

Jan. 16, 1968

B. PALATINI ET AL
DEVICE FOR ELECTRICALLY HEATING SURFACE STRUCTURES
SUCH AS ROADS, BRIDGES, AIRPORT
RUNWAYS, WALLS, AND THE LIKE
Filed Oct. 1, 1964

3,364,335

Fig.1

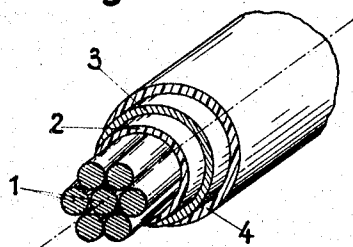
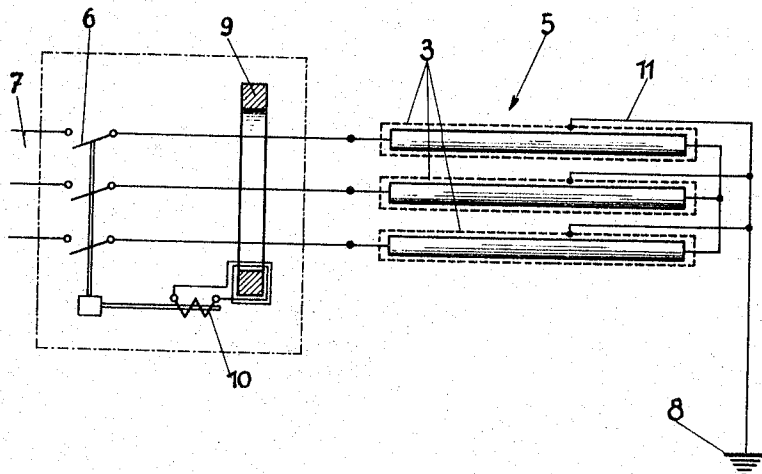


Fig.2



3,364,335

DEVICE FOR ELECTRICALLY HEATING SURFACE STRUCTURES SUCH AS ROADS, BRIDGES, AIRPORT RUNWAYS, WALLS, AND THE LIKE

Benno Palatini, Ruti, Niederteufen, Switzerland, and Herbert Pferschy, 23 Radetzkystrasse, Dornbirn, Vorarlberg, Austria

Filed Oct. 1, 1964, Ser. No. 400,814

4 Claims. (Cl. 219-213)

The invention relates to a device for electrically heating surface structures such as roads, bridges, airport runways, floors, walls, and the like.

The suggestion to heat electrically traffic areas is known in itself, bare or insulated wires being embedded in or below the pavement, these heating wires being connected to a low voltage source up to about 50 v. so that owing to the low voltage any danger to man or an animal is precluded. In order to prevent the traffic area from being covered by a layer of snow or ice, particularly in cold winter weather, a significant electrical capacity is required which means high current intensities and thus enormous conductor cross sections, if low voltages are used.

If, on the contrary, higher operating voltages are chosen in order to render large conductor cross sections unnecessary, for safety reasons the conductors must be buried so deeply below the surface that the operation becomes uneconomical, since not only is too much energy consumed until the surface proper gets heated, but also the time required therefore becomes too long. These adverse circumstances make it almost impossible to use such a heated surfacing, if ice formation is contemplated, since in this instance a rapid temperature change of the surface is required.

Moreover, surfacings are known which consist of a plastic grid the stays of which are hollow. These hollow stays carry heating conductors closely below the surface. The grid is fastened to the support and fixed to it by pouring a filler into the meshes. The heating conductors consist, for instance, of an insulated standard copper-aluminum-iron strand. They are arranged in the grid in meander shape with small spacings so that the entire heated area is covered. They are directly connected to the service net. In mechanical respects, particularly due to their excellent adherence to the support and their thermal properties, these heated surfacings are eminently suitable for taxiways and runways. Since the heating conductors are arranged immediately below the surface, the heat-up times are extraordinarily short so that their use is not only economical, but moreover a preset control is made possible which enables efficient operation under all conditions occurring in practice. This plurality of advantages is compared to the only substantial shortcoming that low voltages can be connected to the heating conductors, since these are not sufficiently protected to avoid risk to man and animal in the case of defects occurring in the device. The risk factor is incompatible with the safety rules existing in most countries so that at present an efficient heated surfacing is indeed known, but can or may not be used.

An object of the present invention is to provide a heating conductor and to choose its connection in such a way that absolute safety is guaranteed, although a high operating voltage is applied.

According to the invention this is obtained by accomplishing the following characteristics in combination: (a) a heating conductor arranged below the surface of the structure, preferably enclosed in a grounded metallic-conductor sheathing, which is connected to a voltage exceeding the permissible tolerance for man and animal; (b) at least one electrical safety connection which,

as soon as a leak current (ground leak, short circuit) occurs, disconnects the current supply, before the surface voltage gradient and the leak current, respectively, have exceeded the permissible tolerance for man and animal.

Due to the application of both characteristics as described in this invention utmost safety is actually provided, although high values are chosen for the service voltage which make it possible to keep the conductor cross section small, since immediate disconnection is ensured, if the plant is damaged either by short circuit or ground leakage.

This immediate disconnection is mainly ensured by the fact that the grounded sheathing enclosing the insulated heating conductor is constituted as a closed sheath or as a coil and that this sheathing is surrounded by an insulating layer so that for the conductor stretching over a considerable length a locally defined grounding is provided and in the case of a short circuit between heating conductor and sheathing a current passes through this defined grounding, which serves to trigger switching operations. The safety connection can be conceived as a voltage-operated leakage protective grounding or as a fault current protective grounding. In order to cope rapidly with those troubles too, where a direct contact is established between the heating conductor and the structure heated or a direct short circuit results between the heating conductors, the arrangement of a differential protection is recommended, in which, as is known, the total currents at the inlet and the outlet of the heating conductors are compared with each other.

Evidently, an appropriate combination of the individual protective groundings is possible.

Mechanical protection of the heating conductors is provided by laying them closely below the surface of the structure in tubes or in unilaterally open sections of preferably trapezoidal cross section made, for instance, of glass-reinforced plastic.

If the heating conductors are arranged as near as possible to the surface to achieve a short heat-up time, the meshes between the tubes or sections should be preferably filled up with an insulating filling cement, e.g., a synthetic-resin mineral aggregate. Independently of the position of the heating conductors or independently of their laying, respectively, the heating conductors are preferably connected to a three phase power current.

The technical particularities pertaining to the surfacing itself are not important. They are determined by the intended use and the service requirements. The use of the surfacing for airport runways, roads or floors, walls and ceilings, evidently determines the selection of the material for the embedding of the heating conductors, the shape of the embedding, and the filler. Here, requirements as to adherence of temperature changes, wear resistance, permissible moisture absorption, etc., play a decisive part. The heating capacity and consequently the selection of the conductor cross section and possibly the operating voltage which exceeds, however, in any case the values of low voltage, are determined by the special duties of the heated surfacing. Particularly high requirements must be met by the heated surfacings of bridges, if freezing or formation of fog is to be prevented. In this case, cleaning is only possible if the temperature of the surface of the runway is rapidly and efficiently controlled in dependence on the ambient temperature, the moisture and the wind conditions. This is mainly possible in case the heating conductor is arranged directly below the surface of the runway so that its heat is quickly transferred to the surface. With such an arrangement of the heating conductors, mechanical damage is possible. Using the heating conductor described by the invention and, moreover, well insulated and moisture repellent fillers and applying the safety switch means indicated,

the risk to man and animal can be almost precluded, since the current supplies are immediately interrupted, if the heating conductor becomes defective at some point. It is true that no insulation is perfect and with very long heating conductors current leakages will always occur, but they can be restricted to a minimum. The safety connection must be such that interruption is only effected with a strictly defined leak current. The upper limit of this leak current is established by the permissible tolerance for man and animal. When the leak current reaches this limit, the current supply is interrupted so rapidly that any harm to man or animal is prevented with certainty. For this, empirical values are available which are incorporated into the safety rules stipulated by law. The absolute values are not completely consistent in the different countries.

The operating system of the safety switch can be chosen arbitrarily. Tests have shown that with a three-phase power current connection the above-mentioned requirements are fully met by an inductive fault current protective switch means. With this fault current protective switch the leak current is determined by means of a totalizing current transformer. The current feeds are found as a primary winding round an iron core carrying a secondary winding. As long as the heating cable is not defective, the vector sum of the current in the current transformer equals zero. If the heating cable becomes defective, the vector sum of the current in the primary winding no longer is zero and thus a current is induced in the secondary winding which triggers a switch via a highly sensitive relay. The sensitivity and the time of response can be adjusted in a relatively simple way. When laying the heating conductor it must naturally be borne in mind that the total of the always present and harmless leakages via the insulation must be substantially less than the tolerance of the safety switch. Thus, it may become necessary, if very large areas are involved, to divide the total area into subareas and provide each subarea with a separate current supply and safety switch. Since, however, with modern materials very good insulation can be achieved, even with 100% moisture, such measures are an exception.

With the device according to the invention a promptly effective and at the same time absolutely safe heating of surface areas, particularly of roads, airport runways and bridge surfacings has become possible for the first time. These surfacings can be constructed at relatively low expense in such a way that they not only meet all mechanical requirements, but are additionally able to prevent the formation of ice and possibly even that of fog immediately above the surfacing.

The attached drawing shows an embodiment of the invention.

In the drawing:

FIG. 1 is a perspective view of a cross-section through a heating cable; and

FIG. 2 shows diagrammatically a fault current protective ground arrangement.

A core 1 of a cable, formed of stranded wires, is enclosed in a polyethylene sheath 2, which in turn is enveloped by a metallic-conductor sheath 3. This sheath 3 is grounded. As an outer insulation covering the sheath 3 a sheathing 4 is provided, made of polyamide with low water absorption; this sheathing 4 not only electrically insulates the sheath 3 along the cable from the surrounding structure, but additionally protects the cable against penetration of moisture and humidity as well as mechanical damage.

In the fault current protective grounding arrangement (FIG. 2) a three-phase heating cable 5 is directly con-

nected through a switch 6 to a network 7. The metal sheathing 3 of the heating cable has a ground connection 8. The switch 6 is associated with a totalizing current transformer 9. A fault current trip 10 is inductively coupled with the totalizing current transformer.

If, owing to some cable defect, the vector sum of the current of the three phases does not equal zero, the current so induced and passing through the fault current trip 10 triggers the switch 6. The sensitivity of the switch ranges within the order of magnitude of 10^1 to 10^2 ma. (milliamperes) and its reaction time is to about 200 msec. (milliseconds).

Instead of the fault current protective system a voltage-operated leakage protective system can be provided. In this instance, the protective conductor 11 is grounded via a voltage-operated trip coil and this voltage-operated trip coil is connected in parallel with an overvoltage arrester.

What we claim is:

1. A device for electrically heating objects of large surface area comprising heating conductor means arranged under the surface to be heated and electrically grounded, means for supplying the heating conductor means with a voltage exceeding the tolerance of human beings and animals, the latter means including a voltage supply means and current feeds from the supply means to the conductor means and an electrical safety device for selectively interrupting the connection between the heating conductor means and the voltage supply means in the event of ground leakage or short circuit of the heating conductor means, said safety device comprising switch means between the voltage supply means and the heating conductor means, a current transformer having a primary winding constituted by said current feeds and a secondary winding inductively coupled to the primary winding, said current transformer having zero output when the vector sum of the current in the current feeds is balanced and equal to zero, and a trip coil operatively coupled to said switch means and to the secondary winding of the transformer for opening the switch means when the vector sum of the current supplied to the conductor means is not equal to zero, said conductor means including a plurality of heating conductors each constituted by a conductive core, an insulative sheath encasing said core, a conductive covering enclosing the sheath and connected directly to ground and an insulating sheath on each conductor enclosing the conductive covering thereon.

2. A device as claimed in claim 1 wherein the conductor means are connected in three phase arrangement and the voltage supply means is a three phase supply.

3. A device as claimed in claim 1 wherein the heating conductors are laid closely under the surface to be heated in casings.

4. A device as claimed in claim 3 wherein the casings, at least partially, are disposed at a distance from each other and the thus created spaces between the casings are filled with an insulating filler.

References Cited

UNITED STATES PATENTS

3,086,999	4/1963	Kramer	219—519 X
3,124,738	3/1964	Smith et al.	317—31 X
3,209,128	9/1965	Chapman	219—213
3,214,638	10/1965	Moser et al.	317—27 X
1,788,107	1/1931	Hynes	219—213 X
2,649,532	8/1953	Woodman	219—335 X

RICHARD M. WOOD, *Primary Examiner*.

C. L. ALBRITTON, *Assistant Examiner*.