United States Patent

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[33] **Sweden**
[31] **No. 1174/68**

[54] **ELECTRICAL HEATER FOR HEATING A WALL OF A FLUID-CARRYING MEMBER**
5 Claims, 9 Drawing Figs.

[52] **U.S. Cl.** **219/535;** 13/22, 219/355, 219/376, 219/525, 219/537, 219/552
[51] **Int. Cl.** **H05b 3/58**
[50] **Field of Search** ..... 219/535—7, 375—6, 301, 422; 13/25, 22, 21; 338/317; 219/553—2, 350—5, 536—7, 524—5; 165/104, 135

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ABSTRACT: An electrical heater for heating a wall of a fluid-carrying member, such heater being formed from a body of material possessing both electrical insulating and heat resisting properties. The body is positioned adjacent to the fluid-carrying member and has spaced ribs which extend radially toward the member and have their ends bearing against the wall thereof. Pairs of adjacent ribs each have a gap therebetween which extends radially from the wall to a zone removed therefrom, the zones extending lengthwise of the body. An electrical circuit includes electrical resistance means having conductors extending lengthwise of and within the gaps at the zones, the conductors being supported by the body at the zones and functioning to produce radiant heat when connected to a source of electrical energy.

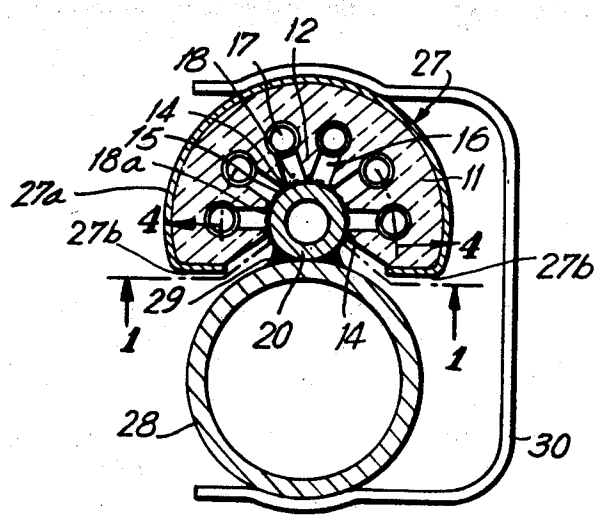


FIG. 1

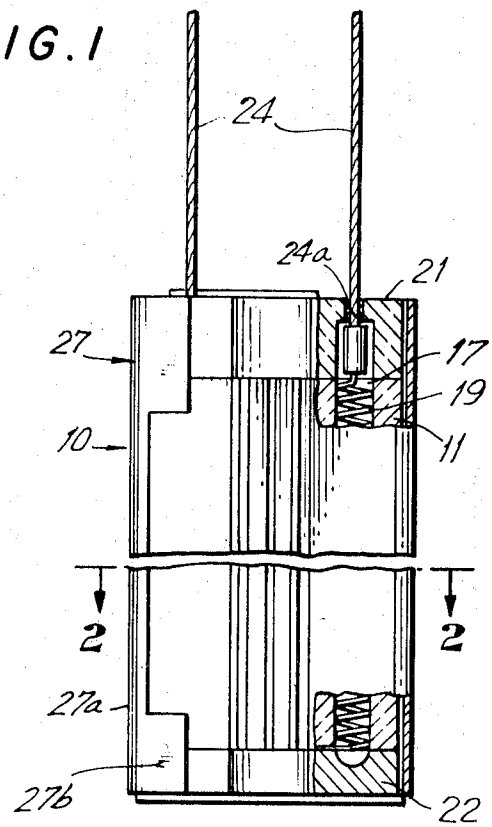
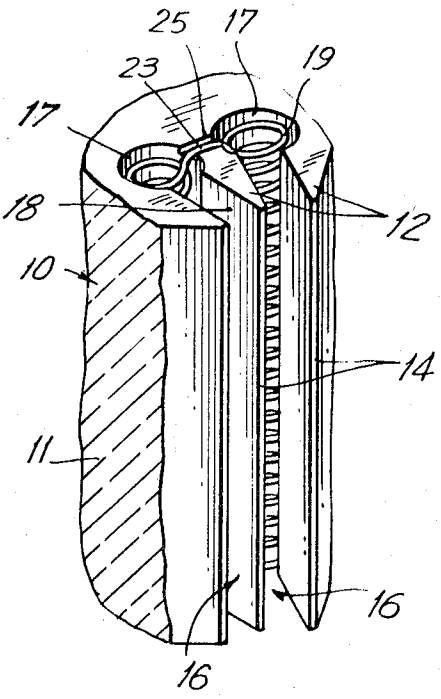


FIG. 3



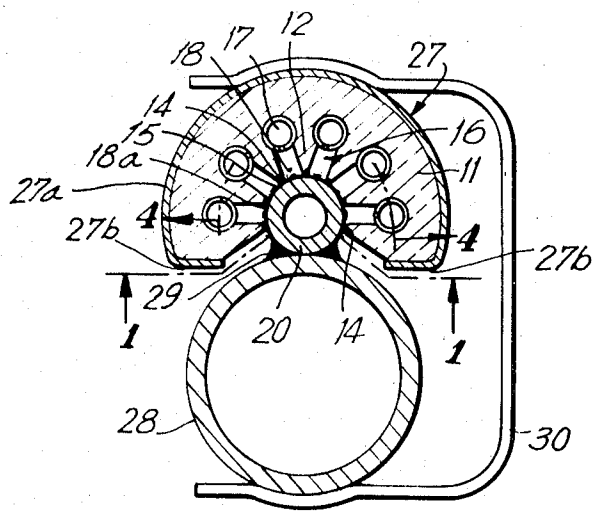


FIG. 2

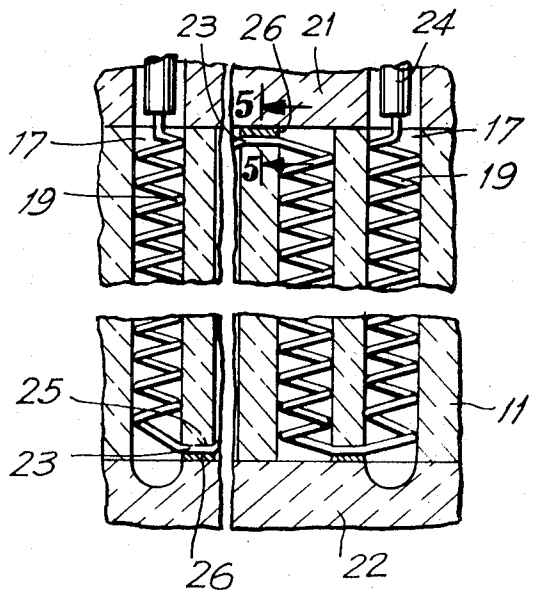
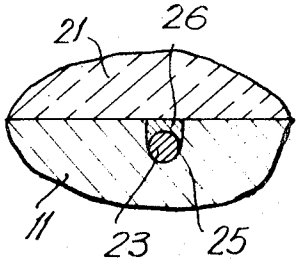


FIG. 4

FIG. 5



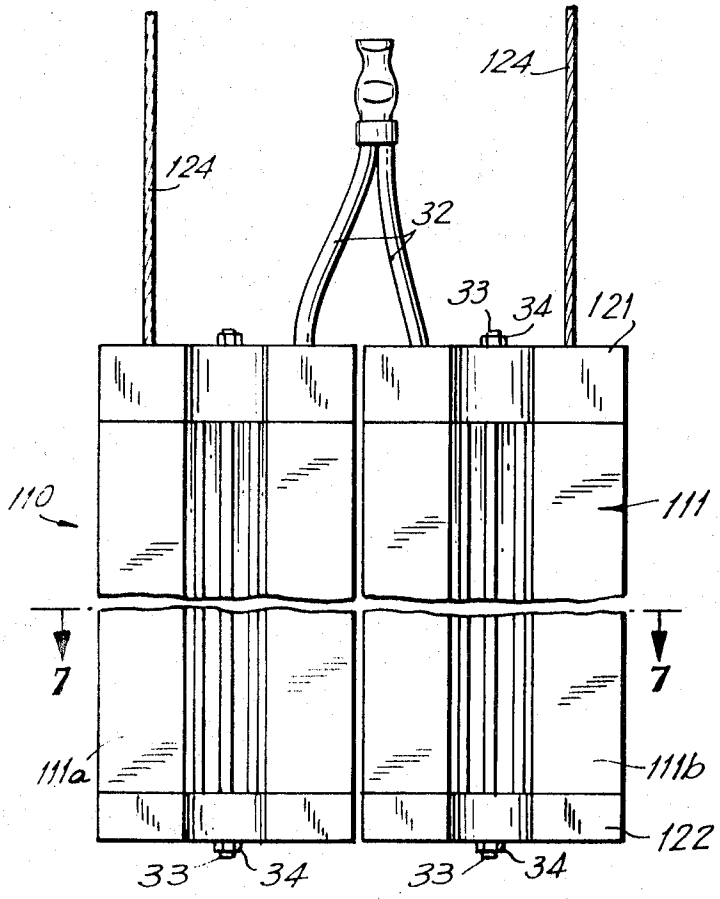


FIG. 6

FIG. 7

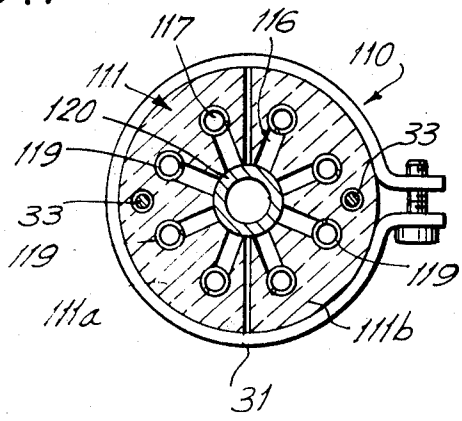


FIG. 8

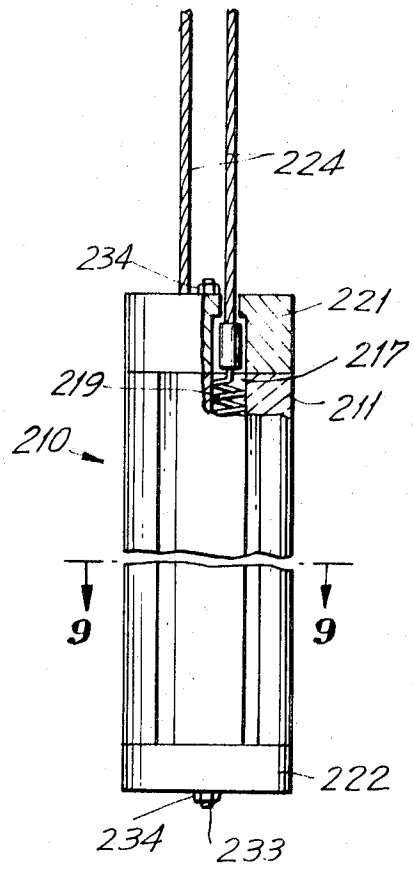
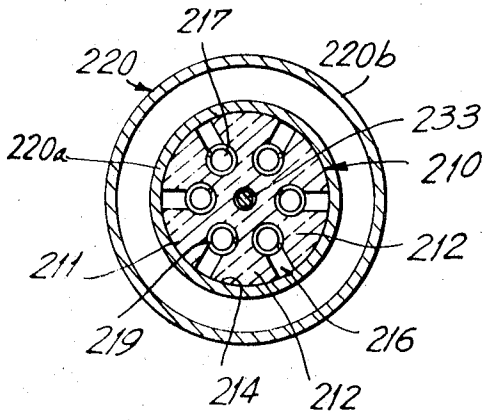


FIG. 9



ELECTRICAL HEATER FOR HEATING A WALL OF A FLUID-CARRYING MEMBER

BACKGROUND OF THE INVENTION

Field of the Invention

It has been the practice heretofore to heat the walls of fluid-carrying members, such as the pipes or conduits of heat-operated refrigeration apparatus, for example, by positioning a hollow sleeve in heat conductive relation with a wall of a pipe or conduit and inserting within the hollow sleeve an electrical heating cartridge which snugly fits therein. Such an electrical heater effects heating of the wall of the fluid-carrying member primarily by conduction and the part of the heating effected by radiation is relatively small.

It has also been proposed to employ electrical heaters to heat the outer wall of a fluid-carrying member by radiating heat thereto through an air gap from an inner surface of a body of material adapted to be heated to an elevated temperature. However, electrical heaters of this type have not been entirely satisfactory because the advantages of heating by radiation have not been fully realized and good electrical and mechanical protection has not been provided for the heating unit.

SUMMARY OF THE INVENTION

This invention relates to an electrical heater for heating a wall of a fluid-carrying member, particularly fluid-carrying members like pipes, for example, of heat-operated refrigeration apparatus.

It is an object of the invention to provide an improvement for heating a wall of a fluid-carrying member by radiant heat produced by electrical resistance means having conductors supported in a body having both electrical insulating and heat resisting properties.

Another object of the invention is to provide such an electrical heater in which a greater part of the radiant heat produced or generated is effectively employed to heat the wall of the fluid-carrying member.

A further object is to provide such an electrical heater having improved electrical and mechanical protection for the components of the heater, especially the conductors of the electrical resistance means which are of helical form and become incandescent when connected to a source of electrical energy.

The foregoing objects are achieved by providing a heating structure comprising a body possessing both electrical insulating and heat resisting properties and electrical resistance means, the electrical resistance means being supported by the body with every part of the electrical resistance means being separated from a wall of a fluid-carrying member by a layer of the body which at least partly functions to develop radiant heat to heat the wall of the fluid-carrying member when the electrical resistance means is energized by a source of electrical energy.

Further, the body of material is formed with elongated openings and passageways extending laterally from such openings to the wall of the fluid-carrying member, and the electrical resistance means includes conductors which extend lengthwise within the openings and are of helical form and bear against the walls of the openings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an elevational view taken on line 1–1 of FIG. 2, partly broken away and in section, illustrating an electrical heater embodying the invention;

FIG. 2 is a sectional view, taken at line 2–2 of FIG. 1, and further illustrating the fluid-carrying member to be heated;

FIG. 3 is an enlarged fragmentary perspective view of parts of the electric heater shown in FIGS. 1 and 2 to illustrate details more clearly;

FIG. 4 is a fragmentary sectional view, broken away both vertically and horizontally, taken on line 4–4 of FIG. 2;

FIG. 5 is a fragmentary vertical sectional view, taken on line 5–5 of FIG. 4;

FIG. 6 is a view of an electrical heater illustrating another embodiment of the invention in which the opposing faces of the two parts seen in FIG. 7 are shown in elevation;

FIG. 7 is a sectional view, taken at line 7–7 of FIG. 6, in which the two parts seen in elevation in FIG. 6 are in assembled relation, and further illustrating a clamping member for parts of the electrical heater;

FIG. 8 is an elevational view, partly broken away and in section, of an electrical heater illustrating another embodiment of the invention; and

FIG. 9 is a sectional view taken on line 9–9 of FIG. 8, and further illustrating the fluid-carrying member to be heated.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1 to 5, the invention is shown embodied in an electrical heater 10 comprising a body 11 of material, such as steatite, for example, which possesses both electrical insulating and heat insulating properties. The body 11 is of cylindrical form having spaced ribs 12 which extend radially inward and have their inner ends 14 defining a central core 15 extending axially through the body.

Pairs of adjacent ribs 12 have gaps 16 therebetween which extend radially outward from the ends 14 of the ribs 12 to zones 17 within and removed from the outer peripheral surface of the body 11. The zones 17 are of cylindrical form and the portions of the gaps 16 extending radially inward therefrom define passageways 18 which are open to the central core 15 at their inner ends 18*a* at the vicinities of the inner ends 14 of the ribs 12. It will be seen that the passageways 18 are narrower than the diameters of the zones 17.

Within each elongated zone 17 is disposed an electrical resistance conductor 19 in the form of helical coil. The individual turns of the conductors 19 bear against the walls of the zones 17. In this way the conductors 19 are firmly supported and mechanically anchored within the body 11, as best shown in FIGS. 3 and 4.

A pipe 20 is positioned in the core 15. This pipe may form a part of heat-operated refrigeration apparatus which is adapted to be heated and through which a fluid flows. As best shown in FIG. 2, the inner ends 14 of the ribs 12 bear against the outer surface of the pipe 20.

In order to reduce heat losses the opposing ends of the body 11 are provided with end closure members 21 and 22 formed of suitable heat insulating material. The end closure members 21 and 22 may be fixed to the body 11 in any suitable manner, as by through bolts and end tightening nuts, as shown in the embodiment of FIGS. 6 and 7.

The conductors 19 of helical form are connected in series relation by conductor sections 23, as seen in FIGS. 3, 4 and 5. The end conductors 19, which are diametrically opposite one another in FIG. 2, are connected at their upper ends to connections 24 which in turn are adapted to be connected to a suitable source of electrical energy.

The top closure member 21 is apertured to receive the electrical connections 24 and is otherwise closed. Hence, the top closure member 21 functions to at least partly close the upper ends of the gaps 16 in the body 11. On the other hand, the bottom closure member 22 is substantially imperforate and functions to close the lower ends of the gaps 16.

As best seen in FIGS. 3 and 4, the body 11 at the opposing ends is formed with grooves 25 to receive the conductor sections 23. Electrically conductive members 26 extend lengthwise of and in electrically conductive relation with the conductor sections 23 and function to short circuit the latter. In this way the resistance of each unit length of the conductor sections 23 is reduced compared to the resistance of each corresponding unit length of the conductors 19 extending lengthwise of and within the zones 17 of cylindrical form.

When the electrical connections 24 are connected to a suitable source of electrical energy, the conductors 19 are heated to incandescense. The conductors 19 of helical form emit both white and especially dark heat radiation which permeates and penetrates the air in the gaps 16 toward the wall of

the fluid-carrying member or pipe **20**. With this arrangement the pipe **20** is capable of absorbing the entire quantity or greatest possible part of the heat produced and generated by the helical conductors **19**. Since the inner ends **14** of the ribs **12** bear against the outer surface of the pipe **20**, the latter also receives heat by conduction from the body **11**.

Further, the pipe **20** also effectively receives heat by convection by the mass of heated air trapped in each vertically extending gap **16**. This is so because the end closure members **21** and **22** seal and close the ends of all the gaps **16** except the ends through which the electrical connections **24** extend. The apertures in the top closure member **21**, through which the electrical connections **24** extend, may be closed by suitable electrical insulating material, as indicated at **24***a* in FIG. **1**.

In view of the foregoing, it will now be understood that the electrical heater just described and shown in incandescence **1** to **5** effectively heats the wall of the pipe **20** by radiation, conduction and convection. Moreover, the heating of the outer surface of the pipe **20** will be effected at the highest thermal head possible depending upon the heating temperatures generated and produced by the conductors **19** and developed in the body **11** in which they are supported.

In order to protect the body **11**, which may be formed of material which is fragile, an outer metallic cover **27** may be provided for the body. The cover **27** includes an arcuate portion **27***a* and flat end portions **27***b* which extend toward one another at opposite sides of the pipe **20**.

Further, a hollow tube **28** may be fixed to the pipe **20** at **29**, as by welding, for example. The electrical heater **10**, pipe **20** and tube **28** may be held in one or more suitable clamps **30**, one of which is shown in FIG. **2**. The tube **28**, which may be referred to as a heating tube, serves as a heating flue into which heated combustion gases are adapted to be discharged from a gaseous fuel burner. With this arrangement the pipe **20**, which is heat conductively connected to the tube **28**, can be heated by the latter when it is desirable to do so and the electric heater **10** is not rendered operable to heat the pipe **20**.

FIGS. **6** and **7** illustrate another embodiment of the invention in which parts similar to those shown in FIGS. **1** to **5** are referred to by the same reference numerals with "100" added thereto. The electrical heater **110** of FIGS. **6** and **7** is generally like the first described embodiment and differs therefrom in that the body **111** is formed of two semicylindrical parts **111***a* and **111***b* which are enveloped by a clamp **31** having one or more tightening nuts **32**. The clamp **31** may be sufficiently high to provide a cover for the body **111** which is similar to the cover **27** in the embodiment of FIGS. **1** to **5**.

As seen in FIG. **7**, the conductors **119** in each zone **117** are of helical form and like the conductors **19** shown in FIGS. **3** and **4**. Moreover, the conductors **119** in each part **111***a* and **111***b* of body **111** are connected in series relation in the same manner shown in FIG. **4**. The conductors **119** at the ends of each heating unit in the body parts **111***a* and **111***b* are connected to electrical connections **124**, as seen in FIG. **6**, such connections being similar to the electrical connections **24** in FIG. **1**. The conductors **119** at the opposite ends of each heating unit in the body parts **111***a* and **111***b* are connected to one another by an electrical connection **32**, as seen in FIG. **6**.

The top and bottom closure members **121** and **122**, which are similar to the closure members **21** and **22** in the first described embodiment, are mounted on the body **111** by bolts **33** which extend through the body parts **111***a* and **111***b* and have threaded ends receiving tightening nuts **34**.

Instead of employing conductors **19** and **119** of helical form in the embodiments that have been described, it will be understood that the conductors **19** and **119** may be essentially straight or of zigzag form or of any other suitable shape. In any event, irrespective of the form of the conductors **19** and **119** which desirably are of heavy gauge wire, the ends of adjacent conductors can be connected to one another by conductor sections like the conductor sections **23** shown in FIGS. **3** and **4**. By employing electrically conductive members **26** to short circuit the conductor sections **23**, undesirable development of heat in the parts of the heating units that connect adjacent conductors **19** and **119** is avoided.

FIGS. **8** and **9** illustrate another embodiment of the invention in which parts similar to those illustrated in FIGS. **1** to **7** are referred to by the same reference numerals to which "200"has been added. In the electrical heater **210** of FIGS. **8** and **9** the spaced ribs **212** extend radially outward from the center of the body **211** and have their outer ends **214** bearing against the inner wall **220***a* of fluid-carrying member **220**, such inner wall **220***a* being spaced from an outer wall **220***b* of the member.

The gaps **216** between adjacent ribs **212** extend radially inward from the inner wall **220***a* of the member **220** to zones **217** which are within the body **211** and of cylindrical form. The zones **217** extend lengthwise of the body **211** along lines removed from the wall **220***a* of the member **220**.

Conductors **219** of helical form are disposed in the gaps **216** at their innermost zones **217**. The conductors **219** are connected to one another in series relation in the same manner that the conductors **19** in the first-described embodiment are connected to one another, as best shown in FIG. **4**. The ends of the heating unit formed by the conductors **219** are connected by connections **224** to a suitable source of electrical energy. The top and bottom closure members **221** and **222** are mounted on the body **211** by a through bolt **233** and tightening nuts **234**.

In the embodiment of FIGS. **8** and **9** it will be seen that the outer ends **214** of the ribs **212** are much larger than the outer ends **14** of the ribs **12** in FIG. **2**. Hence, in the embodiment of FIGS. **8** and **9**, the quantity of heat received by the wall member **120***a* by conduction will be greater than the quantity of heat received by the pipe **20** by conduction from the inner ends **14** of the ribs **12** in FIG. **2**.

In the embodiment of FIGS. **8** and **9**, it will also be apparent that the inner wall **220***a* of the fluid-carrying member **220** can serve as a protective cover for the body **211** of the heater **210**.

In view of the foregoing, it will be understood that heat developed and generated in each of the electrical heaters **10**, **110** and **220** will be effectively applied to a wall of a fluid-carrying member by radiation, conduction and convection. Moreover, heat will be applied effectively to the wall of the fluid-carrying member at an extremely high thermal head to promote rapid heating of fluid in the fluid-carrying member.

I claim:

1. Structure comprising a fluid-carrying member through which fluid is adapted to flow, an electrical heater for heating a wall of said member to heat fluid therein, said heater comprising a body formed from material having both electrical insulating and heat resisting properties, said body being disposed adjacent to said member and having spaced ribs which extend radially toward and have their ends bearing against the wall of said member, pairs of adjacent ribs each having a gap therebetween which extends radially from the wall of said member to a zone removed therefrom, said zones extending lengthwise of said body, electrical resistance means comprising conductors extending lengthwise of and within said zones, said conductors being of helical form and bearing against the walls of the gaps at said zones, whereby said conductors are supported by said body at said zones and adapted to be heated to a glowing temperature to produce radiant heat when connected to a source of electrical energy, heat insulating closure members, and means for securing said closure members to the opposite ends of said body to at least partially enclose the ends of said gaps.

2. Structure as set forth in claim **1** in which pairs of said electrical conductors extending lengthwise of and within adjacent gaps at said zones are connected in series relation by conductor sections, said body at the ends thereof at which said conductor sections are disposed having grooves to receive said conductor sections.

3. Structure as set forth in claim **2** comprising electrically conductive members extending lengthwise of and in electrically conductive relation with said conductor sections, said

electrically conductive members functioning to short circuit said conductor sections.

4. Structure as set forth in claim 1 in which said fluid-carrying member comprises a pipe, said body being disposed about said pipe with said spaced ribs extending radially inward and having their inner ends bearing against the outer surface of said pipe, and the gap between each pair of adjacent ribs extending radially outward from the outer surface of said pipe to said zone which is within said body and removed from the outer peripheral surface thereof.

5. Structure as set forth in claim 1 in which said fluid-carrying member comprises a pair of concentrically disposed inner and outer cylindrical walls, said body being disposed within said inner cylindrical wall with said spaced ribs extending radially outward and having their outer ends bearing against the inner surface of said inner cylindrical wall and the gap between each pair of adjacent ribs extending radially inward from the inner surface of said inner cylindrical wall to said zone which is removed from such inner wall.