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DEVICE FOR HEATING SURFACES SUBJECT TO STRONG MECHANICAL STRESSES OR CONSIDERABLY VARYING ATMOSPHERIC CONDITIONS

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Fig.1

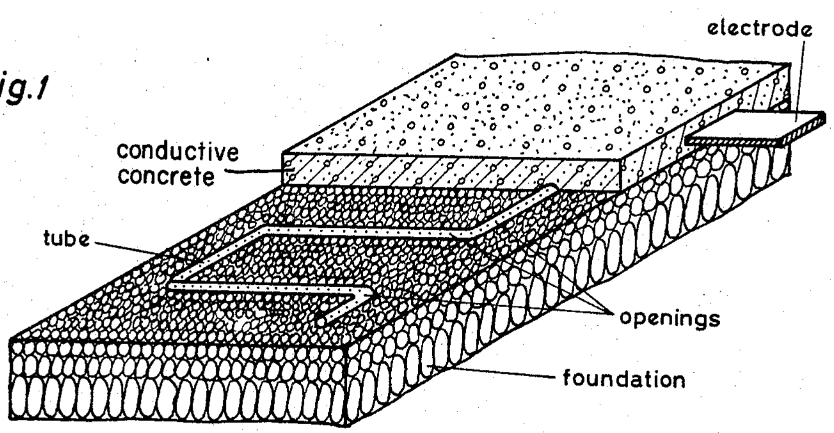
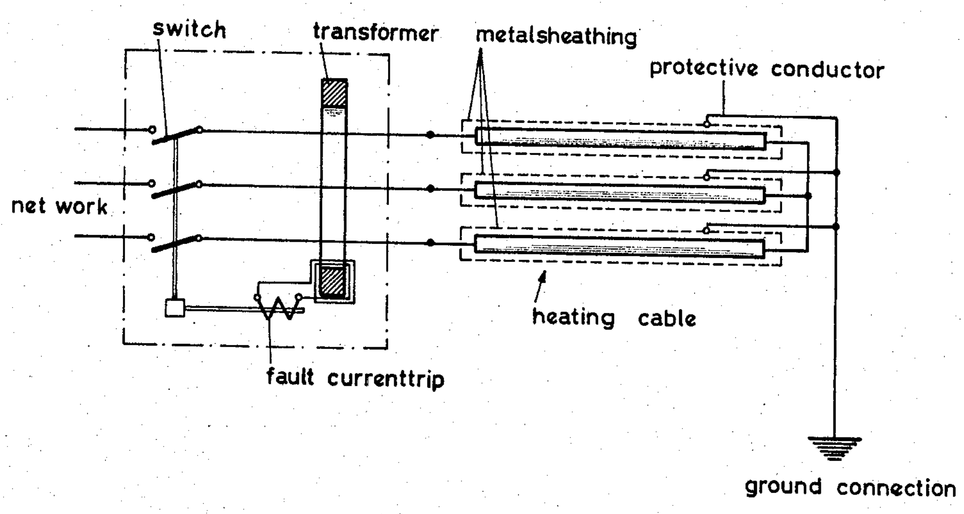


Fig.2

fault-current protective circuits



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DEVICE FOR HEATING SURFACES SUBJECT TO STRONG MECHANICAL STRESSES OR CONSIDERABLY VARYING ATMOSPHERIC CONDITIONS

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4 Claims. (Cl. 219—213)

The invention relates to a device for heating surfaces subject to strong mechanical stresses or considerably varying atmospheric conditions such as roads, airport runways, bridges and other traffic areas, using electric resistance heating elements.

The invention will be explained hereinafter with reference to the accompanying drawing in which FIG. 1 shows a fragmentary perspective view of a portion of a traffic area to be heated; and

FIGURE 2 shows a diagram of a fault-current protective circuit.

It has been proposed to use the heat developed by electric current in resistance elements to heat traffic areas such as roads, bridges, runways, parkings, and the like. This has been achieved by providing heating cables and grids in the pavement; these have, however, the disadvantage of a non-uniform release of heat.

It is an object of the present invention to provide a device ensuring uniform and homogeneous heating and to design the heating element such that the surface releasing the heat is large compared to the cross section of the heating element.

According to the invention this is achieved by providing laminar electric resistance elements.

A particularly favorable type of laminar heating element is shown in FIG. 1 and consists of an electrically conductive concrete layer, since in this instance the heating element is at the same time supporting the traffic area. Since the set concrete normally used has a very high electric resistivity, it is necessary to add admixtures ensuring a satisfactory conductivity for the heating even after the concrete has set, or to achieve a sufficient humidification of the concrete.

A satisfactory, substantially electrolytic conductivity can be achieved in the concrete by suitable chemical admixtures such as salts, for instance NaCl, or acids, for instance hydrochloric acid. The chemical admixtures mentioned above can be introduced into the concrete using, for instance, a system of tubes embedded in the concrete layer and provided with numerous openings through which the chemical admixtures are discharged in liquid state. In this case it is recommended to seal the concrete layer with a coat inhibiting evaporation.

Another possibility of obtaining a satisfactory conductivity, this time a substantially electrical (metallic) conductivity, in the concrete consists in incorporating particles of metals and/or conductive ores. By way of example this can be done by pre-compressing, as in the prepact process, a bed consisting of grit and filling then under pressure the cavities with cement or cement mortar. Instead of cement other binding agents can be used, e.g., magnesia.

When a concrete layer rendered conductive is used as a heating element as mentioned above, connecting electrodes are required to feed the heating current. The shape and arrangement of the connecting electrodes can be varied. By way of example, plate electrodes are appropriate, the electrode plates being applied to the surface of the concrete layer, e.g., to its lateral faces and/or are embedded in the said concrete layer. Instead of plate electrodes, bar-shaped electrodes or wires serving as

electrodes can be used which are incorporated in the conductive concrete layer. Moreover, wire grids, wire gauzes or metal foils can be used as electrodes and applied to the concrete layer or embedded therein. The arrangement of the electrodes can be conceived such that the heating current flows substantially parallel to the plane of the traffic area being heated or transversely of the same, thus from top to bottom or inversely.

If the conductivity is electrolytic (ionic), alternating current must be used as a heating current in order to prevent electrolytic decomposition as far as possible. In this instance it will also be useful to arrange the electrodes such that they can be replaced and/or cleaned, if need be.

It is possible to operate the installation with a low voltage of about 40–50 volts. Under normal conditions the heating capacity (connected load) will be about 200 va./m^2. If the installation is very large, a use of the low voltage harmless to man and animal necessitates a large dimensioning of the feeds. It is true that this disadvantage can be overcome to a certain degree by providing several transformers, but it proves much more convenient to apply an operating voltage above 40–50 volts, preferably above 110 volts. To avoid any risk in this instance, all installations of this type will be operated with highly sensitive safety circuits known in themselves, and be insulated efficiently.

The safety circuits or safety measures considered are, e.g.: fault-current protective circuits; protective transformers or generators insulated against the ground; current reduction triggers; covering or enveloping of the insulation of the heating elements with an electrically conductive grounded material; suitable arrangement and dimensioning of the heating elements to keep the step voltage low, insulating bordering of the traffic area; insulating surfacing, preferably consisting of wear resistant and impact resistant material. Evidently it is possible to use several of the individual safety circuits and measures indicated at the same time or to combine them with each other.

In the following, the above-mentioned safety measure of the fault-current circuit will be described in detail with reference to FIG. 2, since it is of special importance in connection with the present field of application. It is here the case of an electric safety circuit provided at the conductor inlet which disconnects the current feeds in a manner known in itself by means of the leak current occurring on damage or ground-leakage in the system, before this leak current reaches the permissable tolerance for man and animal. The upper limit of this leak current is defined by the permissable tolerance for man and domestic animal and is about 20–40 milliamps. When the leak current reaches this limit, the current supply must be interrupted so rapidly that any damage to man or animal is prevented with certainty. For this, empirical values are available which were incorporated into the safety rules stipulated by law. The absolute values are not completely identical in the different countries. Since the upper limit of the reaction time is about 200 millisec., disconnection by the leak current switch must be effected at about 20–40 milliamps within a maximum delay of 200 millisec.

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. With this fault-current protective switch the leak current is determined by means of a totalizing current transformer. The current feeds are wound as a primary winding around an iron core carrying a secondary winding. As long as the heating cable is not defective, the total current in the current transformer equals zero. If the heating cable becomes defective, the total current in the primary winding is no longer 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. Thus, it may become necessary, if very large areas are involved, that the total area must be divided into sub-areas and each sub-area must be provided with a separate current supply and safety switch. Since, however, with modern materials very good insulation can be achieved, even with 100% moisture, such a measure will always remain an exception.

With a view to the fact that the heating elements are arranged within a region of possible mechanical destruction, the safety measures must satisfy particularly rigorous conditions, but with the present state of technology this is possible without difficulty.

What I claim is:

1. A device for heating surfaces subject to strong mechanical stresses or considerably varying atmospheric conditions, such as roads, airport runways, bridges or other traffic areas, said device comprising a foundation layer and at least one coating covering said foundation layer, said coating comprising a heating element of at least one layer of concrete which is uniformly electrically conductive throughout the entire layer, and means in contact with said conductive concrete layer for connecting the latter to a source of electrical energy.

2. A device as claimed in claim 1, wherein said electrically conductive concrete layer contains admixtures causing an electrolytic conductivity.

3. A device as claimed in claim 1 comprising a tubular system with numerous openings emebdded in said elec-

trically conductive concrete layer through which a liquid rendering said concrete layer electrolytically conductive can be passed into said concrete layer.

4. A device as claimed in claim 1, including and wherein said electrically conductive layer is covered with a sealing layer inhibiting evaporation of the liquid rendering the concrete layer electrically conductive.

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