United States Patent

Harris

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[54] **SPACE HEATING APPARATUS**

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[30] **Foreign Application Priority Data**

March 6, 1969 Great Britain..........12,054/69

[52] **U.S. Cl.**..................................**219/213,** 219/345

[51] **Int. Cl.**..**H05b 1/00**

[58] **Field of Search**............219/213, 345, 528, 529, 543–545; 165/49; 25/41 J

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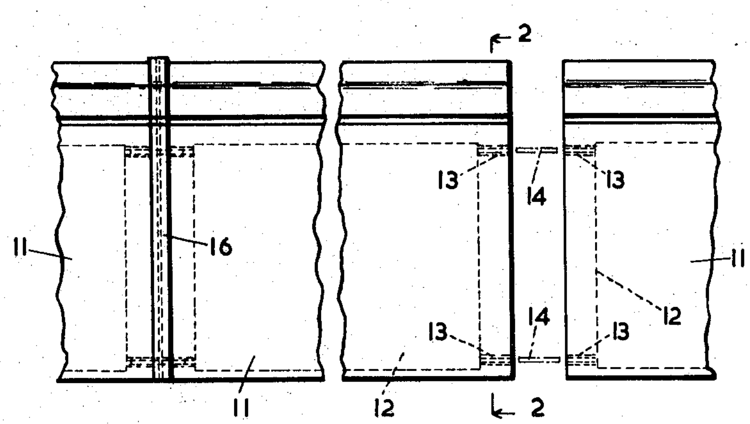
[57] **ABSTRACT**

An electrical space heating unit having an electrically conductive sheet resistance with circuit leads for connection to a source current supply, the whole being encapsulated in a mass of electrically insulating refractory material containing a synthetic resin.

20 Claims, 10 Drawing Figures



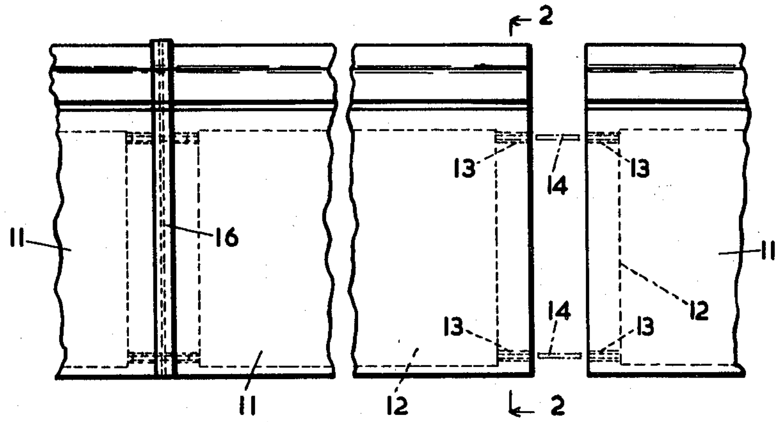

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FIG. 1.

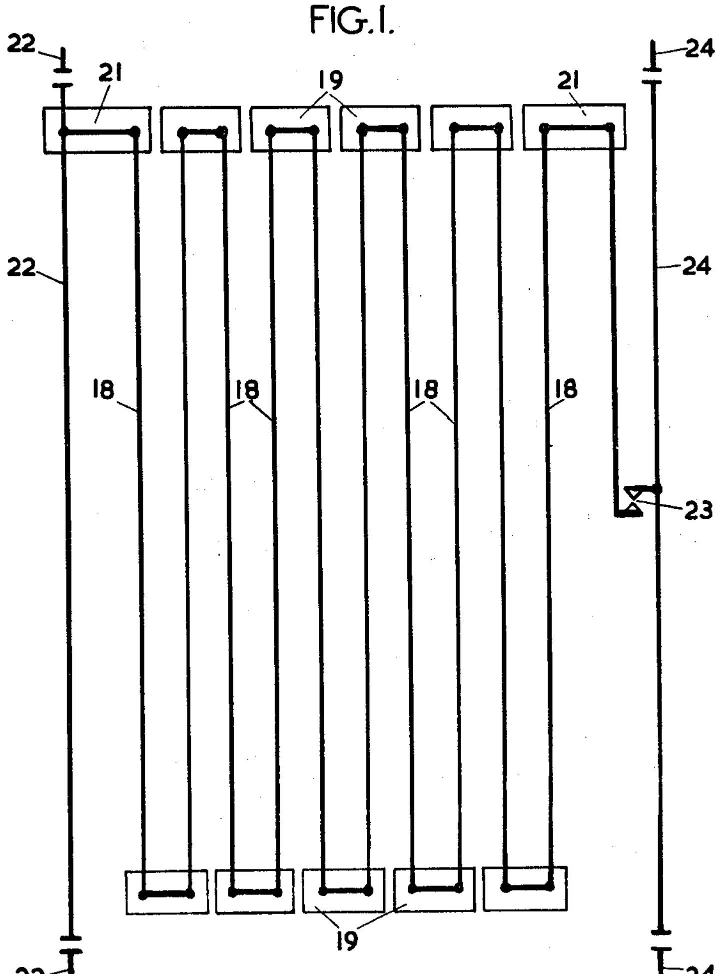
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FIG. 4.

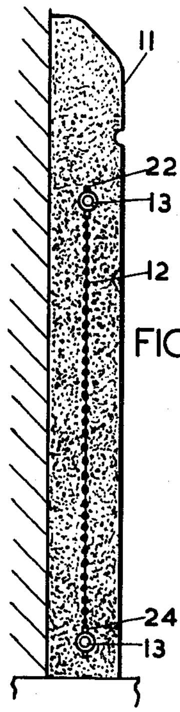

FIG. 2.

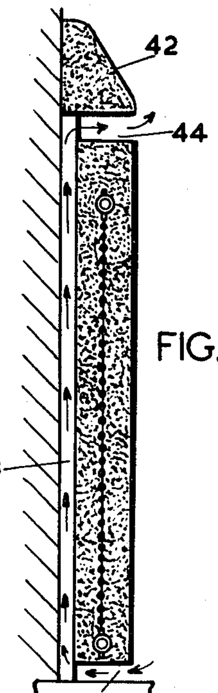

FIG. 10.

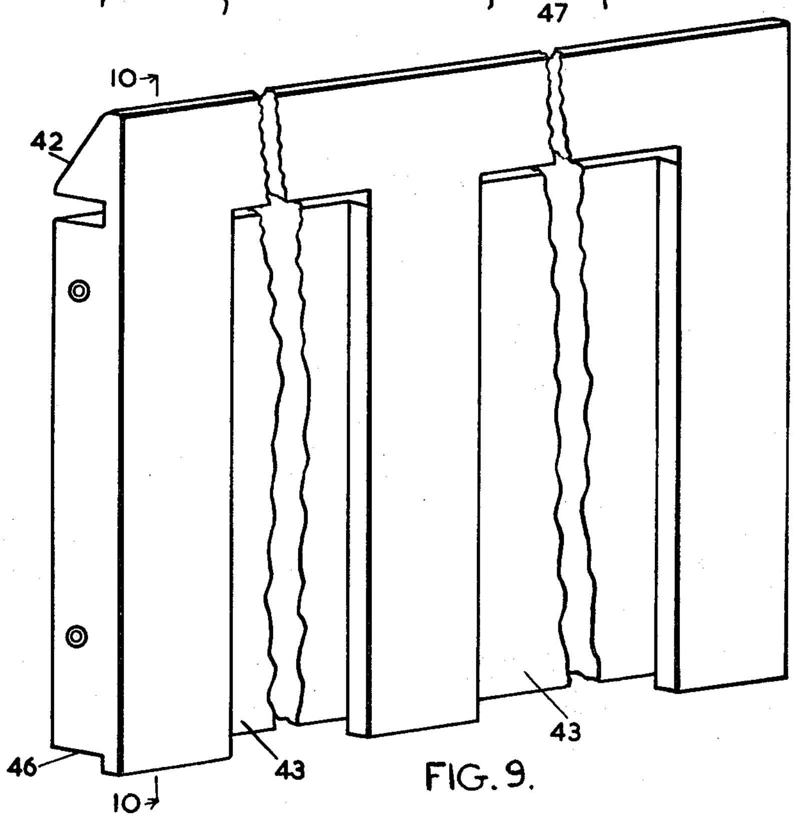

FIG. 9.

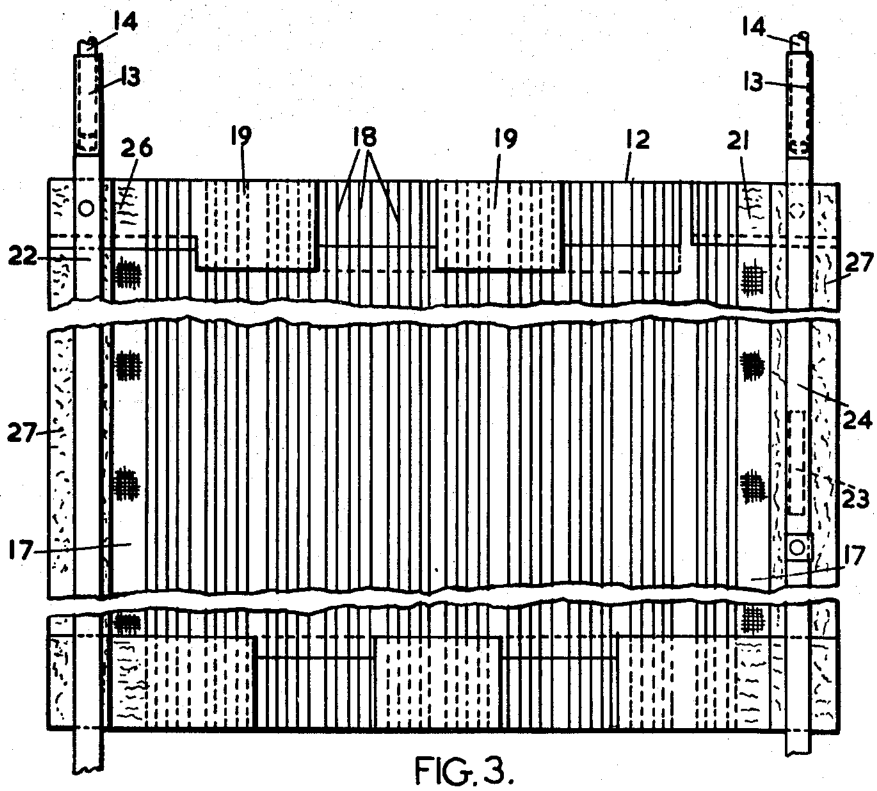
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FIG. 3.

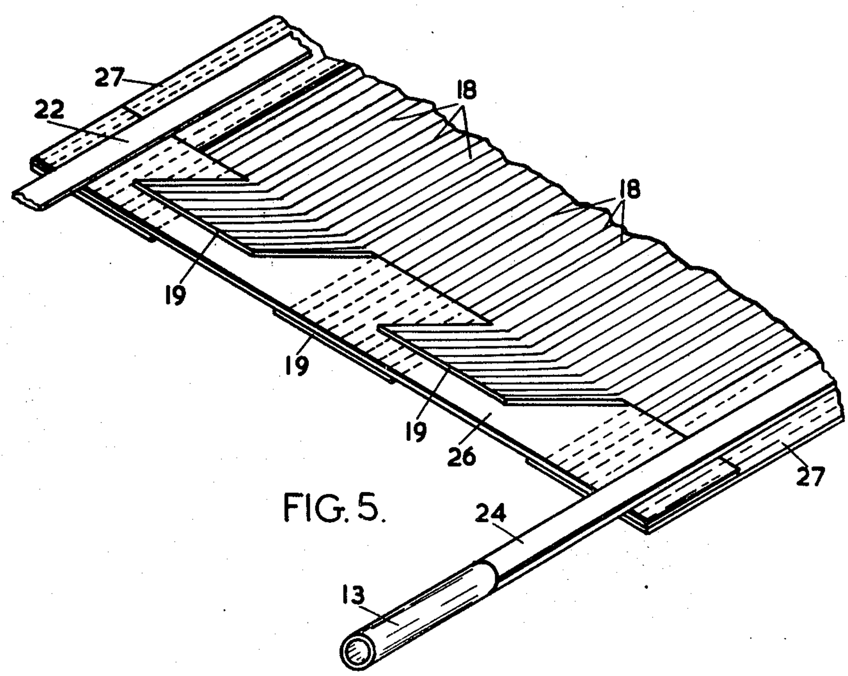
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FIG. 5.

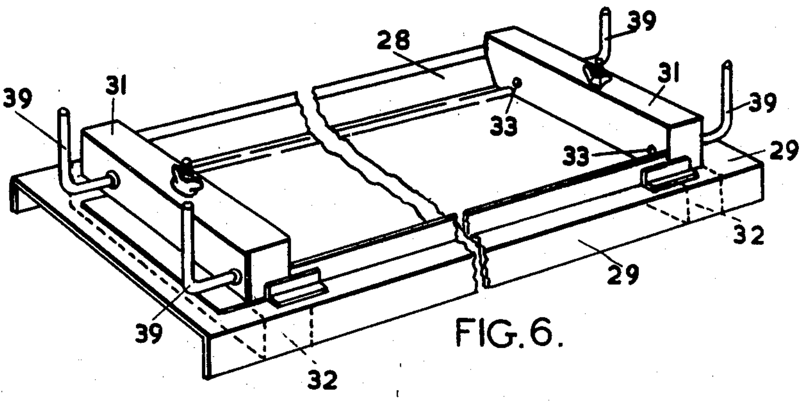

FIG. 6.

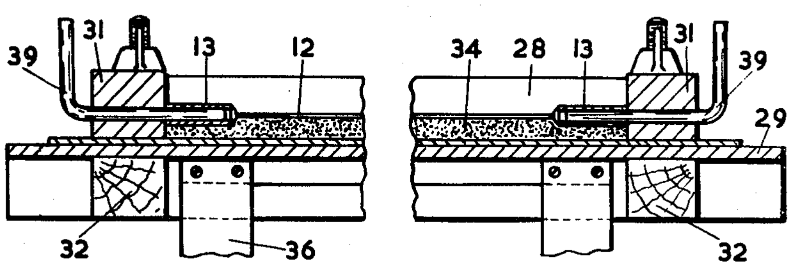

FIG. 7.

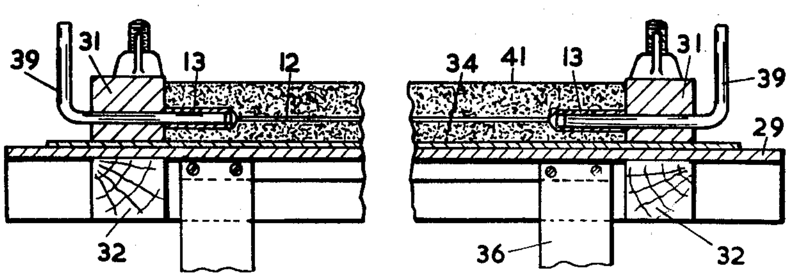

FIG. 8.

SPACE HEATING APPARATUS

This invention relates to electrical space heaters of the storage type, i.e., capable of storing heat absorbed during "off-peak" periods and giving up such heat during the periods when the current is switched off. The invention is particularly though not exclusively concerned with space heaters of the above type intended for location along the lower parts of the walls of a room normally occupied by skirting boards.

According to the present invention, an electrical space heating unit comprises at least one electrically conductive sheet resistance provided with circuit leads for connection to a source of current supply, and a mass of electrically insulating refractory material enveloping the resistance, said refractory material containing a synthetic resin.

The synthetic resin, e.g., a polyester, polyurethane or epoxy resin, should have a high "heat distortion point", i.e., sufficiently high to resist the working temperature of the elements plus a safety margin. It has been found that refractory mixtures containing polyester, polyurethane or epoxy resin mixtures are very satisfactory as heat storage materials. It is preferred to use material having a density of at least 150 lbs./cu.ft. and a specific heat of at least 0.2.

A refractory material having the desired qualities may be obtained by first treating a polyester resin with an amount, e.g., 20 percent by weight, or a mixture in equal proportions of autimony oxide and a bromine mixture to give fire-retarding qualities. Alternatively, the additive may be a mixture in equal proportions of clorentic acid and chlorinated paraffin. To this is then added an amount, e.g., up to 86 percent or more by weight of the refractory material, of an aggregate of calcium silicoaluminate and an amount, say 2 to 5 percent by weight of aluminous cement to reduce to a minimum any moisture in the basic material. The aggregate preferably contains approximately 40 percent of alumina. Such a mixture may have a heat distortion point as high as 280° to 300° F.

The invention includes a method of forming a heating unit, comprising preparing a mould with an internal shape appropriate to the desired external shape of the finished unit, forming a mastic layer of electrically insulating refractory material containing a synthetic resin in the lower portion of the mould, placing an electrically conductive sheet resistance on the surface of the layer with its circuit leads supported at a predetermined distance from the inner surface of the base of the mould and at a predetermined distance apart, adding a further quantity of said material sufficient to encapsulate said resistance, and allowing the whole mass of the material to cure. Preferably, the mould is vibrated during the formation of the layer and also during the addition of the further quantity of the material. The circuit leads of the sheet resistance conveniently terminate in sockets to be embedded in the end faces of the unit. To facilitate removal of the moulded unit, the inner surface of the mould is first coated with a release material such as a non silicone wax or a polyvinyl alcohol solution.

To promote the curing action with such synthetic resins, there is added to the polyester mixture, before mixing with the aggregate, at the rate of about 14 c.c. per lb. of resin mixture, an accelerator, e.g., cobalt

naphthenate, and a catalyst, e.g., methylethyl ketone peroxide.

The unit thus formed is found to have a high heat resistance factor. It is also found to have a specific heat of up to 0.3 and a thermal conductivity of up to 12 BTU/sq.ft./hr/F./in., while its heat capacity may be as high as 40 BTU/cu.ft./°F.

When intended for use as "skirting heaters", the mould is constructed to produce a unit having an external shape similar to that of a skirting board, and to allow for series connection of a plurality of units, a pair of conductor leads connects pairs of sockets embedded (during moulding) in the end faces of the unit, the circuit leads extending from the sheet resistance being in such a case connected one to each of the conductor leads.

The units are conveniently made in various standard lengths so as to be fitted along walls of different length, a convenient main standard length being three feet.

Though many different kinds of sheet resistance may be employed, a particularly satisfactory one comprises a supporting sheet of electrically insulating material, a plurality of resistance wires secured to the support and extending length-wise thereof in laterally spaced relationship, and a series of conductor bars for connecting adjacent batches of wires in continuous alternation at opposite ends of the supporting sheet so as to provide a continuous multi-wire circuit extending in series from end to end of the supporting sheet and terminating in the circuit leads mentioned above.

The electrically insulating material forming the supporting sheet may be in the form of a fiber glass mat, i.e., a sheet formed from glass fibers matted or felted together and preferably reinforced by a "scrim", i.e., continuous glass filaments randomly arranged in the felted mass. Such a sheet may be quite thin, e.g., having a thickness of only a few thousandths of an inch. Alternatively, the supporting sheet may be formed from a woven cotton or nylon fabric.

The resistance wires are preferably of steel having a resistivity of 40 ohms/ft., such wires being as fine as 0.004 inch diameter and providing an operating temperature of approximately 170° F. when connected to a mains supply of around 230 v. The wires may be attached to the supporting sheet in any convenient manner. For example, they may be attached to the mat by stitching, e.g., by means of a sewing machine with the wire in the shuttle and a terylene or other thread on the spool. Again, when the supporting sheet is in the form of a woven fabric, the wires may be "woven in" during the weaving of the fabric.

The conductor bars are conveniently formed from copper foil, e.g., having a thickness of around 0.002 inches, the foil being attached to the end portions of each batch of wires and the corresponding portion of the supporting sheet by stitching, the sheet being longitudinally slit between the batches of wires for the purpose.

Alternate conductor bars at each end of the support are insulated from each other by a strip of insulating material, e.g., matted fiber glass, the alternate bars passing on opposite faces of the insulating sheet and being attached to the sheet by adhesive or stitching. The two free ends of the multi-wire circuit conveniently terminate at the same end of the supporting sheet, and the conductor bars attached to those ends are provided with the circuit leads which terminate in sockets as mentioned above.

The use of a fiber glass mat or fabric sheet as the supporting sheet of the resistance is particularly useful in combination with the refractory material mentioned above, the mat or fabric being porous and allowing the refractory material, during the moulding process, to impregnate the mat or fabric so as to encapsulate the sheet resistance to give good thermal contact with the refractory material and to resist oxidization. The completed unit constructed in the above manner constitutes a fully insulated appliance and thus needs no "earth".

Experience has shown that, for an average room, a loading of 2 KW per 1,000 cu.ft. is sufficient to provide comfortable temperature conditions within a reasonable time, and it is found that such loading may be provided by sheet resistances formed as above in roughly 3 ft. lengths, i.e., to suit the length of the unit, and having fifty wires arranged in 10 batches of five wires each the batches being series connected, the individual wires being spaced at 1/10-inch intervals, such elements having a resistance of about 240 ohms per 3 ft. length. Sheet heating elements constructed in this manner are the subject of patent Application No. 12053/69 filed Mar. 6, 1969.

With units constructed as above secured directly to the masonry, it is found that a substantial part of the heat from the heating elements passes into the wall which thus acts, together with the refractory material in the units, as storage medium for radiating the heat, as required, during the periods during which current is switched off.

When secured to solid, i.e., non-cavity walls, however, heat is stored throughout the entire thickness of the wall and is thus radiated by the surfaces of both the inner and outer walls, which may not be generally desirable, particularly on outside walls where the heat radiated by the outer surface is lost to atmosphere.

Units may, however, be designed for use on solid walls by so shaping the mould as to produce a recess in the rear face of the unit, i.e., that to be secured to the wall, to provide an air insulation space, and to provide the surface of the recess with an anti-radiation coating, e.g., light colored paint or a covering of metal foil. It is also advantageous to provide the surface of the wall to which the unit is attached with a reflecting surface to reflect back into the refractory material any residual heat passing across the cavity formed by the recess.

The overall control of a heating system constructed in the above manner may be by thermostat in the usual way but, since the resistance of the heating elements increases with temperature, the system as a whole is to some extent self-compensating in that, as the heat exchanged from storage medium to room increases or decreases, respectively, the current consumption will increase or decrease accordingly.

With units constructed and fitted in the above manner, it is found that even temperatures may be maintained in the room during storage periods of substantial duration, extending well over the periods between "off peak" times.

Although units as described above are conducive to even temperature conditions when also using the walls of the room as storage media, such units have been found quite satisfactory when applied as skirting to walls having little or no heat storage capacity, e.g., walls formed from heat insulating material the units thus constituting self-contained storage heaters.

By way of example, the invention will now be described in greater detail with reference to the accompanying drawings, in which,

FIG. 1 is an elevation illustrating the assembly of a series of skirting heater units according to the invention,

FIG. 2 is a sectional view of a unit taken on line 2—2 in FIG. 1,

FIG. 3 is a plan view of a sheet resistance used in the unit of FIGS. 1 and 2,

FIG. 4 is a wiring diagram of the sheet resistance shown in FIG. 3,

FIG. 5 is an isometric view of one end of the sheet resistance of FIG. 3,

FIG. 6 is an isometric view of a moulding device for forming the units,

FIG. 7 is a cross-section of the device shown in FIG. 6,

FIG. 8 is a similar cross-section,

FIG. 9 is an isometric view from the rear side of a modified form of unit, and

FIG. 10 is a sectional view of the unit of FIG. 9 taken along the line 10—10 of FIG. 9.

Referring to FIGS. 1 and 2 a series of skirting heater units **11** are shown assembled against a room wall, each unit consisting of a moulded mass of refractory material prepared in the manner described above, encapsulating a sheet resistacne **12**. The resistance **12** is formed at each end with a pair of connecting sockets **13** which serve to connect adjacent units **11** together in parallel, the sockets **13** being connected by split-ended plugs **14**. Before insertion of the plugs **14** a fillet **16** of butyl rubber of T-shaped cross-section is placed between the meeting faces of each adjacent pair of units **11**, the plugs **14** then being inserted into the sockets **13** and the units drawn together. The fillets **16** serve the dual purpose of covering the joints between adjacent units and acting as an expansion joint. The end faces of the units are sealed to the adjacent faces of the fillets by a coating of neoprene or like rubber solution. The right hand side of FIG. 1 shows two units about to be connected and the left hand side shows a completed joint.

The sheet resistance **12** is constructed as best illustrated in FIGS. 3,4 and 5, a support **17** of cotton fabric having stitched along its length ten batches each of five resistance wires **18** each (the wires, e.g., as fine as 0.004 inch diameter, being shown as single lines in FIGS. 3, 5 and each batch of five wires being represented by a single line in FIG. 4, for the sake of clarity), the wires being laterally spaced from each other. Conductor bars **19** serve to connect adjacent batches of wires **18** in continuous alternation at opposite ends of the support **17** so as to provide a continuous multi-wire circuit in series from end to end of the sheet **17**, the ends of the circuit terminating at the same end of the support **17** in circuit leads **21**, one of which is directly connected to a conductor lead **22** and the other via an overload thermostatic switch **23** to another conductor lead **24**, the conductor lead **23** and **24** serving to connect the series of units to a source of current supply. Alternate conductor bars **19** are insulated from each other by an undulating strip **26** of insulating material in the form of matted fiber glass, the alternate bars **19** passing on opposite faces of the strip **26** and being attached thereto by the wire-stitching operation. The conductor leads **22** and **24** conveniently pass adjacent opposite edges of the support **17** and are similarly insulated therefrom by strips **27** of matted fiber glass. The leads **22** and **24** and strips **27** are shown in FIG. **3** somewhat exaggerated in lateral position for the sake of clarity.

The units **11** are each moulded by means of the device shown in FIGS. **6** to **8** and the method will now be described with reference to those figures.

A mould **28** having an internal shape appropriate to that of a skirting board is secured by welding to a support **29** of inverted channel section. End walls **31** for determining the length of the unit **11** are clamped to the support **29** through stiffening blocks **32**, the base of the mould **28** passing between the walls **31** and the blocks **32** so as to enable locating holes **33** for determining the position in the unit **11** of the sockets **13** of the resistance **12** to be accurately determined.

After preparing the mould **28** with a coating of release material, an appropriate quantity of the refractory material is mixed in the manner d described above and while the mixture has a mastic consistency of cement mortar a layer **34** of about half the thickness of the unit **11** is formed in the base of the mould **28**. The moulding device as a whole is then place on an electro magnetic vibrator **36**, of known construction, which causes the mixture to consolidate in the mould leaving a substantially smooth upper surface.

A sheet resistance **12** is then placed on the upper surface of the mixture and is located in position by pins **39** passing through the locating holes **33** and into the bores of the sockets **13**. A further layer **41** of the mixture is then laid on top of the sheet resistance **12** to fill the mould **28** and the device is again placed on the vibrator **36** to consolidate the complete unit **11**. The mixture is then allowed to cure after which the completed unit **11** is removed from the mould. Though the curing time varies according to the relative quantities of the ingredients forming the mixture, it is found that, after about fifteen minutes, the unit is sufficiently cured for removal from the mould **28** to a storage place where complete curing takes place.

A modified form of unit having provision for convection is shown in FIGS. **9** and **10**, the unit **42** having essentially the same moulded construction as before. Thus, recesses **43** are formed in the rear face of the unit **42** and break laterally into a longitudinal channel **44** formed towards the top of the unit. A step **46**, forming with the floor a further channel **47** similar to the channel **44**, is formed on the lower face of the unit **42**, the recesses **43** and channels **44** and **47** forming convection passages for the flow of air as indicated by arrows in FIG. **10**.

I claim:

1. An electrical space heating unit of the storage type comprising at least one electrically conductive sheet resistance provided with circuit leads for connection to a source of current supply, and a rigid cast monolithic mass of electrically insulating refractory material enveloping the resistance, said refractory material containing a synthetic resin, said synthetic resin including a fire-retarding agent and an aggregate of calcium silicoaluminate.

2. A heating unit as in claim **1**, wherein the synthetic resin is selected from the group consisting of a polyester, polyurethane and epoxy resin.

3. An electrical space heating unit of the storage type comprising at least one electrically conductive sheet resistance provided with circuit leads for connection to a source of current supply, and a rigid cast monolithic mass of electrically insulating refractory material enveloping the resistance, said refractory material containing a synthetic resin, said refractory material being obtained by first treating a synthetic resin with a fire-retarding agent and then mixing the treated resin with an aggregate of calcium silicoaluminate, said aggregate including an aluminous cement.

4. An electrical space heating unit of the storage type comprising at least one electrically conductive sheet resistance provided with circuit leads for connection to a source of current supply, and a rigid cast monolithic mass of electrically insulating refractory material enveloping the resistance, said refractory material containing a synthetic resin, said refractory material being obtained by first treating a synthetic resin with a fire-retarding agent and then mixing the treated resin with an aggregate of calcium silicoaluminate, said fire-retarding agent being a mixture in equal proportions of antimony oxide and a bromine mixture.

5. A heating unit as in claim **4**, wherein the amount of mixture of antimony oxide and bromine is at least 20 percent by weight of the synthetic resin.

6. An electrical space heating unit of the storage type comprising at least one electrically conductive sheet resistance provided with circuit leads for connection to a source of current supply, and a rigid cast monolithic mass of electrically insulating refractory material enveloping the resistance, said refractory material containing a synthetic resin, said refractory material being obtained by first treating a synthetic resin with a fire-retarding agent and then mixing the treated resin with an aggregate of calcium silicoaluminate, the amount of the aggregate being at least 70 percent by weight of the refractory material.

7. A heating unit as in claim **6**, wherein the amount of aluminous cement is at least 2 percent by weight of the calcium silicoaluminate.

8. An electrical space heating unit of the storage type comprising at least one electrically conductive sheet resistance provided with circuit leads for connection to a source of current supply, and a rigid cast monolithic mass of electrically insulating refractory material enveloping the resistance, said refractory material containing a synthetic resin, said refractory material being obtained by first treating a synthetic resin with a fire-retarding agent and then mixing the treated resin with an aggregate of calcium silicoaluminate, an accelerating agent and a catalyst being added to the treated resin, said accelerating agent being cobalt napthenate.

9. An electrical space heating unit of the storage type comprising at least one electrically conductive sheet resistance provided with circuit leads for connection to a source of current supply, and a rigid cast monolithic mass of electrically insulating refractory material enveloping the resistance, said refractory material con-

taining a synthetic resin, said refractory material being obtained by first treating a synthetic resin with a fire-retarding agent and then mixing the treated resin with an aggregate of calcium silicoaluminate, an accelerating agent and a catalyst being added to the treated resin, said catalyst being methyl ethyl ketone peroxide.

10. A heating unit as in claim **1**, wherein the sheet resistance comprises a supporting sheet, a plurality of resistance wires secured to the supporting sheet and extending lengthwise thereof in laterally spaced relationship, and a series of conductor bars for connecting adjacent batches of wires in continuous alternation at opposite ends of the supporting sheet so as to provide a continuous multiwire circuit extending in series from end to end of the supporting sheet and terminating in the circuit leads.

11. A heating unit as in claim **10**, wherein the supporting sheet is constituted by a fiber glass mat.

12. A heating unit as in claim **10**, wherein the supporting sheet is constituted by a textile fabric.

13. A heating unit as in claim **10**, wherein the resistance wires are of steel having a resistivity of 40 ohms/ft.

14. A heating unit as in claim **10**, wherein the resistance wires are attached to the supporting sheet by stitching.

15. A heating unit as in claim **14**, wherein the stitching operation is performed by a sewing machine with the wire in the shuttle and a synthetic thread on the spool.

16. A heating unit as in claim **14**, wherein the conductor bars are formed from copper foil, the foil being attached to the end portions of each batch of wires and the corresponding portion of the supporting sheet by the stitching action, the sheet being longitudinally slit between the batches of wires for the purpose.

17. A heating unit as in claim **16**, wherein alternate conductor bars at each end of the support are insulated from each other by a strip of insulating material, the alternate bars passing on to opposite faces of the insulating sheet.

18. A heating unit as in claim **17**, wherein the conductor bars are provided with circuit leads which terminate in sockets embedded in the refractory material.

19. A method of forming a space heating unit, said method comprising treating a synthetic resin with a fire-retarding agent and then mixing the treated resin with an aggregate of calcium silicoaluminate, forming a mastic layer of electrically insulating refractory material containing said synthetic resin in the lower portion of a mould, placing an electrically conductive sheet resistance on the surface of the layer with its circuit leads supported at a predetermined distance from the inner surface of the base of the mould and at a predetermined distance apart, adding a further quantity of said material at least sufficient to encapsulate said resistance, and allowing the whole mass of the material to cure.

20. A method as in claim **19**, wherein the mould is vibrated during the formation of the layer and also during the addition of the further quantity of the material.

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