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ELECTRICAL CONNECTOR FOR REFRIGERATOR DEFROSTING MEANS

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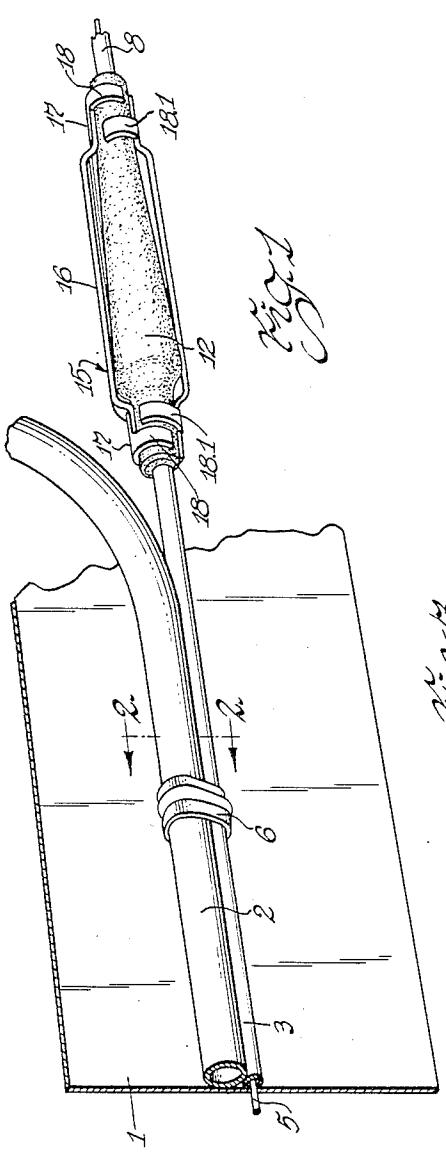


Fig. 1

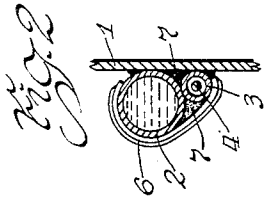


Fig. 2

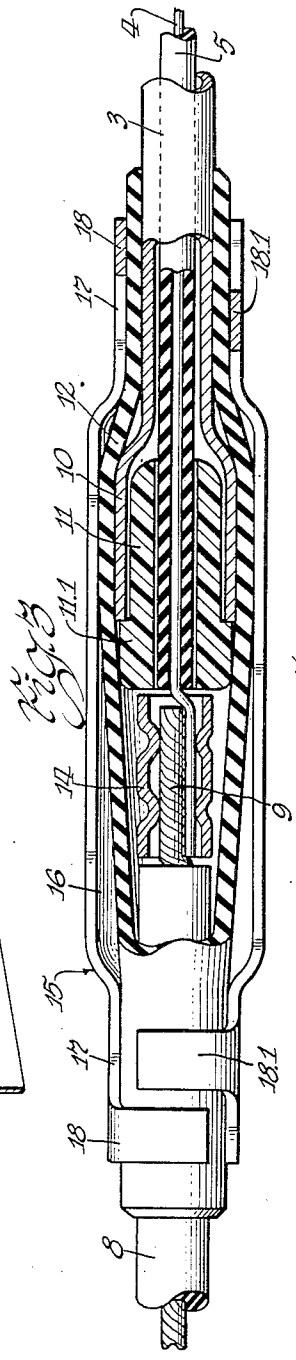


Fig. 3

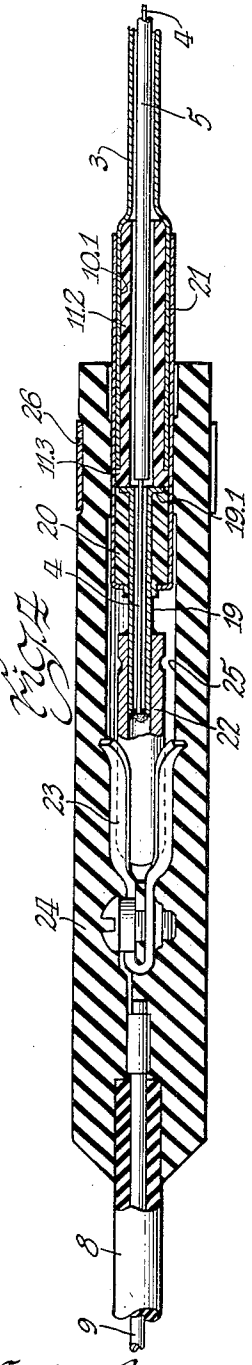


Fig. 4

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ELECTRICAL CONNECTOR FOR REFRIGERATOR DEFROSTING MEANS

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4 Claims. (Cl. 174—84)

This invention relates to an improved heating element for defrosting refrigerators, and in particular relates to an improved heating element having a moisture-proof terminal assembly for connecting the heating element to electrical power conductors.

Among the objects of my invention are: to provide a heating element comprising an insulated heating conductor housed in a moisture-impervious sheath such as a flexible tube of aluminum or the like of small outside diameter; to provide an improved terminal construction for such a heating element; and to provide a simplified terminal construction for connecting the heater wire to an electric service conductor while protecting the electrical connection against ingress of moisture.

Other features and advantages of my invention will be apparent from the following detailed description of presently preferred embodiments thereof read in the light of the accompanying drawing, in which:

Fig. 1 is a fragmentary perspective of a refrigerator evaporator plate and evaporator tube having in heat exchange relation therewith a heating element embodying one form of my invention;

Fig. 2 is a cross-section taken through 2—2 of Fig. 1;

Fig. 3 is an enlarged sectional elevation showing means of connecting the heating element terminal to an electrical energy conductor and a protective sleeve for said connection; and

Fig. 4 is a sectional elevation of a second terminal construction.

Figs. 1 and 2 show a fragment of a refrigerator evaporator 1 having the usual evaporator tube 2, which as is well known in the art, receives for evaporation liquid refrigerant from the conventional compressor-condenser system (not shown). It is understood that evaporator 1 may comprise a U-shaped or platelike structure disposed within the cabinet space (not shown) to be cooled, and that the evaporator tubing is welded or brazed thereto for good heat transfer; the tube extends in variously disposed convolutions about the plate or basic structure of the evaporator. It will also be understood that each end of the evaporator tubing is connected into the refrigerator system for circulation of liquid and/or gaseous refrigerant therein.

It is well known that the heat of the atmosphere within the cabinet causes ebullition of the refrigerant within the evaporator tubing, whereupon heat is extracted from the walls of the tubing and the evaporator structure. The reduction in temperature of these elements usually results in an accumulation of frost thereon; the frost must be removed periodically to maintain the efficiency of the refrigerator operation. It has previously been proposed to apply heat directly to the evaporator and/or the tubing thereof; usually the heating element comprises an electrical resistance wire connected into a circuit under the control of a timeclock which energizes the heating element for a brief interval each day.

The present invention differs from the earlier heat application means by providing a very small diameter heating element which can be placed in such relation to the evaporator tubing as to improve the heat transfer to the evaporator and therefore speed the removal of frost. Features of the invention are that the heating element is protected by the evaporator tubing against being accidentally touched by the user of the refrigerator, and that the temperature of the heating element in operation is far below a level which would burn the user of the refrigerator if he should, in fact, touch the heating element while it was operating.

The heating element per se includes an outer sheath 3 of moisture-impervious material having good thermal conductivity—for example, thin walled aluminum tubing. Throughout its length—which may be 16 or more feet between terminal portions—the sheath is preferably of the order of .140 inch O. D., with a uniform wall thickness of the order of .025 inch. Within the sheath 3 is a resistance conductor comprising a nickle-chrome resistance wire 4 having a covering 5 of heat-resistant, moisture-impervious, resistance material such as silicone rubber. The wire is of small gage, for example, 24 gage, and the insulating cover is of the order of .025 inch in thickness; accordingly, the assembly of metallic sheath and resistance element is highly flexible and capable of being bent to follow closely the convolutions of the evaporator coil. I have found that a silicone rubber insulation withstands a high potential (1500 volts) test for one minute and will not lose its mechanical and electrical characteristics for the above purpose after 100 hours of continuous heating at 400 degrees F.

As best appears in Fig. 2, the heating element is placed in surface contact with the evaporator tube and the evaporator structure 1. The heating element may be run below or above the evaporator tube; in either case, the relative sizes of the evaporator tube and heating element are such that the evaporator tube affords a substantial measure of protection for the heating element and minimizes the possibility of accidental contact with the element by the hand of the user. For example, the sheath outside diameter is .140 inch, whereas that of the tube 2 may be within the range of .3125 to .375 inch in conventional domestic refrigeration. The heating element may be removably secured to the evaporator tube at appropriate intervals by suitable metal clips 6, and to improve the heat transfer between the heating element sheath 3 and the evaporator tubing and evaporator plate structure, it is expedient to apply suitable thermalmastic compound 7 between the sheath of the heating element and the evaporator tube and structure. The resulting rapid heat transfer between the sheath 3 and the evaporator holds the sheath temperature low; in actual test under service conditions in which a 475 watt heating element was energized, the sheath temperature was not in excess of 125 degrees and over most of the run of the element was below 110 degrees F. During this and other tests, from 10 to 16 ounces of water were evaporated in from 12 to 15 minutes. This rate of defrosting is satisfactory for a daily defrost operation and the duration of the defrost period is so short that frozen foods kept in the usual freezer compartment of the evaporator do not thaw. In a refrigerator evaporator for which a 16 foot heating element gives the satisfactory results above-noted, the length of evaporator tubing is approximately 19 to 20 feet. The heating element does not follow all of the convolutions or runs of the tubing; a portion of the element may advantageously be placed on evaporator surfaces which do not carry evaporator tubing and yet are subject to frost accumulation.

The respective ends of the heating element are arranged for connection to the terminals of an energizing

circuit. Fig. 3, for example, shows a presented preferred type of terminal. It will be understood that each of the required two terminals may be identical. The electric power lead 8 may be of any rubber or plastic insulated type from the end of which a short length of insulation has been stripped to expose the conductor 9. With respect to the heating element: the end of sheath 3 is expanded to provide a short cylindrical bell 10. A bushing 11 is slid over the end of the resistance wire insulation to enter the bell 10 to the extent permitted by the head 11.1. There is a small clearance between the bushing and the walls of the bell 10 and insulation 5 to facilitate the insertion of the bushing. Excellent results obtain by making the bushing from polytetra fluorethyline a synthetic plastic manufactured and sold by E. I. du Pont de Nemours & Company under the trade-name "Teflon"; said plastic is inherently lubricous and has advantageous physical and electrical qualities. It will be understood, of course, that silicone rubber and other insulation materials may be employed for the bushing.

A sleeve 12 of rubber or the like is slid over the end of either the electrical lead 8 or the sheath 3 of the heating element and slipped or turned back sufficiently to expose the respective bare ends of the conductor 9 and the resistance conductor 4. A crimp-sleeve type of connector 14 is applied over the end of conductor 9 and the bared end of resistance conductor 4 brought within the connector to lie along the conductor 9, whereupon the sleeve is crimped as shown to join the two conductors in good electrically conductive relation. The sleeve 12 may then be moved to cover the joint and a clamp member 15 applied.

In a preferred form, clamp 15 may include a semi-cylindrical portion 16 of large enough diameter to receive the enlarged central portion of the sleeve, and two semi-cylindrical end portions 17 which rather snugly receive the smaller diameter end portions of the sleeve. Each end portion 17 has bendable ears 18, 18.1 which may be bent about the ends of the sleeve to cause the sleeve to grip the conductor and the heating element sheath. It will be understood, of course, that the outside diameter of conductor 8 may be larger than that of the sheath 3. The protective sleeve 12 is sized so that its ends will expand over an tightly grip the respective outer walls of the conductor and heating element, and, of course, the semi-cylindrical end portions of the clamp member may be spread or compressed according to requirements. Cement or other sealing and adhesive material (not shown) may be applied about the ends of the sleeve to bond the same to the associated elements and thus additionally guard against ingress of moisture. However, the length of tight engagement between the ends of the sleeve and the associated conductors should provide a sufficient seal for most installations.

As best appears in Fig. 1, the clamp 16 rigidifies the electrical connection zone for a substantial distance on each side of the actual connection, thus portecting against separation of the connection during installation of the heating element.

The embodiment of Fig. 4 contemplates a plug-type connection between the heating element and its service conductor. The heating element includes the resistance wire 4 with its silicone rubber insulation 5, and the aluminum sheath 3 having a relatively longer belled portion 10.1. Within said belled portion and in slight clearance relationship with the insulation 5 (the figure shows an exaggerated amount of clearance) is a "Teflon" or other insulating bushing 11.2 having an enlarged head 11.3 which seats against the edge of the sheath as shown. Threaded over the bared extension of the resistance conductor is a metallic sleeve 19 having a relatively heavy wall. Said sleeve is brazed or otherwise permanently electrically connected at its end to the conductor 4. A "Teflon" or equivalent bushing 20 is placed on the sleeve

19, and the flange 19.1 of said sleeve is confined between the respective bushings 20 and 11.2. Sleeve 19 is thereby held against contact with the sheath 3 of the heating element. A cap 21 of aluminum or other light metal is slipped over the end of the sleeve 19 and the expanded sheath 10.1 and is crimped or otherwise secured thereon. Cap 21 fits tightly on the bushing 20 and the head portion of bushing 11.2. As shown, a short tip of the bushing projects through the end opening of cap 21 to insure good electrical insulation between the sleeve 19 and cap 20. To complete the terminal portion of the heating element, a brass terminal 22 is placed over the end of sleeve 19, crimped in position; if desired, silver brazed to sleeve 19 to insure electrical connection therewith.

To the conductor 9 is affixed a female connector 23 of conventional pattern for cooperation with terminal 22 as shown. A rubber or equivalent insulating sleeve 24 is molded about the insulation 8 of the service conductor. The sleeve provides an axial passage 25 into which the terminal end of the heating element may be inserted to bring the terminals 22 and 23 into connection. The bore diameter of the passage 25 is preferably a little larger than the maximum outside diameter of the heating element, as represented by the outside diameter of the cap 21. This size relationship, plus the inherent stiffness of strength of the heating element terminal assembly makes it possible easily to insert or remove the heating element. After insertion of the heating element, the rubber sleeve may be secured about the heating element sheath by a suitable clamping band or ring 26.

Where a permanent type of electrical connection is satisfactory—that is, one in which the heating element may not be withdrawn from the sleeve—the sleeve may be vulcanized or otherwise bonded to the sheath 3. In either case, the rigidity of the terminal assembly plus the inherent stiffness of the rubber sleeve 24 guards against bending in the area of the electrical connection.

It will be noted that in each of the terminal construction embodiments, the tubular sheath 3 is protected against shorting against the resistance conductor 4 or the power conductor 9. In Fig. 3, the head 11.1 of the insulating bushing 11 prevents the connector sleeve 14 from reaching the bell 10. Similarly, the head portion 11.3 of bushing 11.2 of Fig. 4 protects the bell 10.1 against contact by the flange 19.1. In each case also, the insulating bushings stiffen the assemblies against bending during assembly. With particular reference to Fig. 3, it will be noted that the diameter of the connector sleeve 14 is larger than the inside diameter of the bushing 11. If prior to the application of the clamp 16 the assembly was bent, the edge of sleeve 14 would strike the wall of head portion 11.1 of the bushing and immediately limit the extent of the bending.

While there has been described what are at present considered to be the preferred embodimnts of the invention, it will be understood that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

I claim:

1. A refrigerator defrost device comprising an insulated resistance conductor housed in a thin-walled metal tube of coextensive length, an end of said tube being belled, a bushing of electrical insulation material disposed over said insulated resistance conductor and extending into the belled end of said tube, means for electrically connecting said resistance wire to an insulated power conductor, a flexible insulating sleeve enveloping the insulated power wire and said metal tube and extending over the adjacent end portions thereof, and clamp means for securing the insulating sleeve tightly thereon while supporting the zone of the electrical connection against bending, said clamp means comprising a rigid substantially semi-cylindrical body portion adapted to receive the

insulating sleeve over substantially the full length thereof, and bendable tab members at the respective ends of the clamp means to be bent about the end portions of the sleeve to secure the same about the metal tube and power conductor respectively.

2. A refrigerator defrost device comprising a resistance conductor insulatedly disposed with a coextensive thin-walled, flexible metal tube having an outside diameter substantially less than one-quarter inch, an end of said tube being belled, an insulated electric power wire disposed in end-to-end relation to said resistance conductor, a metallic sleeve for electrically connecting said resistance conductor and the conductor of said power wire, a bushing of electrical insulation material disposed over said insulated resistance conductor and extending into the belled end of said tube, said bushing having a head portion interposed between said metallic sleeve and the adjacent end wall of said metallic tube to maintain the same in insulated spaced relationship, a flexible insulating sleeve extending continuously between said metal tube and said insulated power wire to envelop the adjacent end portions thereof, and rigid clamp means disposed about said flexible insulating sleeve for substantially the full length thereof, said clamp means having bendable tab means at each of its ends for compressing the ends of said insulating sleeve tightly about said metal tube and said insulated power wire respectively.

3. Means for making a substantially rigid electrical connection between two essentially flexible electrical conductors of which one has an outer metal sheath, comprising a metal sleeve for electrically connecting said conductors, a bushing of insulating material disposed about the metal-sheathed conductor and interposed between the metal sleeve and the adjacent end wall of said metal sheath to maintain the same in insulated spaced relation, a flexible, water impervious, insulating sleeve disposed about said conductors and said metal sleeve, said insulating sleeve covering the adjacent end portion of said metal sheath, and clamp means comprising a rigid, substantially semi-cylindrical body portion receiving said insulating sleeve for substantially its full length and bendable tab members at the ends of said body portion for compressing the ends of said insulating sleeve tightly about said conductors.

4. Means for serially interconnecting electric conductors against moisture and flexure in the area of interconnection, comprising a water-impervious insulating sleeve disposed about said interconnected conductors and clamp means for securing said sleeve thereon, said clamp means comprising a rigid substantially semi-cylindrical body portion receiving said sleeve over substantially the full length thereof and bendable tab members at the ends of said body portion for compressing the ends of said sleeve tightly about said conductors.

References Cited in the file of this patent

UNITED STATES PATENTS

868,460	Pieper	Oct. 15, 1907
2,549,647	Turenne	Apr. 17, 1951
2,601,466	Thomas	June 24, 1952
2,665,566	Grimshaw	Jan. 12, 1954