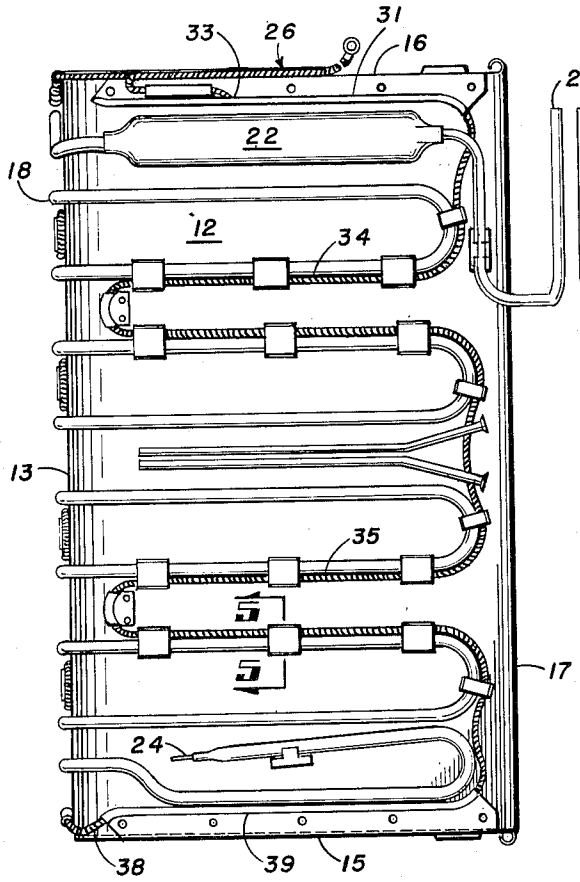


Fig 2

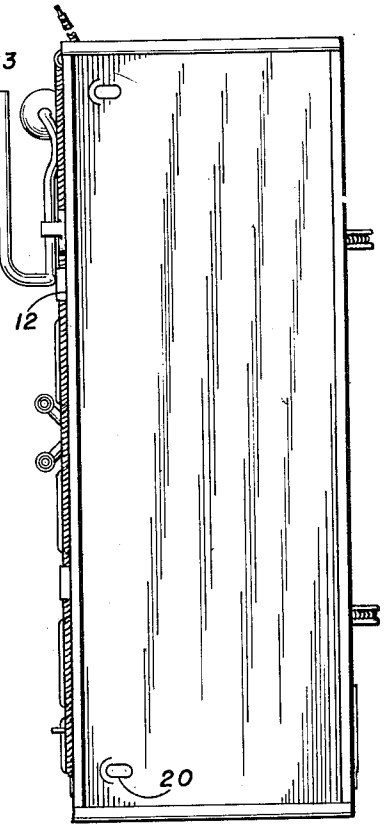


Fig 4

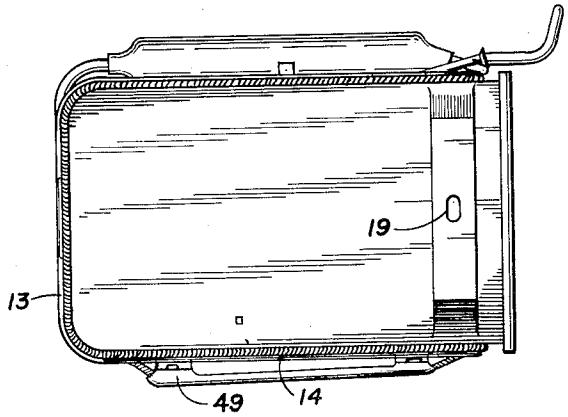


Fig 3

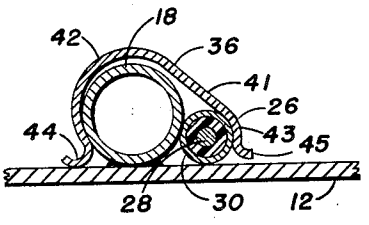


Fig 5

INVENTOR.
DAN B. DUNCAN
WILLIAM R. MITTENDORF
BY Alden D. Redfield
Warren Kunz
ATTORNEYS.

June 12, 1956 D. B. DUNCAN ET AL 2,749,717

FLEXIBLE DEFROSTER-HEATER INSTALLATION FOR REFRIGERATOR

Filed Oct. 15, 1952 3 Sheets-Sheet 3

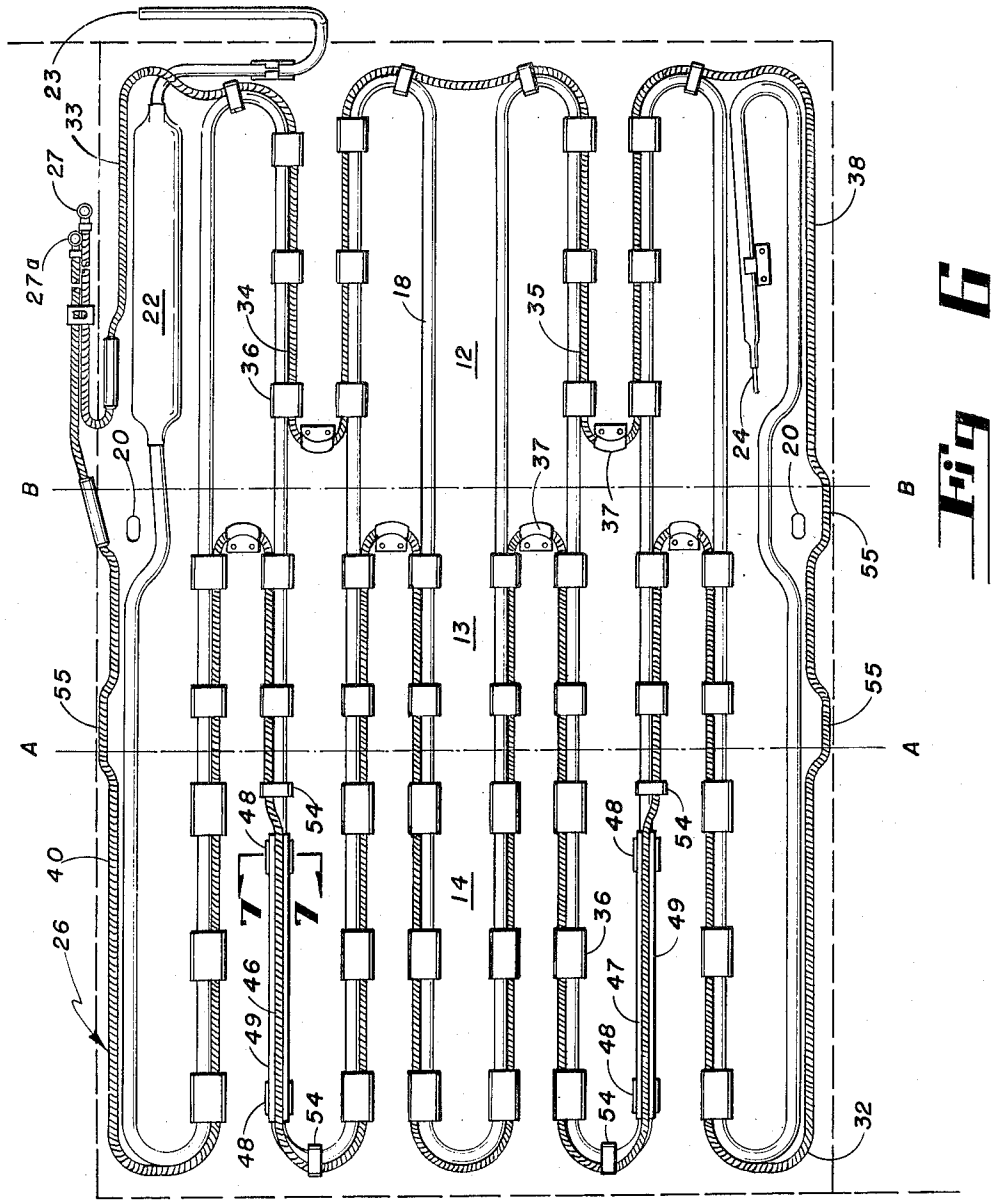


Fig 6

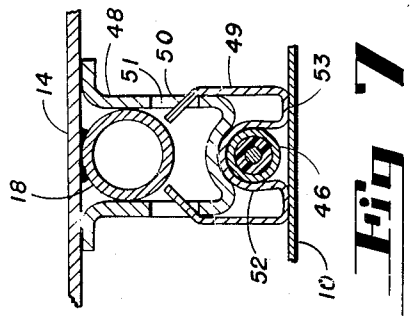


Fig 7

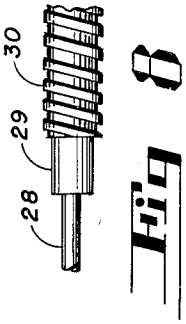


Fig 8

INVENTOR.
DAN B. DUNCAN
WILLIAM R. MITTENDORF
BY Alden D. Redfield
Warren Kurz
ATTORNEYS.

United States Patent Office

2,749,717

Patented June 12, 1956

2,749,717

FLEXIBLE DEFROSTER-HEATER INSTALLATION FOR REFRIGERATOR

Dan B. Duncan and William R. Mittendorf, Cincinnati, Ohio, assignors to Avco Manufacturing Corporation, Cincinnati, Ohio, a corporation of Delaware

Application October 15, 1952, Serial No. 314,836

6 Claims. (Cl. 62—3)

The present invention relates to refrigerators, and, more particularly, to a defroster-heater installation for the evaporator of a domestic refrigerator.

Although automatic means for removing frost from a refrigerator evaporator have been known for many years, only recently have such devices come into practical use. Such automatic defrosting devices are now meeting with widespread public acceptance, and represent one of the important advances in refrigerators made during the past generation. Despite initial success, it is obvious to manufacturer and user alike that there is still room for improvement and that there are problems in the construction and operation of a refrigerator having automatic defrosting which have not been solved. The present invention eliminates many of the present difficulties and comprehends the provision of a defroster-heater installation which is simple and more effective than devices known heretofore.

Many defroster-heaters now used consist of a relatively rigid tubular electrical resistance element which is preformed into the configuration which the heater must assume when secured to the evaporator. Although this type of heater has much to recommend it, it is a relatively expensive unit, must be carefully prefabricated, must be carefully installed on the evaporator, and occasionally is not entirely satisfactory in its performance because of insufficient contact with the evaporator. The present invention avoids these shortcomings.

Briefly stated, the invention comprehends a flexible defroster-heater which comprises an electrical resistance wire covered by water and heat resistant insulation over which is provided flexible metallic armored sheathing for protecting the insulation and wire from damage. The armored sheathing may be formed in a variety of ways but preferably is manufactured from strip material which is wound in an interlocking spiral formation in a manner resembling the armor used on commercial electrical cable. The flexible defroster-heater is clipped to the surface of a refrigerator evaporator, the heater being positioned on the evaporator in a predetermined pattern to meet its particular thermal requirements during defosting. Thus, the flexible assembly may be positioned in a sinusoidal pattern the greater part of its length may be positioned adjacent those areas which require the greatest amount of heat for satisfactory defrosting.

A typical evaporator with which the present invention finds particular utility is made from sheet metal to the surface of which is welded, or otherwise secured, a continuous length of tubing which defines the refrigerant flow channel of the evaporator. The flexible defroster-heater is removably clipped to the tubing contiguous to the surface of the evaporator.

The heater is supplied with electrical energy through an electrical timer which may be set to energize the heater once every twenty-four hours. The details of a highly successful circuit for this purpose are described in Patent No. 2,601,466, issued on June 24, 1952, to B. D. Thomas for a Defroster Circuit.

Experience with refrigerators having automatic defrosting devices has indicated that satisfactory operation can best be obtained when heat is also supplied to the transverse insulating baffle normally positioned beneath the evaporator for defining within the refrigerator an upper freezing compartment and a lower food storage compartment. A structure for supplying heat to such a baffle is shown in Patent 2,592,394, issued on April 8, 1952, to J. E. Cochran, entitled "Refrigerator Defrost Product Disposal System." The present invention lends itself well to an installation in which heat is supplied to the baffle, as will be described fully in the course of this specification.

In view of the foregoing, it is an object of the present invention to provide an improved defroster-heater installation for a refrigerator.

Another important object of the present invention is to provide, in an improved defroster-heater and evaporator combination, a flexible heater which may be easily applied to the evaporator to supply heat thereto for defrosting purposes.

A still further object of the present invention is to provide a flexible defroster-heater which can be applied in excellent heat transfer relationship directly to the surface of an evaporator.

A particularly important object of the present invention is to provide a defroster-heater which can be secured to an evaporator in a predetermined pattern as needed to meet the particular thermal requirements of the evaporator for successful defrosting.

Another object of the invention is to provide a defroster-heater which is not only easy to secure to the evaporator during initial assembly, but which may also be easily replaced in the field, should repairs be necessary.

A further object of the invention is the provision of mounting means for securing a flexible defroster-heater to an evaporator in such a fashion as to make possible conductive heat transfer to an insulated baffle provided transversely beneath the evaporator.

An advantage of the present invention is that the heater can readily be installed on the evaporator in close contact relationship with it since the flexibility of the heater assures surface contact regardless of irregularities of the evaporator. Further, there need be no concern for bending or deformation of the heater itself resulting from handling or manufacturing inaccuracies. Another object and advantage of the invention is the provision of a heater which may be secured to an evaporator without regard to the circulatory system for the refrigerant. Thus, the heater may be secured to the evaporator to supply heat as required for satisfactory defrosting, without regard for the fact that the requirements of the evaporator, for satisfactory refrigeration, are entirely different and concern different areas of the evaporator.

The structure for accomplishing these objects will be fully understood from the following description. The novel features that are considered characteristic of the invention are set forth in the appended claims; the invention itself, however, both as to its organization and method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in conjunction with the accompanying drawings, in which:

Figure 1 is a side elevational view of a refrigerator in which the present invention is installed, the side wall of the refrigerator being broken away to illustrate the interior construction thereof;

Figure 2 is a top plan view of the evaporator and defroster removed from the refrigerator;

Figure 3 is an end elevational view of the evaporator and associated defroster;

Figure 4 is a front elevational view of the evaporator;

Figure 5 is a cross sectional view of the defroster-heater clipped to a section of refrigerant tubing, the view being taken on plane 5—5 of Figure 2;

Figure 6 is a developed view of the evaporator showing the location of the refrigerant tubing and the associated defroster-heater;

Figure 7 is a cross sectional view taken on plane 7—7 of Figure 6 showing a support and associated bridge for mounting a portion of the heater for heat transfer to a baffle provided beneath the evaporator; and

Figure 8 is a fragmentary view of a part of the defroster-heater showing its construction.

Refrigerator arrangement

As illustrated in Figure 1, the present invention is adapted for installation in a domestic refrigerator, generally indicated 1, including an external shell 2 and an interior liner 3. A door 4 closes access opening 5. A machine compartment 6, located in the lower part of the refrigerator, houses a refrigerant compressor 7 and condenser 8.

Within the refrigerator there is provided an evaporator 9 beneath which is positioned a transverse insulating baffle 10 which divides the refrigerator into vertically spaced compartments, the upper one including the evaporator and constituting a freezing compartment, while the lower one is a higher temperature food storage compartment. A door 11 is hingedly attached to the evaporator for permitting access to its interior.

Evaporator construction

The evaporator is shown particularly well in Figures 2, 3, and 4. As illustrated in these figures, the evaporator is of the "horizontal" type and has a box-like formation including a top wall 12, rear wall 13, bottom wall 14, and end walls 15 and 16. The evaporator has an open front face 17 through which articles may be introduced to the evaporator for storage purposes.

Although the particular construction of the evaporator does not constitute a limitation of this invention, it has been found economical and convenient to form top, rear, and bottom walls 12, 13, and 14, respectively, from a single sheet of material. After these walls are bent into their proper relative positions, end walls 15 and 16 are secured to them to complete the box-like enclosure.

The evaporator illustrated in the attached figures includes a sinuous pattern of refrigerant tubing 18 which may be permanently secured to the exterior surfaces of the evaporator walls, as by furnace brazing. Figure 6 shows a developed view of the exterior of the evaporator, excluding the end panels. Bend lines AA and BB will be noted on this figure, line AA indicating the point at which wall 14 is bent at 90° relative to the rear wall 13, while line BB indicates the point at which the top wall 12 is bent at 90° relative to the rear wall 13. Top wall 12 may be disposed at an angle slightly greater than 90°, such as 95°, with the rear wall to produce a slope towards the rear of the evaporator to favor drainage of defrost water.

In the course of manufacture, the refrigerant tubing 18 is first placed on a flat sheet of material of suitable dimensions, as indicated in Figure 6. These two components are then intimately joined, as by furnace brazing, soldering, or any other suitable fabrication method; furnace brazing has been found particularly desirable for an evaporator made from sheet aluminum and aluminum tubing.

After the tubing is secured to the sheet, it is bent into the final form about bend lines AA and BB, after which end walls 15 and 16 are riveted to the assembly to complete the box-like evaporator. Holes 19 and 20 are formed in the end and rear walls of the evaporator to accommodate mounting bolts which secure the evaporator to the inner liner of the refrigerator, as indicated at 21 in Figure 1.

With particular reference to Figures 1, 2, and 6, it will be noted that a suction header 22 is also secured to the exterior of the evaporator. A suction tube 23 extends from this header to the inlet of refrigerant compressor 7 which sucks gaseous refrigerant from the header and compresses it prior to its entering condenser 8. In a manner well-known in the art, the gaseous refrigerant liquifies in the condenser and flows from the condenser to the evaporator through a capillary tube 24 which extends from filter 8*a* at the outlet of the condenser to one end of tubing 18 on the evaporator.

Defroster installation

The low temperature at which the evaporator operates causes the moisture in the air within the refrigerator to deposit on the exterior surfaces of the evaporator. This frost layer acts as an insulating blanket and retards heat transfer from the interior of the refrigerator to the evaporator, thereby reducing its operating efficiency. If the ice is not removed periodically, the accumulation tends to increase, eventually causing mechanical difficulties in the operation of the refrigerator components, such as the evaporator door, and deleteriously effecting the circulation of air currents within the refrigerator which cool the food storage compartment beneath baffle 10.

To avoid these difficulties, it is desirable to remove the frost from the evaporator periodically, preferably by automatic means, not requiring the attention of the refrigerator owner. As described more fully in Patent 2,601,466, a time clock 25 (Figure 1) may be provided on the control panel of the refrigerator. This clock may be set to supply energy once in every twenty-four-hour period to a defroster-heater, indicated generally at 26. The defroster-heater includes an electrical resistance element which, while energized, generates heat which is transferred directly to the evaporator for heating its exterior surfaces and removing the frost accumulation. It has been found from actual tests that frost can be completely removed in a few minutes if the heat is supplied at a sufficiently high rate and the heat is properly distributed over the entire area of the evaporator. It has also been found that the heating requirements of the various parts of the evaporator differ depending upon the location within the evaporator of ice trays. Other factors effecting the distribution of heat are the form of the evaporator itself and its location within the refrigerator.

It is desirable to supply a relatively large amount of heat, in the order of 600–800 watts to an evaporator of 40–60 pounds storage capacity, so that the frost will be removed rapidly. If the rate of heating is quite high, the frost can be entirely removed before the heat has penetrated to the interior of the evaporator and its contents. Thus, efficient defrosting can be accomplished without injury to the food stored within the evaporator.

With particular reference to Figure 6, it will be noted that defroster-heater 26 is secured to the evaporator in a sinusoidal pattern and is an endless unit extending between electrical terminals 27 and 27*a* which are attached to the electric control clock 25, as will be discussed more fully later in this specification. The heater is intimately secured to the tubing 18 of the evaporator and, by virtue of the intimate relationship, the heat generated by the heater during its energization is transferred directly and efficiently to the evaporator.

Defroster-heater mounting details

As illustrated in Figure 8, the defroster-heater itself comprises a resistance wire 28 which is surrounded by suitable heat and water resistant insulation 29 having high thermal conductivity. The insulation, in turn, is covered by a flexible metallic sheathing 30 which protects the heater wire throughout its length. The metallic sheathing may be made from strip aluminum of suitable thickness, the strips being wound in interlocking

spiral formation to provide a protective armor which has suitable flexibility for the purpose intended.

The heater extends from terminal 27 along one side of the evaporator, as illustrated at 33. To hold the heater in position on the evaporator, out-turned flange 31 is provided adjacent one side edge of the evaporator. This flange may be formed integrally with the sheet metal member forming end wall 16. After passing flange 31, the defroster-heater extends across the top of the evaporator and defines two rearwardly extending loops 34 and 35 which lie between portions of tubing 18, as illustrated particularly well in Figures 2 and 6. The heater is positioned adjacent the tubing by spring clips, indicated at 36, the spring clips being provided at intervals as required to hold the heater securely adjacent the tubing. At the bight of each loop 34 and 35 an anchor 37 is provided to hold the bight securely against the surface of the evaporator and to prevent dislocation after assembly.

After passing across the top of the evaporator, the heater is again passed along a side edge, as indicated at 38. Section 38 of the heater is also positioned by an outturned flange 39 provided at the side of the heater and, if desired, made integrally with side wall 15.

The heater continues along the side of the evaporator, eventually coming to a lower forward corner of the evaporator where the heater makes a 90° bend as at 32 (see Figure 6). The heater then traverses the bottom and rear of the evaporator in sinusoidal formation and eventually returns to the initial side from which the heater portion 33 began, as indicated at 40.

It is to be noted that a plurality of spring clips 36 are provided, as required, to maintain the heater adjacent the tubing. Additional anchors 37 are secured to the rear wall of the evaporator to securely position each bight of the heater defined by the loops which extend from the bottom up the rear wall of the evaporator.

The structural details of a spring clip 36 are illustrated in Figure 5 which shows the clip in engagement with tubing 18 and the defroster-heater 26. It will be noted that clip 36 includes a planar central section 41 which is formed integrally into cylindrical sections 42 and 43 which partially encompass the refrigerant tubing and heater, respectively. Cylindrical section 42 blends into a reversely bent lip 44, while section 43 joins integrally with a second lip 45.

The clips may be made from spring temper aluminum, or any other suitable resilient material, and are so formed that they must be deformed in order to be installed on the tubing and heater, as illustrated in Figure 5. As will be understood from a study of this figure, the clip tends to draw the heater against the side of the tubing 18 and down against the adjacent evaporator wall so that the heater, during energization, delivers heat, not only to the tubing, but also to the surface of the evaporator. Lips 44 also aid in the transfer of heat by virtue of any contact made with the surface of the evaporator.

Any number of clips may be employed, as necessary to meet the requirements of a particular installation. The clips are easily installed and may be positioned wherever necessary to hold the heater closely adjacent the refrigerant tubing.

As discussed more fully in the Cochran Patent 2,592,394, it has been found necessary to transfer heat to baffle 10 during the defrosting period to remove any frost accumulation on the baffle, or any ice formed on the baffle from water deposited there during previous defrosting periods. In the preferred embodiment of this invention, heater sections 46 and 47 have been provided adjacent the surface of the baffle. With particular reference to Figures 6 and 7, it will be noted that spaced supports 48 are provided near the ends of heater sections 46 and 47. These supports are welded, or otherwise secured, in pairs to the bottom wall of the evaporator 14. Across each pair of supports there is positioned a bridge 49 which has inturned prongs 50 engaging holes 51 formed in the supports 48. In this way, the bridge member 49 is positioned immediately beneath the lower surface of the evaporator.

The bridge itself is substantially channel-shaped in cross section and includes an inturned cylindrical section 52 into which the heater sections 46 and 47 may be forced in tight engagement. As illustrated in Figure 7, the heater itself does not extend beyond the lower surfaces 53 of the bridge member, but is in intimate contact with the bridge member so that heat is readily transferred thereto. Faces 53 of the bridge members physically contact the top surface of baffle 10 and provide a large heat transfer path from the heater to the baffle.

Extra spring clips 54 may be provided, if desired, near the ends of the bridge members to assure that the defroster-heater does not hang loosely beneath the evaporator.

As illustrated in Figure 6, it will be noted that the defroster-heater is bowed towards the ends of the evaporator at localized sections 55 to provide clearance for the passage of mounting bolts through the rear of the evaporator, as illustrated in Figure 1.

Heater characteristics

A particular advantage of the present invention is that the defroster-heater may be installed on the evaporator as required to meet its particular thermal requirements. It has been found that more heat must be supplied to the rear and bottom walls of the evaporator than to the top wall for satisfactory defrosting. On the other hand, the refrigerant tubing must be evenly distributed over the entire area for maximum absorption of heat. By virtue of its flexibility, the defroster-heater of the present invention may be secured to the evaporator to meet the requirements of defrosting without regard to the heat transfer characteristics of the evaporator during normal use.

Another feature of the invention is that the flexibility of the heater makes it possible to hold the heater closely adjacent to the refrigerant tubing and the surfaces of the evaporator. The heater itself has little, if any, rigidity and does not tend to bow away from the surface of the evaporator as occurs when more rigid heaters are used. The heater can be secured to the evaporator without the use of special tools, and makes possible rapid assembly with resulting economies both to the manufacturer and the user. Furthermore, the heater can readily be removed from the evaporator in the field, should servicing be required. It is merely necessary to remove spring clips 36 and to remove the heater from its various positioning members. After the necessary repairs have been made, the heater may be readily installed by reversing the procedure.

Since the heater need not be preformed to the shape of the evaporator before attachment, it is obvious that it is easy to store and ship the heater and that it is not damaged by being flexed prior to assembly with the evaporator.

A given heater can be used on various types of evaporators, and the pattern of the heater on the evaporator can be adjusted to meet its particular defrosting requirements. It is entirely conceivable that one evaporator may require more heat on the bottom and rear surfaces than on the top, while another evaporator may require more heat on the bottom with a lesser amount on the rear and top walls. Under such circumstances, the versatility of the heater is particularly advantageous to a manufacturer making a number of different refrigerators having different evaporators with various defrosting characteristics.

By virtue of the support and bridge construction shown in Figure 7, it is possible to locate heat transfer faces 53 accurately beneath the evaporator to assure that sufficient heat will be transferred to the baffle 10. In prior constructions, it was not always possible to establish contact between the heater and the surface of the baffle, if

the heater had been distorted, with the result that the defrosting characteristics of refrigerators of the same model differed markedly. By virtue of the present arrangement, this difficulty can be eliminated and a uniform distribution of heat to the baffle can be assured.

The defroster-heater per se is fully disclosed and claimed in copending application Serial No. 471,432, filed on November 26, 1954, in the names of Dan B. Duncan and William R. Mittendorf entitled "Flexible Electric Defroster-Heater For Refrigerator."

In view of the foregoing description, it will be obvious to those skilled in the art that a novel structure has been disclosed which represents a very useful and important advance in the art and one which makes possible the production of refrigerators having automatic defrosting features superior to any presently known.

Having described a preferred embodiment of our invention, we claim:

1. In combination in a refrigerator, a sheet metal evaporator having refrigerant tubing projecting from its exterior surfaces and including a transverse horizontal lower wall, a transverse horizontal insulating baffle disposed beneath the lower wall of said evaporator, a metallic sheathed flexible defroster-heater, resilient means for clamping said heater adjacent the tubing of said evaporator, horizontally extending bridge members secured to the lower wall of said evaporator parallel to said baffle, portions of said defroster-heater being supported by said bridge members in intimate heat transfer relationship with said baffle, an electrical circuit including time clock control means, and a source of energy for periodically energizing said heater through the time clock.

2. In combination in a refrigerator having an evaporator including refrigerant flow channels projecting from its exterior surfaces and a transverse insulating baffle disposed beneath the evaporator, a flexible defroster-heater comprising a length of resistance wire, insulation over said wire, and flexible metallic sheathing over said insulation; a plurality of spring clips engaging the refrigerant flow channels and holding said flexible heater contiguous to the surfaces of the evaporator; and bridge means secured beneath the evaporator for supporting a portion of said defroster-heater in heat transfer relationship with the insulating baffle.

3. In combination, a sheet metal evaporator including refrigerant tubing intimately secured to its exterior surfaces, a flexible armored defroster-heater, flanges at the sides of said evaporator for holding and guiding said heater, and a plurality of spring clips in clamping engagement with said tubing and said heater for holding said heater in a predetermined pattern contiguous to said tubing and the surfaces of said evaporator whereby intimate heat transfer relationship is established between said heater and said evaporator.

4. In combination, an evaporator comprising a single sheet of metal formed to define its top, rear, and bottom walls, on which is intimately secured a continuous length of refrigerant tubing; sheet metal end panals secured at the sides of the top, rear, and bottom walls of the evaporator; out-turned flanges on said end panels lying adjacent the top and bottom walls of the evaporator; a flexible armored defroster-heater engaged by said flanges and lying adjacent the exterior surfaces of the evaporator and said evaporator tubing; and resilient means engaging said tubing and said heater for releasably securing it in position.

5. In combination, a sheet metal evaporator having top, rear, and bottom walls to the exterior surfaces of which is secured refrigerant tubing in a sinuous configuration; a metallic armored flexible defroster-heater on the exterior surfaces of said evaporator lying between said tubing; said heater defining a sinusoidal pattern extending across the top of said evaporator and across the bottom of said evaporator, certain portions of said heater secured to the bottom of said evaporator extending in heat transfer relationship up the rear wall of said evaporator; and spring means engaging said tubing for releasably securing said heater to said evaporator.

6. In combination, an evaporator defining a refrigerant channel having a sinuous configuration; a flexible defroster-heater comprising an electrical resistance wire, resilient insulation over said wire, and flexible protective armor over said insulation; said armor comprising interlocked spiral-wound metal; and a plurality of resilient fasteners for securing said flexible heater in intimate heat transfer relationship against the surface of said evaporator adjacent said refrigerant channel.

References Cited in the file of this patent

UNITED STATES PATENTS

1,936,391	Harrower	Nov. 21, 1933
2,274,394	Atchison	Feb. 24, 1942
2,276,454	Becker	Mar. 17, 1942
2,592,394	Cochran	Apr. 8, 1952
2,601,466	Thomas	June 24, 1952
2,665,567	King	Jan. 12, 1954