PORTABLE WEATHERPROOF HEATING UNIT FOR SOFTENING PVC CONDUIT

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References Cited

UNITED STATES PATENTS

1,260,564 3/1918 Magnusson et al. 219/10.51
2,001,219 5/1935 Shaw 219/10.79 X
3,335,251 8/1967 Rolfs 219/10.51
3,644,696 2/1972 Magner et al. 219/10.57

ABSTRACT

A portable electrically powered heater for softening rigid plastic electrical conduit to allow forming to fit the installation has a tubular electro-magnetic induction heater mounted in and extending out through each end of a rigid weatherproof housing. One end of the tubular induction heater is clamped to the end wall or end cap of the housing with the other end of the tubular induction heater being slidably engaged with the end wall or end cap through which it extends. When connected to an electrical outlet on the jobsite the inside of the tubular heating element heats up within a few minutes. Long lengths of rigid plastic electrical conduit may then be inserted into and through the induction heater so that the portion left within the heater will soften within a minute or less for small sizes and within one-half hour for sizes up to 4 inches. When removed from the heater the heated and softened portion of the tube may be bent by hand to the desired shape without cracking or collapsing the tube.

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5 Claims, 7 Drawing Figures
PORTABLE WEATHERPROOF HEATING UNIT FOR SOFTENING PVC CONDUIT

BACKGROUND OF THE INVENTION

Use of rigid plastic tubing such as PVC for electrical conduit in place of soft steel tubular conduit has introduced a problem of how best to bend the plastic tubing to fit the installation. Mechanical tube benders such as used with steel conduit may not be used with PVC plastic at ambient temperatures as the PVC will merely crack or spring back to original shape. A variety of slip-on elbows and sleeves are on the market and used in many installations since PVC can be easily sawed to length and the elbows or sleeves slipped on and cemented at the desired position. Disadvantages of such an installation method include dependence upon a large supply of elbows and sleeves, the added labor of cutting and cementing, and the limitation of use of bends of fixed angle and radius.

Electricians have found that an easier method of fitting the PVC conduit on the job is to heat the conduit over a bonfire near the point of installation, holding the conduit over the fire until it softens sufficiently for bending and then forming it to the required shape by hand. A blow torch is substituted for the bonfire by some. Others use an electrical resistance carload heater with or without a radiant shield. The bonfire or torch method produces non-uniform heating resulting in irregular bends and also introduces fire hazards. The electrical resistance units use a great amount of electricity and cannot be used in bad weather since heat is not well retained, and are severely limited as to length of conduit which can be effectively heated at one time.

A problem faced on construction jobs is a ready source of electrical power since a network of high wattage outlets is not ordinarily available. The worker depends upon the use of long heavy duty extension cords. Electrical resistance type heaters used for softening PVC conduit draw several thousand watts of power thus limiting their use to the vicinity of a central electrical outlet or requiring the use of cumbersome size extension cords.

In this day of high labor costs it will be appreciated that tools to make the job easier, to help the worker to obtain consistent results, and to reduce costly rework are being constantly sought.

While electro-magnetic induction heaters have been used for many purposes including the heating of metal pipe to facilitate bending, and have been designed for high efficiency, portable electro-magnetic induction heaters for softening electrical conduit have been unknown.

In U.S. Pat. No. 1,980,875 inventor Northrup disclosed an induction heater designed as a continuous pass heat-treating furnace being a long tubular heat treat furnace through which rod or tubular stock is continuously passed to be heated thereby. The Northrup concept was a stationary device and not adapted to portability and use in unsheltered areas. To be noted in several versions of the Northrup heater and in one version of the Barfield et al induction heater U.S. Pat. No. 2,868,938 is the provision of water cooling passages either in the induction coils themselves or surrounding them. The provision of water cooling in some versions of induction heaters indicates one of the problems to be solved in making the induction heater for PVC conduit portable and for use in unsheltered areas.

BRIEF SUMMARY OF THE INVENTION

This invention is an efficient portable electrical heater for softening appreciable lengths of PVC conduit to prepare it for forming at installation. This heater has an electro-magnetic induction heater formed by wrapping a layer of many spaced turns of iron or copper wire around a galvanized steel pipe suitably insulated by fiberglass cloth, and held in place. One end of the induction heater is inserted through and attached to an end cap or wall of a spaced surrounding weather-tight metal or plastic housing. The other end of the induction heater is inserted through the opposite end wall of the housing. A thermostat control is attached to and in contact with the pipe midway of its length. Electrical connections from the electro-magnetic induction heater and thermostat control to the appliance cord are made either within the housing or within weather-tight electrical junction boxes attached to the housing. A carrying handle or handles are attached to the outside wall of the housing. Thus with this heater long lengths of rigid PVC conduit may be readily inserted into either open end of the electro-magnetic induction heater core pipe and the electrical connections and the hot surfaces of the heater are protected from weather and handling by the housing.

The primary object of the present invention is to provide a portable electro-magnetic induction heater for softening PVC conduit on the jobsite and near the place of installation. In providing such a portable heater it is an object to have the electrical components weathertight so that it can be used in unsheltered areas such as alongside a ditch into which the conduit is to be laid for an underground wiring system. In such a portable heater it is an object to provide a long heating tube open at both ends so that a major portion of a long length of PVC conduit may be formed, even when such a portion is midway of its length.

A primary object of this invention is to provide a portable electrically powered heater for softening PVC conduit which will allow its use at the end of a long heavy duty extension cord having no larger than No. 14 size copper conductors.

It is also an object of such a portable heater that the portions of the heater which might be handled will not be so hot that a workman would be burned by it.

It is also an object of such a portable heater that the connection to the flexible appliance cord will be sufficiently cool that the insulation on the cord will not be damaged by overheating.

It is an object of such a portable heater that provisions be made for controlling the temperature for a sufficiently high temperature to soften the PVC conduit but sufficiently low that the PVC conduit will not be scorched or blistered from its contact with the inside wall of the heater core.

It is an object of such a portable heater that for its size it shall be sufficiently light in weight for ease in handling that it be simple in construction, and sturdy to withstand heavy usage.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings FIG. 1 shows a preferred embodiment of the portable unit for softening PVC tubing.
FIG. 2 is a detail showing the hollow electromagnetic induction heating element. FIG. 3 is a schematic electrical diagram for the heater. FIG. 4 shows an alternate form of construction of the portable unit for softening PVC tubing. FIG. 5 shows a detail of the alternate construction. FIG. 6 shows a detail of an alternate construction for the support of the hollow heater element. FIG. 7 shows the heater as used on the jobsite.

DETAIL DESCRIPTION OF THE INVENTION

As shown in FIGS. 1, 2, and 3 a preferred embodiment of the portable weatherproof unit for softening rigid PVC conduit is enclosed in a long box or housing 1 with round openings 2 in each end, an electrical appliance cord 4 and a carrying handle 5. The housing 1 in this embodiment is a standard NEMA class 3 raintight electrical gutter. Such a gutter is well adapted as a housing for this unit as it is sturdy, can be readily obtained in a wide range of sizes, and is designed to be sufficiently raintight for electrical equipment.

Modification of the gutter for use as a housing 1 include removing a knockout to provide a hole at each end through which the heater element core, 1 is extended and drilling holes in the top or side wall to install junction boxes 6 and 7 and for routing the wires from the two ends of the induction heater 8.

In the preferred construction the junction boxes 6 and 7 are attached to the top with the removable side panel 3 on one side. For the most raintight construction the junction boxes 6 and 7 should be cast iron using gaskets 9 between junction boxes and housing 1 and a housing facilitate moving the unit about.

Since these larger units can weigh as much as 180 pounds a handle 23 may be required at each side so that the unit may be carried by two men.

The hollow induction heater 8 has as its transformer secondary the galvanized steel pipe 11, threaded one end and cut to a length of 1 to 1½ inches longer than the housing 1. Upon installation this added length allows it to extend out through the hole in the housing 1 at each end for support. The threaded end of pipe 11 is locked to the housing 1 by jam nuts 12. The opposite unthreaded end is slidably supported to allow for expansion and contraction in length of the pipe with changes in temperature.

In construction of the heater 8 the outside of the pipe 11 is wrapped with two half-lapped layers of fiberglass cloth electricians insulating tape 13 for its full length within the housing 1. The most satisfactory material found to date for this purpose is Scotch 69 manufactured by 3M. By tests this material has been measured for electrical resistance at heater operating temperature after having been stored in a humid atmosphere for several days and found to have a resistance across this two layer thickness of ten megohms.

A single layer bare copper or steel wire wound on top of the double layer of insulating tape so that each turn lies in spaced relationship to the adjacent turn forms the transformer primary coil 14. Tabulated data on models of various sizes is disclosed below. The coil covers almost the entire length of the pipe within the housing. Because of its lower resistance primary coils of copper result in a lower outside temperature than those formed of iron wire.

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**TABULATED DATA**

<table>
<thead>
<tr>
<th>Diam. PVC (Trade Size)</th>
<th>Steel Pipe Secondary Size</th>
<th>Housing</th>
<th>Primary Wire Size Gage</th>
<th>Type</th>
<th>No. Turns</th>
<th>Input Volts</th>
<th>Amps- Cold Start</th>
<th>Hot Amps Operating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>1/4&quot; Conduit</td>
<td>4&quot;x4&quot;x4&quot;</td>
<td>Steel 16</td>
<td>16</td>
<td>Steel</td>
<td>120</td>
<td>17.5</td>
<td>9</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>3/4&quot; Conduit</td>
<td>6&quot;x6&quot;x4&quot;</td>
<td>Steel 16</td>
<td>16</td>
<td>Steel</td>
<td>120</td>
<td>17.5</td>
<td>9</td>
</tr>
<tr>
<td>2&quot;</td>
<td>7/8&quot; Conduit</td>
<td>7&quot;x7&quot;x6&quot;</td>
<td>Steel 16</td>
<td>16</td>
<td>Steel</td>
<td>208</td>
<td>21</td>
<td>10.5</td>
</tr>
<tr>
<td>3&quot;</td>
<td>1&quot; Conduit</td>
<td>8&quot;x8&quot;x6&quot;</td>
<td>Copper 14</td>
<td>14</td>
<td>Copper</td>
<td>208 or 240</td>
<td>11</td>
<td>8.5</td>
</tr>
<tr>
<td>4&quot;</td>
<td>1-1/4&quot; water pipe</td>
<td>8&quot;x8&quot;x6&quot;</td>
<td>Copper 14</td>
<td>14</td>
<td>Copper</td>
<td>208 or 240</td>
<td>11</td>
<td>8.5</td>
</tr>
</tbody>
</table>

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cast iron electrical conduit tee 10 through which the appliance cord 4 is passed. An alternate handle construction, particularly for the larger heaters accepting 3 inch and 4 inch PVC or plastic tubing, is shown in FIG. 7.

This utilizes standard pipe flanges 20 gasketed and bolted to the top of the housing supporting vertical pipe nipples, 21, standard pipe elbows 22 and a horizontal length of pipe 23 to form the carrying handle. At one end of the handle a vertical pipe nipple several inches long spaces the handle well above the top of the housing to prevent uncomfortable heating. The same vertical rise is obtained at the other end by insertion of a standard "Tee" conduit 10 conduit fitting for exiting the electrical cord 4 and fitting.

Four castors on the corners of the bottom of the housing facilitate moving the unit about.

A second criss-crossed layer of high temperature resistant fiberglass cloth tape 13 is wound on top of the wire coil to hold it in place throughout changes in temperature and shock loads due to handling.

Although a simple heater as described above can be used successfully without thermostatic control it is possible to leave a PVC conduit in the heater for too long a period at the high temperature at which it will stabilize thus discoloring and/or blistering the outside surface of the PVC at the point upon which it rests in the heater. An adjustable thermostat 16 mounted at the center mid-section of pipe 11 with the temperature sensing element of the thermostat in contact with the outside wall of the pipe 11 as shown in FIG. 2 can be used to automatically open the circuit at the control temperature. In this instance the coil 14 is wound in
two segments which are interconnected through the normally closed thermostat contacts 16. The raintight electrical wiring gutter is very satisfactory for a housing because of its square cross-section preventing rolling, its weatherproof rugged construction and ready access for maintenance by a full length removable side panel. However, the gutter is made of steel and variations of a light-weight alternate plastic or aluminum construction is illustrated in FIGS. 4, 5, and 6.

Referring to FIGS. 4, 5, and 6 the housing is made from a circular or rectangular cross-section aluminum or plastic tubing and two end caps 17 which can be inserted into the tubing and secured thereto by screws 18. If the tubing is circular, legs 19 may be provided to prevent rolling. As illustrated in FIG. 6 with this alternate construction the induction heater pipe 11 and the electrical connection 4 may be attached to one end cap 17 and mounted thereon before inserting into the tube thus making a readily manufactured subassembly. As shown in FIG. 4, by providing inset end caps 17 for support of the heater 8 in a housing 1 which is longer than the hollow induction heater 8, the hot ends of pipe 11 can be guarded. Although the end of the pipe 11 may not be as hot as the interior of the pipe this construction will keep the end out of easy reach and thus prevent uncomfortable contact. If the housing tube is an electrically non-conducting plastic the inset end caps will also help to prevent electrical shocks.

The end cap constructing shown in FIG. 6 could also further protect the user from shocks or burns. In such case end cap 17 and nut 19 can be made from a heat resistant non conductor such as neoprene.

Theory of Operation

The heat is generated in the walls of the galvanized steel pipe 11 by electrical eddy currents and magnetic hysteresis. The coil 14 on the outside of the pipe 11 forms the primary winding of a transformer. The walls of the galvanized steel pipe 11 constitute the un laminated magnetic core of the transformer and also the equivalent of a short-circuited secondary winding. The electromagnetic induction eddy currents are caused to flow in the walls of the pipe when voltage is applied across the primary winding. Due to the electromagnetic resistance of the steel pipe the eddy currents generate heat in the walls of the steel pipe. Additional heat is generated in the walls of the steel pipe by hysteresis losses. Heat is also generated in the primary winding due to its resistance. Some of this heat is conducted to the walls of the steel pipe, but since the major portion of the heat is generated within the walls of the steel pipe, a high concentration of uniform heat is applied to the area immediately surrounding the plastic conduit or pipe to be heated.

Several unique design features are incorporated into the construction of this heater. The steel pipe used is ordinary mild steel galvanized electrical rigid conduit or water pipe. Also in one version the primary winding is wound with the mild steel wire commonly used for reinforcing steel in concrete forms. The electrical and magnetic characteristics of these steels are such that the current consumption at the time the heater is first turned on at ambient temperature is approximately double the current prevailing after the heater has reached its normal operating temperature. Thus the heater automatically adjusts its current consumption to provide a rapid increase in temperature during startup and then a reduced rate of heat generation to maintain its normal operating temperature. In this induction heater the primary coil is only one layer deep. Thus the length of the heater can easily be as long as is found necessary for the particular operation. The first heaters according to this invention were four feet in length in which case the entire length of PVC conduit within the heater or four feet can be softened simultaneously within one minute. This is in contrast to existing resistance type heaters which require the electrician to slide the PVC conduit back and forth to soften sufficient material for a bend. Lengthening the induction heater of this invention to 6, 8 or 10 feet merely increases the number of turns in the primary proportional to that length. The closed secondary composed of the pipe 11 becomes proportionately longer and thus the result obtained is approximately the same in maximum operating temperature throughout the length of pipe 11. Standard lengths of PVC conduit are 10 feet. Heaters 4 and 6 feet long have been found satisfactory for softening the conduit to fit most installations. However, a 10 foot long heater could soften the entire length for installations where numerous bends are required.

In further contrast to the conventional resistance type conduit heater, which draws several thousand watts the heater according to this invention only draws from 1,000 to 2,000.

The housing 1 protects the coils, thermostat and electrical connections from mechanical damage, protects the electrical components from shorts due to rain, mud, etc., provides insulation against heat losses, and protects the operator from injury due to electrical shocks and burns from high temperatures.

Mode of Operation of the Invention

In operation the portable unit is carried to the point where the electrician will be installing conduit, laid on the ground, floor or bench, and connected to a source of AC electrical power. Within a 15 minute to two hour period according to the size of the unit the induction heater will have reached a satisfactory operating temperature. This varies with the size of the heater. All of the heat is concentrated in the walls of pipe 11. Normal operating temperature within the heater is about 260° F. However, the PVC conduit will soften sufficiently for forming at 205° F.

In using the portable heater of this invention the electrician merely marks the portion of PVC to be formed, slides the conduit into an open end of the heater so that the marked portion is within the heater, leaves it in the heater for up to ten minutes, removes it at which time it may be easily bent by hand. Within a few minutes after bending the PVC will cool off and again become rigid, but in the desired shape. When raised to forming temperature in a heater set at a temperature of between 200° and 260° F the PVC conduit will not collapse or crack upon bending. As indicated in the drawing FIG. 8, a long length may be easily softened in the portable unit even in inclement weather and laid directly into a ditch naturally conforming to the curve of the ditch. Likewise bends and offsets can be readily formed for installation of conduit on and within the walls and floors of a building.

I claim:

1. A portable weatherproof heating unit for softening rigid plastic tubing comprising:
7 a. a hollow electrical induction heater having both ends open, and including induction heater coil means,
b. a rigid housing surrounding said hollow induction heater in spaced relationship therewith including an opening at each end concentric to said hollow induction heater,
c. means to support said hollow induction heater within said surrounding housing,
d. means to allow linear and diametrical expansion of said hollow heater within said supporting means,
e. an electrical appliance input, connection,
f. means to electrically connect the ends of the heater coil to the electrical appliance input connection, and
g. means to attach said appliance input connection to said housing.
2. A portable weatherproof heating unit as claimed in claim 1 wherein said support for said induction heater comprises a removable end cap of said housing.
3. A portable weatherproof heating unit as claimed in claim 1 wherein said hollow electrical induction heater comprises:
a. a length of steel pipe,
b. a high temperature resistant electrical insulation covering on the outside of said pipe,
c. a continuous single layer coil of electrically conducting wire wound with adjacent turns in spaced relationship throughout a major portion of the length of said pipe, and
d. a second layer of high temperature resistant electrical insulation covering said wire coil.
4. A portable weatherproof heating unit as claimed in claim 3 which also comprises a thermostatic control switch in contact with said steel pipe and connected in series with said coil, said thermostatic switch having normally closed contacts allowing energizing of the said coil when the pipe is cold and said thermostatic switch opening at a control temperature so that when the temperature of the pipe reaches the control temperature the switch will open to deenergize the heater coil.
5. A portable weatherproof heating unit as claimed in claim 1 in which the hollow induction heater is shorter than the housing and each end of the hollow induction heater is inset from the adjacent end of the housing so that the housing ends serve to protect the user of the heating unit from accidental contact with the heater.