Dec. 5, 1967 L. M. WATSON 3,356,835

HEATING STRUCTURE

Filed Oct. 8, 1964 2 Sheets-Sheet 1

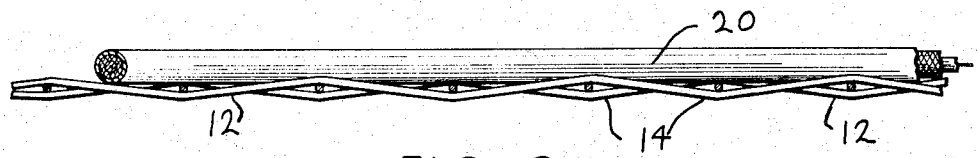

FIG. 2

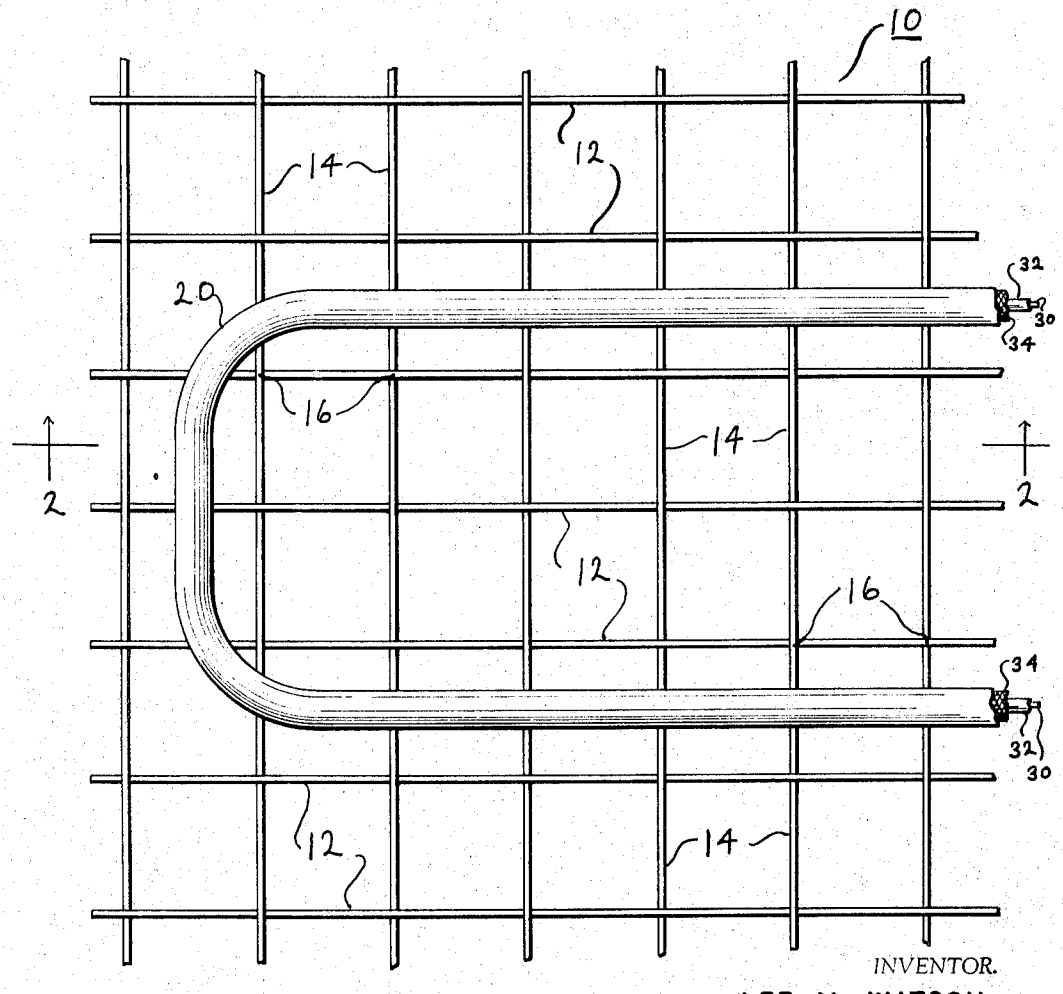

FIG. 1

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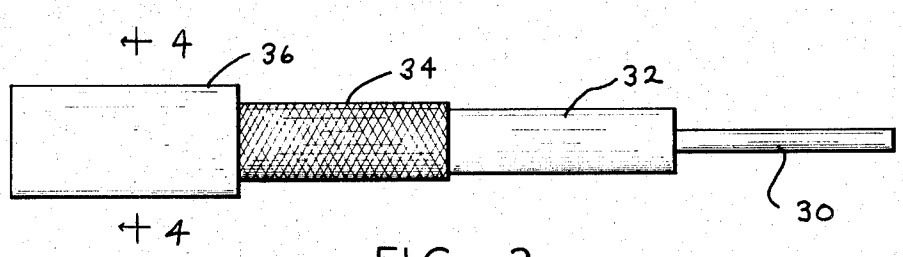

FIG. 3

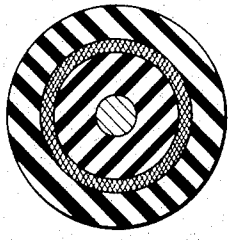

FIG. 4

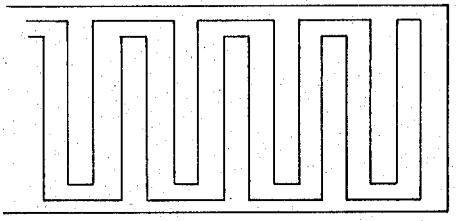

FIG. 8

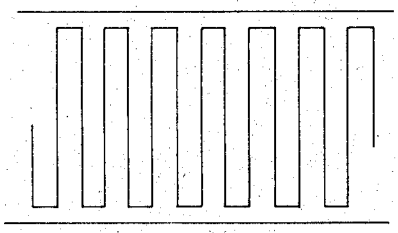

FIG. 6

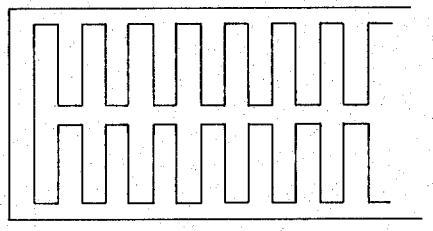

FIG. 7

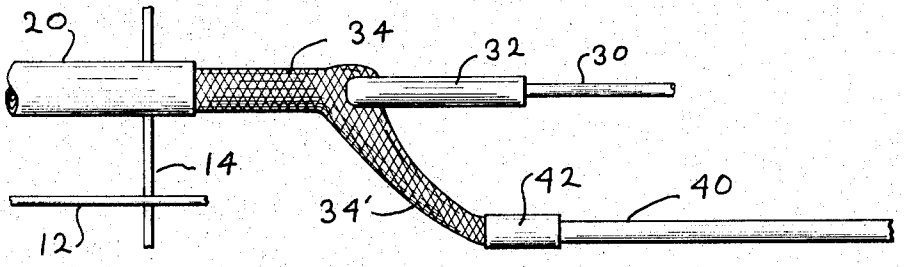

FIG. 5

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3,356,835

HEATING STRUCTURE

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Filed Oct. 8, 1964, Ser. No. 402,481
5 Claims. (Cl. 219—549)

The present invention relates to a heating structure and more particularly to a special heating wire construction for use in various heating structures.

In the melting of snow and ice from pavement, walks, steps, runways and the like, the use of electrical heating wire has, in recent years, been employed extensively by embedding the wire in the pavement and other structures. This wire is embedded beneath an inch or two of paving material and is used to maintain the surface of the pavement above the freezing point. While the individual, single-strand heating wire laid back-and-forth in the pavement has been used to a limited extent, this type of heating installation is difficult and time consuming to make and may result in a heterogeneous pavement structure. In recent years, a heating structure has been made available, which consists of an open type metal wire mesh an which is mounted in a predetermined pattern, an insulated heating wire secured in place by means spaced along the wire. Since there is always a possibility that the insulation on the heating wire or the entire insulated heating wire will be broken, in the interest of safety, the metal wire of the mesh is grounded so that should the mesh become charged, the current will not be conducted through the wet concrete or standing water to a person standing on the pavement. The grounded wire mesh constitutes an effective means of grounding the embedded heating wire unit so long as the mesh is in good condition; however, the metal mesh occasionally will eventually disintegrate from rust and lose its ability to ground the heating wire. Further, in order to reduce the cost of the initial installation, a plastic mesh has been used in place of the metal mesh and, consequently, this unit has not, in the past, been effectively grounded, and therefore, under certain conditions, is dangerous to persons standing or walking on the pavement. It is therefore one of the principal objects of the present invention to provide a heating structure of the foregoing type which is, at all times, effectively and reliably grounded, regardless of the type or condition of the mesh and which will remain effectively grounded under all operating conditions for the life of the pavement in which the heating structure is embedded.

Another object of the invention is to provide a heating unit of the foregoing type, in which the heating wire is effectively shielded from damage, abrasion, nicks and cuts to which it may be subjected during fabrication, installation and operation of the heating unit, and which can readily and easily be secured to the mesh, particularly to various types of plastic or other non-metallic mesh structures.

Still another object of the invention is to provide a heating wire which will give maximum safety and protection to any structure in which it is incorporated and to persons coming into contact therewith, and which has substantially longer life in service than conventional heating wire for comparable uses.

A further object is to provide a rugged, versatile heating wire structure which can be bent or flexed into various configurations with numerus and intricate curved portions and which is highly flexible and adapted to conform readily and fully to the contoured surface in which it is mounted or secured.

Another object of the invention is to provide a heating wire structure having a ground conductor which becomes effective whenever the external insulation of the wire is

broken and which can be grounded effectively at any number of places along the wire and at either end thereof.

Additional objects and advantages of the invention will become apparent from the following description and accompanying drawings, wherein:

FIGURE 1 is an enlarged plan view of a heating structure having the present wire structure incorporated therein;

FIGURE 2 is a vertical cross sectional view of the heating structure shown in FIGURE 1, the section being taken on line 2—2 of FIGURE 1;

FIGURE 3 is an enlarged fragmentary view of the heating wire shown in the preceding figures with portions of the heating wire broken away to more effectively illustrate the construction thereof;

FIGURE 4 is a transverse cross sectional view of the heating wire shown in the preceding figures, the section being taken on line 4—4 of FIGURE 3;

FIGURE 5 is an enlarged view of another portion of the heating structure shown in FIGURES 1 and 2, illustrating the manner in which the heating structure and heating wire are grounded; and

FIGURES 6, 7 and 8 are schematic diagrams of practical predetermined arrangements of the heating wire on the mesh, which can be effectively used in pavements, walks, driveways and the like for melting snow and ice.

Referring more specifically to the drawings, and to FIGURES 1 and 2 in particular, in which one embodiment of the present invention is illustrated, numeral **10** designates a flexible mesh which may be of any suitable material; however, in the interests of economy including ease in fabrication, it is preferably constructed of plastic or fiberglass material, the mesh being illustrated as having longitudinal and transverse strands **12** and **14**, respectively, joined together by heat-sealing at the points of intersection, indicated by numeral **16**, or by any other suitable joining means. The particular open type mesh configuration is not important and various types of structures other than separate strand or wire construction may be used. For example, the mesh may be of the expanded plastic or metal type of a perforated sheet of plastic or fiberglass material. The mesh should be of the open type construction so that when the heating structure is embedded in the concrete, the concrete will flow readily through the spaces between the strands and form a homogeneous and monolithic structure. The mesh, whether plastic or metal, will, in most installations, give some degree of reinforcement to the concrete or pavement structure and serve effectively as a carrier for the heating wire so that the heating wire can be transported and laid in a minimum amount of time and with a small amount of effort.

The heating wire **20** is mounted on the flexible mesh and is secured, attached or held thereon or adjacent thereto by any suitable means, such as, either by a physical or chemical bond or by loosely or tightly connected securing means. While it is preferable to hold the heating wire **20** in a fixed position on mesh **10** so that the longitudinal heating sections and curved sections will not become displaced and form hot and cold spots in the structure, it is not necessary that the heating wire be joined rigidly or firmly in a particular place and may be permitted to slip laterally, within a limited range, and still remain effective as a heating structure.

The structure of the heating wire is best illustrated in FIGURES 3 and 4 and consists of a resistance wire **30** of any suitable composition, an inner insulating material **32**, preferably of plastic, fully sealing resistance wire **30**, a flexible layer or shield **34** of braided metal wire is tightly woven around layer **32**, and surrounding this layer is an outer insulating layer **36**, preferably of relatively thick structure, enclosing the shield and forming the final insulation for the heating wire. The ground wire **34** may

be of other than braided construction. For example, it may consist of a wire helically wound around layer **32** or it may be a layer of foil or the like. Layer **32** may be of any suitable flexible insulating material, such as plastic, rubber or fiber, and the outer layer is preferably thermoplastic material, although other suitable insulating materials may be used. Layer **34** is constructed of relatively fine metal wire, preferably copper, and the completed layer should be highly flexible so that it will not interfere with the overall flexibility of the final wire.

In fabricating the wire structure, the inner insulating material **32** is first extruded on wire **30**, and after it has fully set, the wire **34** is braided tightly onto the external surface of insulation **32**. Thereafter, the outer insulation **36**, of thermoplastic material, is extruded onto the braided structure, forming an effective connection therewith. The heating wire fabricated in the foregoing manner is mounted on the open type mesh, illustrated in FIGURES 1, 2 and 5, by pressing the heating wire firmly against the strands of the mesh, and preferably while the pressure is applied thereto, heating the structure to a temperature where the thermoplastic outer insulation material **36** will either fuse with the plastic strand material or will form a physical bond therewith by embracing the strands in contact therewith. In order to form the optimum bond or joint between the heating wire and the strands of the mesh, a relatively thick outer insulation layer **36** is provided, so that the strands may be, in effect, embedded in the insulation material wherever the strands cross the heating wire. In this type of structure the heating wire is held firmly in place on the mesh and will not slide or slip relative to the mesh strands. Other methods of securing the heating wire to the mesh may be used, including clips extending over the wire and preferably spaced along the wire throughout substantial portions of its length. If desired, the wire may be laced or otherwise woven into the mesh so that it crosses over and under the strands on which it lies transversely. Further, it may be held by a second mesh secured to the first mesh. The second mesh forming spaced securing means along the wire and being of an open type permits the first mesh to function in the normal manner in the installation. The braided wire layer **34** is intended, primarily, to serve as a ground for the heating wire so that if the inner insulation **32** is broken at any place along the heating wire, the current will be effectively grounded. One method of grounding the structure is illustrated in FIGURE 5, wherein a short length of braided wire shield **34'** is removed from inner insulation **32** and connected to a ground wire **40** by connector **42**, the ground wire **40** being connected to an effective grounding device, such as a water pipe or a rod extending deeply into the earth.

After the heating structure has been fabricated in the foregoing manner, i.e. with the heating wire secured or connected to or otherwise mounted on the mesh at the fabrication plant, the mesh is usually rolled, folded or otherwise placed in a compact condition and shipped to the place of installation. A first layer of concrete or paving material is poured and the heating structure is placed on top of the initial layer and a second layer of concrete or other pavement is immediately poured on top of the first layer and the heating structure. Since the first layer has not had adequate time to set, the second layer forms an integral structure therewith, thus resulting in a monolithic structure in the entire pavement.

During the installation or use of the heating structure, if the insulation **32** should be broken or ruptured, the metal wire **34** will effectively conduct the current to the ground wire **40**, regardless of the position in the wire in which the break occurs. While the braided wire layer **34** is of a corrosion resistant material, it is also protected for long life by the outer insulating layer **36** and is protected thereby from corrosion, abrasion, nicks and cuts.

Although the present invention has been directed primarily to the heating wire with the braided ground structure mounted on a flexible mesh, the heating wire structure may be used for other purposes apart from the mesh. Only one embodiment of the present invention has been described in detail herein; however, various changes and modifications may be made without departing from the scope of the invention.

I claim:

1. A heating structure for embedding in pavement and the like, where the structure encounters water and moisture and which is subjected to abuse and strain during installation and use, said structure comprising a mesh of fiberglass material of open type construction having longitudinally and transversely arranged strands between which the paving material will readily pass, an electrical heating wire secured to said mesh in a sinuous path, said heating wire having an electric resistance wire, an inner insulating layer of plastic material on said wire, a braided wire forming a protective shield and an electric ground layer around said inner insulating layer extending substantially the full length thereof, and an outer insulating layer of thermoplastic material around said braided wire, said outer layer being relatively thick and embracing the strands engaged thereby and forming a bond therewith securing said heating wire to said mesh carrier.

2. A heating structure for embedding in pavement and the like, where the structure encounters water and moisture and which is subjected to abuse and strain during installation and use, said structure comprising a mesh of fiberglass material of open type construction having spaced strand-like members between which the paving material will readily pass, an electrical heating wire held adjacent to said mesh in a sinuous path, said heating wire having an electric resistance wire, an inner insulating layer of plastic material on said wire, a braided wire forming a protective shield and an electric ground layer around said inner insulating layer extending substantially the full length thereof, and an outer insulating layer of thermoplastic material around said braided wire, said outer layer being relatively thick and engaging members of said mesh and securing said heating wire to the mesh.

3. A heating structure for embedding in pavement and the like, where the structure encounters water and moisture and which is subjected to abuse and strain during installation and use, said structure comprising a mesh having spaced members through which the paving material will readily pass, an electrical heating wire connected to said mesh in a sinuous path, said heating wire having an electric resistance wire, an inner insualting layer of plastic material on said wire, a braided wire forming a protective shield and an electric ground layer around said inner insulating layer, an outer insulating layer around said braided wire, said outer layer being relatively thick and embracing members of said mesh for securing said heating wire to said mesh carrier.

4. A heating structure for embedding in pavement and the like, where the structure encounters water and moisture and which is subjected to abuse and strain during installation and use, said structure comprising a flexible carrier of perforated plastic material construction through which the paving material will readily pass, an electrical heating wire mounted on said carrier in a sinuous path, said heating wire having an electric resistance wire, an inner insulating layer of plastic material on said wire, a braided wire and a protective shield forming an electric ground layer around said inner insulating layer extending substantially the full length thereof, and an outer insulating layer of thermoplastic material around said braided wire, said outer layer being relatively thick and engaging said carrier and securing said heating wire to the mesh.

5. A heating structure for embedding in pavement and the like, where the structure encounters water and moisture and which is subjected to abuse and strain during installation and use, said structure comprising a flexible carrier, of perforated construction through which the paving material will readily pass, and electrical heating

wire mounted on said carrier in a sinuous path, said heating wire having an electric resistance wire, an inner insulating layer of plastic material on said wire, a layer of electrical conducting material forming a ground around said inner insulating layer extending substantially the full length thereof, and an outer insulating layer disposed around said layer of electrical conducting material and securing said heating wire to the mesh.

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